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Celebrating the Space Age

50 Years of Space Technology, 40 Years of the Outer Space Treaty

Conference Report
2-3 April 2007

UNITED NATIONS

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The United Nations Institute for Disarmament Research (UNIDIR)—an intergovernmental organization within the United Nations—conducts research on disarmament and security. UNIDIR is based in Geneva, Switzerland, the centre for bilateral and multilateral disarmament and non-proliferation negotiations, and home of the Conference on Disarmament. The Institute explores current issues pertaining to the variety of existing and future armaments, as well as global diplomacy and local tensions and conflicts. Working with researchers, diplomats, government officials, NGOs and other institutions since 1980, UNIDIR acts as a bridge between the research community and governments. UNIDIR's activities are funded by contributions from governments and donor foundations. The Institute's web site can be found at:

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FOREWORD

"Celebrating the Space Age: 50 Years of Space Technology, 40 Years of the Outer Space Treaty" was the sixth conference held by the United Nations Institute for Disarmament Research (UNIDIR) on the issue of space security, the peaceful uses of outer space and the prevention of an arms race in outer space.

Participants at the conference reflected on the anniversaries celebrated in 2007—the launch of Sputnik I in 1957 and the entry into force of the Outer Space Treaty in 1967—and how the Space Age has shaped, and continues to shape, the world of today. The necessity of making human use of outer space sustainable was a common theme, underlined by discussions of the challenges and threats faced by all states in this regard. Various understandings of and approaches to space security were put forward, as well as concrete proposals on how to guarantee that outer space is preserved as an environment to be used peacefully by humankind, for the good of humankind.

A fiftieth anniversary is known as a golden anniversary and a fortieth is known as a ruby. We refer often to stars in the myriad of galaxies as the jewels of the heavens. Outer space is most certainly a wealth of enormous potential—almost the entire world depends on communications via satellite, the poorest of people now have their local and regional economies empowered by wireless technology, farmers in developing and developed countries alike check weather conditions and market prices daily on-line, and health care and education reaches people in remote locations who otherwise would be unreachable. Space debris from accidental or deliberate collisions and the weaponization of space would halt all such important developments.

UNIDIR is grateful to all of our colleagues from academia and the United Nations for coming to Geneva every year to give their time and expertise. We are also grateful for the financial, political and material support of the Governments of Canada, the People's Republic of China and the Russian Federation, as well as of the Secure World Foundation and The Simons Foundation, that makes these conferences and publications possible.

Patricia Lewis, Director
UNIDIR

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UNIDIR would like to express its gratitude to the Governments of Canada, the People's Republic of China and the Russian Federation, as well as to the Secure World Foundation and The Simons Foundation, for their financial, political and material support of this conference.

In particular, UNIDIR would like to thank Ambassador Paul Meyer, Eric Walsh and Gillian Frost of the Permanent Mission of Canada in Geneva; Douglas Aldworth from Foreign Affairs and International Trade of Canada; Ambassador Cheng Jingye, Li Yang and Zhao Li of the Permanent Mission of China in Geneva; and Ambassador Valery Loshchinin, Anton Vasiliev, Valery Semin and Alexey Petrenko of the Permanent Mission of the Russian Federation in Geneva. We are also indebted to Cynda Collins Arsenault of the Secure World Foundation and particularly to Jennifer Allen Simons of The Simons Foundation for her unswerving support for this series of conferences.

Special thanks are due to Arjun Dutta for compiling the conference report with the assistance of William Assanvo. Jason Powers edited this publication and Anita Blétry, Nicolas Gérard and Kerstin Vignard followed it through the production phase.

The opinions expressed in the papers are those of the authors and the authors alone.

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OPENING REMARKS

Sergei Ordzhonikidze

It is indeed a pleasure to welcome you all to the Palais des Nations. I am grateful for the opportunity to continue our good tradition of coming together for this annual conference. Allow me first of all to congratulate the United Nations Institute for Disarmament Research for establishing this highly valuable forum for discussion of space security issues.

This year, the debates will centre on two anniversaries—the fiftieth anniversary of the advent of the space age, and the fortieth anniversary of the Outer Space Treaty.

Since the Soviet Union successfully launched Sputnik I—the world's first Earth-orbiting artificial satellite—on 4 October 1957, hundreds of satellites and other space objects, including probes, shuttles and space stations, have been put into orbit. As we can clearly see in our daily lives, peaceful cooperation in outer space has—over the past fifty years—given an unprecedented boost to the development of revolutionary new technologies that benefit all countries. As the title of this seminar suggests, there is much reason to celebrate the space age.

As space technologies have entered our lives, we have become increasingly dependent on them. And with this collective dependence has come a growing sense of shared vulnerability. Indeed, any interruption of the use of outer space could significantly disrupt our day-to-day activities. After a half-century of growth, the number of space objects has increased exponentially, and the space environment has grown more unstable. These developments only add to the feeling of vulnerability.

Yet, nothing is more alarming than the prospect of a military conflict in outer space. For the past four decades, the 1967 Outer Space Treaty has been the cornerstone of international space law. The treaty was—at the time when it was concluded—a great historic achievement, and it still is. The strategic—and at the same time, noble and peaceful—idea behind the Outer Space Treaty of 1967 was to prevent the extension of an arms race into outer space.

Initially, the world was given some hope for the full demilitarization of outer space. Later, it came to be only partial demilitarization. Now, we are again witnessing a militarization of outer space. The very principle of the peaceful use of outer space—a cornerstone of strategic stability—is in question, especially given the scrapping of the Anti-Ballistic Missile Treaty and plans to develop new outer space weapons. In this respect, developments in outer space are a reflection of the political and military situation here on Earth. Yet, militarization of outer space undermines the strategic stability of all countries.

The Outer Space Treaty prohibits only the deployment of weapons of mass destruction in outer space. It does not deal with conventional weapons. It bans military activities on the Moon and other celestial bodies, but is silent about such activities in outer space. These gaps—combined with major scientific innovation since the completion of the treaty—raise serious questions as to whether the current international legal framework is robust enough to prevent outer space from becoming an arena for military competition.

As Secretary-General of the Conference on Disarmament, I hope that this unique disarmament negotiating body will not only discuss—but also make progress on—the issue of the prevention of an arms race in outer space—known as PAROS in the disarmament community. As most of you will be aware, the Conference concluded the first part of its 2007 session only last week, at the end of March. This event is thus an occasion to review and evaluate the work of the Conference on Disarmament concerning PAROS during this first part. If the present proposal by the Six Presidents—the "P6 proposal"—is adopted, the Conference will be able to move ahead, also in the critical area of PAROS. Following the discussions on Friday, the Conference is set to have a Special Session in April 2007. I hope that the Conference will adopt the proposal, which would allow it to become—again—a main organ for peace and security.

During the recent high-level segment of the Conference, several speakers referred to the importance of moving ahead on the issue of PAROS. I believe that Members of the Conference have managed to deepen their understanding of the status of space security, the existing legal regime and the proposed treaty prohibiting placement of weapons in outer space through the in-depth discussions held over the past two months.

Nevertheless, the discussions have also highlighted that considerable differences remain in the views of the Members regarding the current legal regime and the approach to space security. More importantly, I observed a degree of mutual suspicion and a lack of trust among the Members. It is therefore critical for the Members of the Conference on Disarmament to build trust and confidence to allay these concerns and dispel any suspicions. Confidence building and consultations are indeed prerequisites for finding a universal approach to space security—indeed to any matter of security—and for reaching consensus on negotiating a new international treaty.

One of the most effective ways to build trust and confidence is to enter into international partnerships in space exploration and expand the scope of international cooperation in outer space. It is therefore a positive development that space exploration today has become in many respects a truly international enterprise. Who could have predicted in 1957, for example, that Americans and Russians, along with nationals from many different countries, would actually be living and working together on the International Space Station? In this way, outer space has been an example of peaceful globalization. I hope it will stay that way.

As civilian and military activities in outer space are becoming less distinct, our engagement with the Committee on the Peaceful Uses of Outer Space becomes increasingly important. So, in this regard, I will welcome the inclusion in this conference of the perspectives of this Committee.

In view of recent developments, today's conference is most timely. It provides a welcome opportunity to analyse the current situation of space security, take stock of the Outer Space Treaty and other relevant instruments, and examine the need for any additional measures to ensure the peaceful use of outer space.

I have no doubt that you will have many constructive—and forthright, I hope—exchanges over the next two days, and that you will help advance our collective efforts toward greater space security.

I wish you all the best in your discussions.

CONFERENCE REPORT

INTRODUCTION

"Celebrating the Space Age: 50 Years of Space Technology, 40 Years of the Outer Space Treaty" is the latest in a series of annual conferences held by the United Nations Institute for Disarmament Research (UNIDIR) on the issue of space security, the peaceful uses of outer space and the prevention of an arms race in outer space (PAROS).

The purpose of this conference series is, in line with UNIDIR's mandate, to promote informed participation by all states in disarmament efforts and to assist delegations to the Conference on Disarmament (CD) to prepare for possible substantive discussions under agenda item 3, PAROS. Since beginning in 2002, these conferences have received the financial and material support of a number of Member States, showing the broad political support for these discussions.

This year's conference focused on three main issue areas:

- a historical overview of outer space diplomacy and possible future developments, including the Outer Space Treaty (OST) and PAROS within the CD;
- the status of and challenges to space security, including a discussion of approaches on how to improve space security; and
- the creation of an environment promoting space security through creative thinking and confidence-building measures.

The conference convened in Geneva on 2–3 April 2007, organized by UNIDIR, with the financial and material support of the Governments of Canada, the People's Republic of China and the Russian Federation, and of the Secure World Foundation and The Simons Foundation. Representatives from UN Member States and Observers, from non-governmental organizations (NGOs) and civil society, as well as speakers from Canada, China, the Czech Republic, France, India, Russia, Sri Lanka, the United

Kingdom and the United States, brought the total number of conference participants to over 100.

Opening remarks were delivered by Sergei Ordzhonikidze, Director-General, United Nations Office at Geneva and Patricia Lewis, Director, UNIDIR.

The following is a summary report of the conference. The keynote speakers are identified along with summaries of their presentations. The Chatham House Rule applied in the ensuing discussions.

Session I
Sputnik, the Outer Space Treaty, Today: 1957, 1967, 2007

Sputnik and Russia's outer space activities

Vladimir Putkov, Russian Space Agency

Activities in outer space are now part of everyday life. Space flight has contributed a number of extremely complex challenges to science and technology and thus has developed many new research methods. Russia was the pioneer in space exploration: on 4 October 1957 it was the first country in the world to place an artificial satellite into orbit—Sputnik I. The names of Konstantin E. Tsiolkovsky (founding father of theoretical astronautics), Sergey P. Korolev (chief designer of the first space launch vehicles) and Yury A. Gagarin (the first man in outer space on 12 April 1961) are known the world over.

Beginning with a research programme of the upper atmospheric layers and outer space in the early 1960s, which included the first docking of spaceships of the two leading space nations, the Soviet Union and the United States in 1975, and continuing today with international crews aboard the international space station being commonplace, Russia remains one of the leading space nations.

Russia's continued expertise has been made possible through the effective development and utilization of its space potential, which includes a space system complex; a technological, industrial and experimental foundation; a system of specialist training; and branches of science and technology that ensure and support further exploration of outer space.

Following the rather negative trends in Russia's "space life" during the last decade, Russia today has stabilized its activities and is pressing forward. The years 2001–2005 have been critical in charting the future course of Russian astronautics, particularly vis-à-vis the development of Russia's space potential in terms of spacecraft and improvements in the quality of the Russian orbital groups used for scientific and socio-economic purposes.

The experience in space research and in the use of outer space accumulated by the space-faring nations is a valuable heritage of the world community. It is an asset that can solve global problems of sustainable development through better use of space assets. To address these problems, Russia stands ready to play its part in implementing global projects that include a unified space system to explore the Earth's natural resources and provide global monitoring of geophysical processes; international communication, broadcasting and retransmission systems; international integrated navigational systems; a system for forecasting and counteracting asteroid and comet threats; integrated systems for delivery of payloads to outer space; a project of building and operating an international space station for civil use; and fundamental space research with Moon and planet research sub-programmes.

Today outer space means are an indispensable component for the functioning of civilization and it is with this in mind that Russia sees an urgent need to solve the problems of the prevention of an arms race in outer space. Russia has put forward a series of initiatives aimed at preventing the weaponization of outer space, including a unilateral and unconditional statement at the First Committee of the Fifty-ninth United Nations General Assembly, whereby Russia would not be the first nation to place weapons of any kind in outer space.

Russia hopes that the approval of the international legal instrument proposed by China, Russia and other countries on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects will be the next benchmark towards a lasting solution to the problem of ensuring space security. Toward this end Russia has prepared a draft treaty which it intends to table in the CD.

Russia also takes note of the efforts aimed at mitigating the threat caused by space debris and sees a potential new stage in the development of international space law to establish traffic rules and the use of space technologies in near-Earth outer space in the interest of space exploration.

For the sake of preserving civilization and its development, Russia sees an urgent need to avoid the weaponization of outer space and recognizes its own responsibility in this process.

The Outer Space Treaty—then and now

Sergey Batsanov, Director, Pugwash Conferences on Science and World Affairs, Geneva

The OST is and remains an outstanding and progressive treaty which laid the legal foundations for a wide range of activities in a new and limitless environment at a time when relatively little was known about it. The drafters of the treaty were able to foresee a number of things. The treaty addresses issues of general jurisdiction, states' responsibilities, addressing among other things issues of non-state participation in deliberations and states' responsibility in this regard. It also addresses regulation of economic activities, environmental law and liability for damage.

The OST embodies principles such as the exploration and use of outer space for the benefit and interest of all countries, and the freedom to use, explore and scientifically investigate outer space. It proclaims outer space as the province of all mankind and prohibits its appropriation by any state. The main theme of the treaty is that no country can claim monopoly over, or the right to govern, outer space.

The OST has an important security dimension but it is not solely a security treaty. The security dimension is represented by the prohibition to place in orbit or station in any other way weapons of mass destruction (WMD) and by the non-militarization of the Moon and other celestial bodies. The treaty also clearly discourages activities and experiments that could cause potentially harmful interference with the activities of other states parties. However, there is no specific reference in this regard to WMD. This may make the treaty much more relevant to the whole question of weaponization of outer space in a manner not limited to WMD. A number of principles stipulated in the treaty were later embodied in a series of follow-up understandings and also in the form of legally binding documents and a number of conventions, which is a useful process to note for future endeavours in ensuring space security.

While the OST was concluded four decades ago in a climate very different from what prevails today, the present combination of geopolitical and other factors makes states feel much less secure. While military force alone can no longer be a solution, there is a tendency, or rather a temptation, to solve these concerns in a simplistic way, which is to say through increased reliance on military force, particularly with the employment of the latest achievements in science and technology.

While there is an inherent risk of an arms race in outer space, it may perhaps not be correct to only refer to an arms race *in* outer space since warfare on the ground is increasingly connected to security in outer space. It is perhaps advisable to think about these issues in a more interconnected way and talk about the prevention of an arms race *in relation to* outer space.

Outer space has become indispensable in many aspects of daily life and any damage to space assets will deal a heavy blow to humankind. While space assets do act as a force multiplier for military forces, they are however very vulnerable and can become easy targets for less-sophisticated, but nevertheless powerful, countermeasures. The other risk is that these countermeasures will not discriminate between friend or foe or neutral countries. There might also be no discrimination between military and civilian space assets, leading to a highly destabilized situation overall. Furthermore, if an arms race in relation to outer space is allowed to develop, it will result in the emergence of asymmetrical capabilities that will not be a repetition of the action–reaction cycles typical of arms races of the twentieth century.

Forty years after the birth of the OST, there is an urgent need for a comprehensive reassessment of all aspects of space security. There is a need to look at issues from more than one security perspective of more than one group of countries. There are many proposals aimed at preventing a space-related arms race, including confidence-building measures, codes of conduct, transparency measures, cooperative risk reduction steps and comprehensive agreements. What should be stressed is that there is an urgent need to start the indispensable processes of general consultations and pre-negotiations, including multilateral and bilateral dialogue.

The OST can still be a part of the solution since its constructive potential has not been exhausted and a number of its basic principles can help to find correct approaches to the problems encountered.

China's space activities: present and future

Xu Yansong, Deputy Division Director, China National Space Administration

China's space activities can be best charted in three fundamental phases: its history and achievements, its future development, and satellite applications and international cooperation. China started its space activities in 1956 and launched its first satellite, the DFH-1, in April 1970, followed by the launch of its first geostationary telecommunication satellite in 1984. Over the past 50 years, China has established a comprehensive space research, design, production and testing system. It has also established a telemetry control and tracking system and has a family of over 12 launch vehicles to execute different missions, including manned missions. China's Long March series has a record of over 93 launches, with over 50 consecutive successful launches.

China has developed a comprehensive satellite system of civilian spacecraft, including meteorological satellites, recoverable satellites, scientific and remote-sensing satellites and telecommunication satellites. China has been actively involved in joint missions with France and Germany with telecommunication satellites and in remote sensing it has established, in partnership with Brazil, the China–Brazil Earth Resource Satellite (CBERS). China has also been cooperating actively with the World Meteorological Organization (WMO) vis-à-vis its meteorological satellites. China has also held joint scientific missions with the European Space Agency (ESA).

China is keen to apply space technology for peaceful purposes especially in urban areas, agriculture, in materials science and in other areas, and for future development it is focusing on space launch capacities and satellite platform capacities. China is developing a new generation of meteorological satellites and is studying the possibility of creating a constellation of satellites for disaster mitigation and monitoring. China has an active deep space exploration programme, including lunar missions. China's lunar mission is composed of a three phase programme: a lunar fly-by, a soft landing and a sample return.

China is currently building an integrated satellite application system to promote space technology and its applications in all fields. This includes remote-sensing, meteorological, telecommunication and navigational satellites among others. China is also actively involved in many bilateral cooperative agreements vis-à-vis space application technologies with countries such as Brazil, Nigeria, Russia, Venezuela and those of the European Union. Most recently China has established the Asia–Pacific Space Cooperation Organization (APSCO) with headquarters in Beijing and has become a member of the Charter on Disaster Mitigation. It is working jointly with Canada and France on building an integrated global disaster mitigation system.

Discussion

Following the presentations by the panellists, the ensuing discussion focused broadly on two issue areas:

- the role of the China National Space Administration; and
- the OST.

Referring to recent events, it was noted that the China National Space Administration is a civilian space organization that conducts activities only related to the peaceful use of outer space and that it was working very hard on the mitigation and the reduction of space debris, and that it has joined the effort of the international coordination committee on this front and is following very closely these activities, including an effort to provide guidance on the reduction of space debris.

Referring to the OST, questions were raised as to why provisions for a formal mechanism of consultation were left out of the OST, and how could Article 9 of the treaty, which requires consultations to be initiated under certain circumstances, be interpreted in that light. Furthermore, a question was raised on the adequacy of the OST in light of the experience of the last 40 years. The response from some participants was that the consultations were envisaged in certain cases and that they could be started by states parties that were either carrying out certain activities or by other states parties who believe another is carrying out such activities.

Regarding the state of the OST as a whole, it was suggested that these consultations were useful but not necessarily sufficient in the present circumstances for two reasons. Firstly, the pace of development has increased significantly and the international community would need to be more attentive individually and collectively to events and developments that may affect the status of the treaty. However, such a mechanism does not exist in the treaty as of now. Secondly, it was suggested that in principle states could not conclude treaties without the possibility of alteration and that this fact had been recognized by the authors of the treaty in the way that was fashionable at the time, through the provision of an amendment procedure. However, in the light of experience, the international community had arrived at a point of view whereby it viewed an amendment, unless it were extremely clear in advance, as a rather risky exercise since it could mean reopening a number of issues and renegotiating the OST. This would mean that states would come to the table with their own agendas. It was suggested that an amendment may be too radical and that a softer mechanism was needed to "tune" the operation of the treaty as required. This tuning is particularly important in the current situation of flux, in contrast to the status quo that had existed when the treaty was created.

Session II
Outer Space: Look Back, Look Forward

Peace in space: building on the Outer Space Treaty

Gérard Brachet, Chairman, UN Committee on the Peaceful Uses of Outer Space

The United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), created in 1959 by the General Assembly, has developed most of the legal framework for international space activities, including the Outer Space Treaty of 1967 and the Convention on Registration of Objects Launched into Outer Space of 1975. In addition to these treaties, COPUOS has also elaborated and submitted for approval to the General Assembly a number of declarations on principles which, while not having the legal strength of treaties, provide an internationally recognized reference for certain space-based activities. These declarations include the Principles Relevant to the Use of Nuclear Power Sources in Outer Space of 1992 and the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries of 1996.

In addition, COPUOS has also elaborated for approval by the General Assembly a number of resolutions which are meant to reinforce and clarify aspects of the international legal framework for space activities. These resolutions include Resolution 1721 (XVI) B of December 1981 on the registration of satellite launches and Resolution 59/115 of 10 December 2004 on the notion of "launching state".

More recently, COPUOS has focused on the development of a consensus-based "rules of the road" approach aimed at minimizing the production of space debris and the risk of collisions in outer space. The adoption of the Space Debris Mitigation Guidelines in February 2007 by the Scientific and Technical Subcommittee of COPUOS is an important step in this direction. It is interesting to note that one of the space debris mitigation guidelines explicitly indicates that states should avoid intentional destruction of space objects and other harmful activities.

While there is no consensus within COPUOS to reopen the OST nor to develop new international conventions, there is however a shared feeling that bottom-up, technically-based guidelines and recommendations are a powerful means to develop rules-based behaviour and keep outer space as safe as possible. A possible path towards developing rules of the road for secure space operations could be through reliance on the existing operational experience of the principal actors, commercial operators and government agencies.

Current CD developments regarding PAROS

Paul Meyer, Permanent Representative of Canada to the CD and Coordinator for the PAROS Agenda Item

The 1967 Outer Space Treaty has provided the basic framework for international space law. However, the record of implementation, and new developments and technological capabilities, have demonstrated that the treaty does not offer a comprehensive solution to current and future challenges of space security and that additional measures may be required to ensure its goals. There are many avenues through which we can build on the existing space security architecture, one of which is the work of the CD.

PAROS has been on the CD agenda for sometime and during the mid-1980s to the mid-1990s had an Ad Hoc Committee devoted to the subject. However, the termination of the Ad Hoc Committee has not prevented some worthwhile discussion and proposals from being generated in the intervening years, both in formal plenary sessions and informal meetings.

In 2006, the promotion of Space Week during the CD was an important step in enabling it to resume some of its substantive work on space security. This year the CD has worked in coordinated effort to build upon the work of the previous year.

The objective of the informal meetings this year was to identify proposals relevant to PAROS that could have the potential to become multilateral agreements of the CD. The work of the CD during the informal sessions was divided along three main themes:

- consideration of the adequacy of the existing legal regime providing for security in outer space and possible means of enhancing this regime;
- transparency and confidence-building measures (TCBMs) regarding outer space activities relevant for international security; and
- elements of a treaty on the non-weaponization of outer space.

On the adequacy of the existing international legal regime there was broad support for the accords relevant to space security with the recognition that strengthening implementation and promoting universalization would lead to an overall improvement in space security. Additionally, there was an acknowledgement of some gaps in the existing space architecture that were not addressed by the existing mechanisms and would need new measures or agreements to ensure the unthreatened access to outer space for peaceful uses.

Under the theme of TCBMs, there was wide acknowledgement that these measures could make a contribution to space security and that there was scope for the CD to develop measures that would address the security/military side of our space environment and that such could help reduce threat perceptions and increase confidence among states. The ideas discussed included developing rules of conduct, a multilateral moratorium on anti-satellite (ASAT) tests, rules of the road and strengthening the implementation of existing accords such as the Hague Code of Conduct.

Under the theme of elements of a treaty on the non-weaponization of outer space, the meetings built on previous discussions in the CD regarding such. Discussions focused mainly on the Chinese–Russian draft text contained in CD/1679 of 2002 and allowed for further elaboration and clarification of key concepts such as definitions, verification and scope. It was felt that the CD would be an appropriate place to negotiate a legally binding ban on space-based weapons as part of an effort to strengthen the multilateral architecture for space security.

The CD is best positioned to play a leading role in addressing the security dimension of outer space and what is needed is for the global community to work together to ensure that we all benefit from continued access to and use of outer space by all, free from threats of attack.

Space security—perspectives of developing countries

Hewa Palihakkara, former Foreign Secretary of Sri Lanka

When referring to developing countries' perspectives on space security, two questions come to mind. Firstly, is not space security a concern for space-capable and space-faring states rather than a worry for developing nations whose economic and social mobility on Earth leaves much to be desired? Secondly, are not developing countries wasting their time and energies on such issues, when instead they should be focusing on realities such as food security, sanitation, and so forth?

The answers to both these questions must necessarily be in the negative, more so at this historical juncture when the potentialities as well as dangers emanating from our intervention in outer space, irrespective of whether they are carried out in a competitive or a cooperative manner, have become so sharply pronounced. It has been almost 25 years since the PAROS item was put on the CD agenda. This is important as the CD remains the most representative multilateral arms control and disarmament treaty-making body in the world.

The developing countries have by their consistent and persistent words, as well as deeds, striven hard to agree on treaties and other barriers against weaponizing outer space at the CD, UN, peace research forums and civil society forums. They have advocated a number of constructive ways forward on space security that include strengthening the existing legal regime, developing TCBMs and developing and implementing rules of the road.

The reason for the consistent advocacy by developing nations is two-fold. Firstly, they would like to ensure the principle of free and unimpaired access to outer space. In its broadest sense this rationale has been most succinctly encapsulated in the CD. Secondly, the developing nations are deeply concerned that they will be again called upon to carry the burden of nurturing and sustaining a non-proliferation regime.

As with terrestrial security, once outer space is weaponized, proliferation will follow. The developing countries would not want this burden on them and they therefore advocate and want to contribute to a less expensive and more equitably enforceable prevention regime to keep the last frontier environment free of weapons and debris. It is not too late to bring to fruition a multilateral process that was initiated 25 years ago to guarantee the non-weaponization of outer space.

Discussion

Following the presentations by the panellists, the ensuing discussion focused broadly on three issue areas:

- the work of the CD and COPUOS;
- developing countries' perspectives; and
- definitional issues.

Referring to the work of the CD and COPUOS, it was suggested that it was very important for the CD to have updated information of developments at COPUOS. Furthermore, it was highlighted that COPUOS did not address military and weaponization issues and that they were really a part of the CD deliberations. Related to this discussion was the reference to the possible contents for a new resolution involving TCBMs and of the role that COPUOS could play in this regard. The response was that resolutions on TCBMs go through the First Committee of the General Assembly whereas COPUOS only reports to the Fourth Committee. Furthermore, it was suggested that COPUOS has a technically based approach relying on principles and resolutions because of the resistance of many nations on modifying the existing legal regime. It was highlighted that this had its own advantages as resolutions could be replaced easily by new ones and that this helped to keep a better grasp on technological developments. Additionally, it was highlighted that although COPUOS did not address weaponization issues, it addressed all peaceful space activities, that is, non-aggressive issues which could include military and civilian use of outer space, as well as addressing the issue of secure access to outer space.

Referring to the issue of developing countries' perspectives, it was highlighted that PAROS was very important for international peace and security and that it was essential for developing countries' voices to be heard vis-à-vis any developments in outer space. It was further indicated that progress in telecommunication, remote-sensing and meteorological satellites had important social and economic implications for developing countries. Peace and stability in outer space was closely related to development and peace in developing countries.

Referring to the question of definitions, particularly of space weapons and differences between military and civilian use of outer space, it was suggested that rules of the road or codes of conduct could circumvent these problems if the focus was on behaviour rather than on definitions. It was pointed out that to try to disconnect dual-use or multi-use technologies was a considerably harder endeavour. Moreover, it was suggested that operationally based or technically based rules of the road could circumvent the problem of definitions.

Related to the above issue areas, interesting points of view were expressed on the issue of liability for damage. It was suggested that there was a place for discussion in the OST under Article 9, but that it was limited only to planned activities. It was also pointed out that it was possible to find legal grounds to claim damages if evidence could be established. Additionally, it was suggested that currently all objects tracked in the US catalogue had a known origin but that there were concerns about using information provided by only one state party, thereby making a strong case for greater international participation and cooperation in tracking space debris.

Session III
Approaches to space security

Alternative approaches for ensuring space security

James B. Armor, Jr., Director, National Security Space Office

When it comes to national security space decision-making in the United States, things are far from monolithic. Actual decision-making is similar to the consensus-building structures in place at the CD and in the European Union. Traditionally US space policy has been grouped into three sectors—civil space, commercial space operators and developers, and national security space which includes military and intelligence. However, with digital convergence and the increasing number of dual-use systems it has become difficult to draw clear lines between different sectors of space activities. Looking specifically at national security space, the United States is organized into 11 mission areas which are missile warning and defence; satellite communications; position, navigation and timing; intelligence, surveillance and reconnaissance; space control; space access; space command and control; environmental monitoring; force application; satellite operations and the industrial base.

Space capabilities have become a foundational component of the US and other space security organizations, however space capabilities have become even more important in the global economy. US President George Bush, in the recent update of US space policy, has recognized that outer space enables the US way of life and is thus of critical national interest. Space capabilities play a critical role in enabling modern warfare. Operation Desert Storm in 1991 was a benchmark in the emergence of space-enabled warfare. In today's US military, space capabilities have become seamlessly integrated into the total force.

The new US National Space Policy is very much similar to its predecessors and has great continuity with US space policy going back to the opening of the space age. It contains a fairly comprehensive approach to govern the conduct of US space activities and its principal motivation is to ensure free access to and use of outer space for all peaceful purposes. It mandates a protection of space assets commensurate with their planned use, and it more clearly and publicly articulates the long-standing US position that no new space arms control is needed beyond the OST.

There is broad consensus on which direction the international space community should take but, as in all important issues, the devil is in the details. The United States would like policies that encourage free access to and freedom of action in outer space for peaceful purposes and for all users, and would like to encourage TCBMs among all like-minded space-faring nations, specifically the sharing of data and the fostering of good housekeeping practices. The United States discourages outer space debris creation and practices likely to generate debris.

The National Security Space Office has already taken steps in trying to encourage cooperation among like-minded states and major space actors through better sharing of space situational awareness (SSA) and good housekeeping practices in space. History suggests that there is an important role for militaries in both setting the stage for the emergence of international legal regimes and then enforcing the norms of those regimes once they emerge. Regarding the desired approach, it would be more productive to work toward universal adherence to the OST and subsidiary conventions along with non-treaty TCBMs. It would be advisable to build upon commercial best practices for safe and responsible operations. It is also important to encourage shared SSA since technical approaches are far more pragmatic and more likely to bear fruit.

Putting current space militarization and weaponization dynamics in perspective: an approach to space security

Kiran Nair, Indian Air Force

Military objectives and structures are extensions of the dynamics of human self-interest and in absolute terms ensure that humanity can never peacefully coexist. However, dynamics of common interest are instrumental in balancing objectives, and given that these compulsions of common interest are progressively increasing, there is reason to believe that they will enable compromises and solutions. It is within these prevailing dynamics of space militarization and weaponization that one must explore options. It is important to weigh the environmental and doctrinal factors before choosing a specific approach.

Regarding possible approaches to space security, the last five decades of no solutions show that there are no easy fixes. The allure of outer space for military advancement is increasing and will continue to do so. However, the allure of outer space for commercial gain and for civilian and commercial advancement is also increasing. The democratization of space affairs, interests and security issues is resulting in more and more stakeholders, which in turn encourages better solutions. It is imperative that we explore a middle path, a path that would enable the fulfilment of reasonable military, commercial and civil aspirations and not indiscriminately endanger the Earth and outer space. We must try to identify workable parameters of the middle path and push for realistic approaches to space security.

Space weaponization is largely an offshoot of military missions in counterspace operations and force application, and, ideally speaking, it would be positive if nations would relinquish this or were dissuaded from this type of role for outer space. However, this appears to be unrealistic at present and, again, one must explore the middle path, that is, attempt to balance reasonable military aspirations with common interest. The declared military aspirations of counterspace operations are deception, disruption, denial, degradation and destruction. Of these, destruction is the most threatening to space security and most damaging to common interests, thus it makes less and less sense. This issue could be targeted for permanent elimination. It is imperative that approaches to the non-weaponization of outer space would need to factor in changing military dynamics of the present and foreseeable future.

Fundamental ways to ensure outer space security: negotiating and concluding a legally binding international instrument

Zhang Ju'nan, Deputy Division Director, Department of Arms Control and Disarmament, Ministry of Foreign Affairs of China

Over the past half century humankind has made great achievements in its exploration and use of outer space, thus helping to advance the evolution of civilization. Outer space has become an indispensable part of human life. The twenty-first century will witness a growing number of countries participating in and benefiting from the exploration and use of outer space.

Lasting peace in outer space is closely linked with the security, development and prosperity of every nation. The security of outer space bears on that of the whole world. What effective measures we can take to safeguard the peace and security of outer space is an important and urgent question for the international community. With the growing exploration and use of outer space the international community has been haunted with the increasing possibility of weaponization of and arms racing in outer space. More and more governments, NGOs and research institutes are very much concerned with this possibility and its consequences. Facing this threat what should we do?

We can simply neglect it and avoid any action, or we can amend the existing legal instruments and attempt to resolve the problem. A third way is to establish confidence-building measures and a code of conduct to increase transparency and guide our activities in outer space. A possible fourth path is to negotiate and conclude a new legally binding international instrument so as to completely avoid the danger of weaponization of and arms racing in outer space. It goes without saying that no one can afford to bear the consequences of the first choice. Weapons and weapon systems placed in outer space will trigger an arms race threatening everything that we have achieved thus far.

Some governments insist that there is no danger of weaponization of or an arms race in outer space, and that therefore there is no need to negotiate a new legal instrument. However, history has shown that prevention is more effective and less costly than remedy. The OST and other related agreements have undoubtedly played a key role in promoting the peaceful uses of outer space. However, they all have limitations—some are targeted only at WMD and others are limited in scope to certain celestial bodies or areas. Amendments to those can hardly close the loopholes. Moreover it may create serious political, legal and technical problems by opening these treaties for discussion. So if amending the existing legal instruments is not feasible, let us turn to TCBMs. While these measures do facilitate trust and reduce conflict, thus playing an active role in disarmament and arms control, they are inherently limited as they are not legally binding. Such measures rely on voluntary implementation by governments and are thus unsatisfactory to keep outer space free from weapons. We need a legally binding international instrument.

The best choice is to conclude a new instrument through negotiation to prevent the weaponization of and an arms race in outer space. We already have a strong foundation for this approach as it enjoys extensive political support. For the past two decades, the General Assembly has adopted yearly resolutions by an overwhelming majority of votes regarding the prevention of the weaponization of outer space and has called for the negotiation and conclusion of an international legal instrument to prevent the weaponization of outer space.

The CD also has experience in negotiating and concluding such instruments. As part of the Ad Hoc Committee, in-depth discussions have been carried out on definitions, guidelines and other important issues. Document CD/1679, submitted in 2002 by China, Russia and a number of other nations, made concrete proposals for elements of a possible treaty which could serve as a blueprint for work. What we need now is political will and the resolution of all governments.

The Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects

Anton Vasiliev, Deputy Permanent Representative, Permanent Mission of the Russian Federation

In the course of recent debates, we have already reached a common understanding that all states are interested in keeping outer space from turning into an arena for military confrontation, and in guaranteeing security in outer space and the safe functioning of outer space assets. It is important that we all share this interest. The issue is how to realize this interest in practice.

Russia is open to all ideas and proposals in this respect. We do not rule out any possibility, but we believe the best way to meet these goals is to elaborate and adopt a new treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects (PPW). Such a treaty is necessary because:

- new obligations, covering the identified gaps in international law, must enjoy the same status as existing norms and rules;
- new obligations will entail inevitable limitations on national military activities and on national business, which should be regulated by domestic legislation, including liability in case of violations; and
- such obligations should be reliable factors of national security for all states.

While an additional protocol to the OST or TCBMs could address these issues, they are no substitute for a legally binding PPW. Such protocols or measures should not deviate our efforts and attention from the PPW in the CD, although reaching an agreement on TCBMs could be a relatively easy and consolidating step towards achievement of the treaty.

Using weapons placed in outer space to assure outer space security is not an option, since it will result in less, not more, security. Although Russia, the United Kingdom and the United States have made specific political statements that they are not going to place weapons in outer space, the non-weaponization of outer space should nevertheless become a legally binding norm. The PPW is not a new idea. It is based on working document CD/1679 tabled by the delegations of China and Russia with a group of co-sponsors in June 2002. The PPW would further enhance security in outer space by supplementing the non-weaponization obligation with an obligation not to use force or threat of force against outer space objects. Thus, in a sense, the PPW could be a solution to the PAROS issue. The main purpose of the PPW is to ensure that the safety and security of space assets is guaranteed; the PPW would serve the security interests of all states and contradict the interests of none.

Discussion

Following the presentations by the panellists, the ensuing discussion focused broadly on three issue areas:

- US space policy;
- SSA; and
- rules of the road.

Questions were raised as to what would be the implications of the new US space policy, which aims at ensuring freedom of US space activities. Furthermore, a clarification was sought on what kind of capabilities the United States would like to develop in order to realize the desired "freedom of action", and on the current and future focus of US space policy. The response was that since outer space had become an indispensable part of the US way of life, it was policy to ensure freedom of action in outer space. It was suggested that the space policy does not lay emphasis on denying access to others insofar as their activities do not encroach on US interests. Furthermore, it was suggested that the US space policy focus was on building SSA.

Referring to SSA, questions were raised about views on approaches to sharing it as well as on the best course of action to see this achieved. The response was that SSA was meant to start out as a cooperative effort among commercial practices that would also include governments and others. Alternatively, it was expressed that although conceptually good, SSA involved many complex factors. It was suggested that while SSA would increase information access, it would still not solve the problem of weaponization.

Referring to rules of the road, it was asked if such would constitute a new regime and if such were looked upon in preferential light. It was responded that while there is no need necessarily for a new regime, nevertheless there was support to be found for common approaches. Alternatively, it was suggested that while rules of the road present a good approach, much needed to be done in terms of refinement, which would take a long time. Related to rules of the road, it was asked whether there was need for a treaty to limit the number of satellites. The response was that while there was broad support to account for debris in outer space and to know where all space objects are, limiting the number of satellites was a new approach and had not been considered yet.

Session IV
Status and challenges to space security

The Space Security Index: changing trends in space security and the Outer Space Treaty

Jessica West, Program Associate, Project Ploughshares

The OST is commonly described as a "non-armament" treaty. That term is inaccurate as the OST does not ban all weapons in outer space, just the most frightening ones. The OST is not about the armament of space; it is about the 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". Taking its cue from the principles enshrined in the OST, which recognized "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.

The SSI reflects a shift in how we conceptualize the goals of the OST, away from a narrow focus on weapons to a broader concern for security. It is also more than a concept—it is a process. By convening researchers and internationally respected space experts to develop an annual, comprehensive assessment of the status of space security according to eight different indicators, the SSI tracks the impact of our use of outer space, the regulation of those activities and the cumulative impact on the space environment over time. In other words, the SSI allows the space community to reflect on how we are achieving the broad goals of the OST.

The changing trends captured by the SSI process indicate that the goals of the OST are more important than ever because the space environment is increasingly threatened. The increase of space actors and stakeholders, of space use and dependence, and the rapid technological advancements that have given rise to this increase, have made outer space a more precarious operating environment. Maintaining stability has become more complex as political and technological advancements have outpaced the international governance framework for outer space. In short, it has become more difficult to achieve the goals of the OST as today the space environment is more dangerous than ever. Added to this mix is the increasing geopolitical competition in civilian space programmes, the regional tensions driving the use of outer space for terrestrial military operations, the long-term military–commercial partnerships, the perils and possibilities of dual-use technologies and the international policy gap.

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 does shed light on issues and actors that must be part of any attempt to revisit laws, institutions, norms or concepts. First, any efforts to preserve and enhance space security must include the relevant actors and stakeholders: governments, militaries, scientists, industry and civil society. Second, these efforts must not be too narrow—arms control issues cannot ignore concerns of 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 technological advancement, revenues or convenience, and examining them in the broader context of space security.

Developments in ballistic missile defences

Peter Hays, Policy Analyst, Science Applications International Corporation

The interrelationship between missile defence and outer space does not get addressed as often as it should. In countries such as the United States they are often treated as conceptually and organizationally split apart. Outer space has become increasingly important to the US military, for example space assets have been used increasingly over the past 15 years to guide precision munitions. Much of the efforts of the US Department of Defense are geared towards increasing the capacity available on dedicated US satellites.

There is a lot of continuity in the US Ballistic Missile Defense (BMD) programme. The total amount of spending on it, as part of the Department of Defense budget, has remained in a very narrow band. Boost-phase-intercept BMD is one of five potential paths to the use of space weapons. While basing such weapons in outer space gives the global coverage required, there are a few problems with this approach as it offers a very limited engagement window. This raises a number of issues on how the system is going to operate, such as will there be a need to pre-delegate launch authority? Will there be human command and control in the loop to make that happen? This latter scenario could lead to missing the limited engagement window.

The main objectives of the US BMD programme are:

- to maintain and sustain an initial capability to defend the United States, its allies and deployed forces against attack;
- to close the gaps and improve the initial capability; and
- to develop options for the future.

In terms of the biggest conceptual issues there is a desire on the part of the United States and many others, especially after 11 September 2001 and the end of the Anti-Ballistic Missile Treaty, to have some kind of constantly deployed boost-phase-intercept global BMD to protect against rogue actors. However, this creates problems in terms of undermining strategic stability with China and Russia, thereby creating a highly destabilized environment. The weaponization of outer space greatly increases the likelihood of creating space debris. Even a very limited BMD system will have significant ASAT capabilities. Thus there is significant overlap of BMD and space weaponization issues, which need to be seen as interlinked issues.

“Hit-to-kill” and the threat to space assets

Jeffrey Lewis, Harvard University

Rather than focus on ASAT weapons as a whole, there should be a focus on one particular technology—hit-to-kill systems. These should be thought of as a technology in their own right because in focusing on many exotic ASAT-like technologies and space weapon programmes—that may or may not be going anywhere—we may be missing a fundamental change in the technological realities that influence the vulnerability of our satellites.

There are three arguments that one can be put forth on this issue. One is that exotic hit-to-kill technologies are now at the early stages of spreading around the world; second, that our broad focus on space weapons and ASAT technologies—many of which are unrealistic—may have distracted from the technological challenges posed by the proliferation of hit-to-kill technologies; and three, partial arms control measures such as a ban on the testing of such weapons may mitigate the most threatening aspects of this technology while avoiding some of the difficulties that have prevented us from reaching a more comprehensive agreement.

Besides China, Russia and the United States, there are other countries, such as India and Israel, who are interested in developing hit-to-kill technology. Given the widespread interest, it is important to understand that the interest in hit-to-kill may be not so much in the individual military missions as in the basic military desire to invest in an interesting and challenging technology that may be relevant in the future. Hit-to-kill has become a fundamental defence technology that many countries with advanced militaries will pursue, if only to know how to counteract the threat.

If we change the way we think about problems facing space technology and emphasize the threats they pose, rather than discuss the concepts of space weapons or ASAT weapons, the challenge becomes much clearer. There are generally two worries with ASAT weapons, one is the issue of international stability and the second is the issue that, if ASAT weapons become a normal part of the international system, it will be much harder to reach cooperative agreements on issues such as debris mitigation or space traffic management.

Partial solutions such as a ban on hit-to-kill ASAT tests would be very valuable. Even a partial agreement will initiate a process of dialogue from which we could work together to develop a more sustainable space environment, perhaps in the form of a code of conduct.

Orbital debris produced by kinetic-energy anti-satellite weapons

David Wright, Senior Scientist, Union of Concerned Scientists

The amount of debris caused by the destruction of a satellite with kinetic-energy ASAT weapons is much larger than what people assume. The reason why this issue is important is because space debris can pose a long-term threat to the future use of outer space. Due to their very high speeds in orbit, even relatively small pieces of debris can damage or destroy satellites. Since debris in high altitudes can stay in orbit for decades or longer, it accumulates with time as more is produced. As the amount grows, the risk of collisions with satellites also grows. If the amount of debris becomes sufficiently large, it can make regions of outer space unsuitable for use by satellites. Since there is currently no effective way to remove large amounts of debris from orbit, controlling its production is essential for preserving the long-term use of space.

The international community is attempting to address this issue in part by developing debris mitigation guidelines to limit the debris created during routine space activities. This includes efforts by the Inter-Agency Space Debris Coordination Committee (IADC), as well as guidelines developed by COPUOS.

However, a major potential source of orbital debris is the intentional destruction of satellites in orbit by kinetic-energy interceptors, which are intended to destroy satellites by colliding with them at high speed. While there is a general recognition that the debris created by such events is a problem for the space environment, the scale and severity of this problem appears to be largely underestimated. The destruction of one large satellite could create as much large debris as would be generated in 70 to 80 years of space activity under strict debris mitigation measures of the kind mentioned above.

The point is that preventing the production of space debris is crucial for preserving the space environment and allowing the sustainable use of outer space. That environment is uniquely suited for some important uses such as communications, Earth observation, navigation and so forth, and interfering with our ability to use outer space for these purposes is incredibly short-sighted. Moreover, attacks on satellites can have serious security implications. It is therefore crucial that the international community develop rules on the kinds of systems that can be put into outer space and the rules of the road that guide how countries operate there. As an urgent and important first step, an international agreement to ban the testing and use of destructive ASAT weapons is very important and can only be achieved through international leadership.

Discussion

Following the presentations by the panellists, the ensuing discussion focused broadly on two issues:

- missile defence; and
- ASAT development, testing and use.

Referring to the issue of missile defence, questions were raised regarding the amount of money that had been spent on the US programme and the future cost projection of such a system. The response was that the budget request for missile defence for fiscal year 2008 was around US$ 8.9 billion and that, since its inception in 1983, the sum would total around US$ 100 billion. Among the many comments on the issue of missile defence were that the United States' attempt to build missile defences in Poland and the Czech Republic were assumed by Russia to be unfriendly and that they would be viewed as a major challenge to Russian security interests as well as in the wider strategic perspective.

It was suggested that the big issues, in relation to Russia, with the basing of US missile defence architecture in Poland and the Czech Republic were, first, that there was an objective correlation between offensive and defensive weapons, and, second, while the basing of the architecture would not intrinsically threaten Russia, this could represent a first step in that direction. Moreover, the deployment could be viewed as an element in a chain of events whereby the United States was continuing its build-up of warning systems around Russia. It was suggested that, unlike the Cold War, Russia would not be dragged into an arms race and would instead look for the cheapest and most effective responses.

It was suggested that if the basing of a few interceptors in Poland could cause such a large effect on the Russian strategic deterrent, then there were probably larger issues at play. It was further suggested that the United States was trying hard to have a limited number of interceptors deployed precisely in order to minimize the strategic effects on others states.

A question was raised about the possible reasons for the failure of talks on the issue of ASAT weapons between the Soviet Union and the United States in the 1980s. It was responded that the ASAT negotiations, held between 1978 and 1979, came to no conclusions as there was no agreement even on fundamentals, that is, the scope or subjects of negotiations, and definition of what constituted a space weapon. Furthermore, it was suggested that the ASAT talks mirrored the collapse of the SALT II talks after the Soviet invasion of Afghanistan. A further impediment was that at the time adherence to the ASAT treaty was perceived by some to be unverifiable.

Still relating to the issue of ASAT weapons, and particularly with reference to debris creation and ASAT tests conducted by the Russian Federation, the United States and more recently China, a view was expressed that it was important to distinguish between the debris created by routine space activities—the kind which could be controlled by debris mitigation guidelines—and the debris created by the deliberate destruction of satellites. This distinction should be made to avoid the issue of routine debris creation being sidelined by the issue of deliberate debris creation. One suggestion was that an advantage of a partial arms control measure, such as a ban on kinetic-energy ASAT testing, is that it would be both easy to define and to verify, and would allow for a dialogue to begin without sidestepping any issues.

Session V
Confidence building measures

A Code of Conduct for Responsible Space-Faring Nations

Michael Krepon, Co-founder, the Henry L. Stimson Center

Satellites are indispensable but also happen to be very vulnerable. The responses to this dilemma have resulted in an improvement in SSA, as well as better intelligence capabilities, redundancy, terrestrial power projection, latent or residual offensive counterforce operations and hedging strategies. While the aforementioned responses share a general consensus, two other types of responses—flight testing and deployment of dedicated space weapons, and the negotiation of a new space treaty—are somewhat more problematic.

The near-term option would be to pursue a code of conduct for responsible space-faring nations. As long as we rule diplomacy out, ASAT tests and the basing of weapons in outer space will lead to greater insecurity. It has been argued that there is no need for diplomacy as there is really no arms race in outer space, that arms control is a vestige of the Cold War, that there are no agreed definitions of space weapons and, moreover, that self-defence is a right of every nation and that freedom of action must not be constrained. These arguments command no consensus within the international community. Moreover, it is important to develop rules, since without rules of the road there will be only less, not more, freedom of action. The absence of rules only makes it harder to prosecute, isolate and punish those who breach the rules.

When comparing the negotiation of a new treaty versus establishing a code of conduct, the latter emerge as less formal and quicker in outcome. Treaties take a long time and may not enter into force and more often than not involve lowest-common-denominator outcomes. This is where rules of the road come in. Establishing rules of the road can increase freedom of action overall by restricting harmful activities. Since rules of the road to prevent dangerous military activities do exist for navies, ground forces and air forces, establishing rules of the road for outer space can only contribute to international security.

Cooperative management of the space environment

Richard DalBello, Vice-President Government Affairs, Intelsat General

Given that our space environment is becoming increasingly congested there is an ever-increasing role for space environment management. Protecting high-value assets is a priority for government and commercial actors. While governments do play an important role in space traffic management, their role remains relatively small. Coordination of activities in outer space is mostly done through informal agreements that allow the routine exchange of orbital information and manoeuvre information among operators. They also rely on data provided by the US Air Force’s Commercial and Foreign Entities (CFE) pilot programme.

While this process has been working effectively there are certain shortcomings. Not all operators participate fully and government operators are inconsistent in their participation. Furthermore, no common protocols exist for exchanging information and the data provided by the CFE is not always sufficient. Government and commercial operators must improve their SSA and need to have access to more relevant and timely information.

It would make sense to have rules of the road that people understand and abide by. Having rules articulated and distributed can reduce potential confusions. There is a need for continued reinvestment in our ability to identify and predict the motion of objects in outer space—a broad sharing of space surveillance information. This is in everyone's common interest.

Study on space traffic management by the International Academy of Astronautics

Petr Lála, Member, Czech Board for Space Activities, Co-Chair of the International Academy of Astronautics Study Group

Space traffic management concerns the set of technical and regulatory provisions for promoting safe access to outer space, operations in outer space and return from outer space to Earth, free from physical or radio-frequency interference. Existing space monitoring is presently limited to the:

- US Space Surveillance Network (SSN);
- Russian Space Surveillance System (SSS);
- limited systems for monitoring space assets are operated by the ESA, India, Japan, probably also China, and by private operators Intelsat, Inmarsat, Eumetsat, and others; and
- experimental monitoring sensors (optical and radio-electronic) in France, Germany, Japan, the United Kingdom and the United States.

While the aforementioned systems are effective, there are however some problems, such as the fact that there is no systematic cooperation among different systems, there are no common standards, there is limited geographic capability and there are different sensitivities and designs associated with sensors.

Five legal treaties form the international legal regime governing the space activities of nations. They include the UN Registration Convention, and were developed by COPUOS, established in 1959 by the UN. In addition to these treaties there exist five principles and declarations on more specific issues.

With reference to the UN Register, there are a number of possible steps to improve its functioning that include space debris mitigation guidelines, collision avoidance, enforcement and checking, and delineating a distinction between valuable spacecraft and worthless space debris. It is envisioned that an international agreement to reinforce the existing regime could contain three distinct parts: one, on securing information needs; two, a notification system; and three, traffic management. It is envisioned that the provisions of these agreements initially would be monitored by COPUOS and administered by UN Office for Outer Space Affairs (UNOOSA). Subsequently, post-2020, this new agreement, together with the existing space treaties, could be superseded or replaced by a comprehensive Outer Space Convention.

The security dimensions of space traffic management

Philip J. Baines, Expert, Department of Foreign Affairs and International Trade of Canada

Space traffic management exists primarily to ensure the safety of space operations. It applies to the three phases of spaceflight to ensure safety during the launch, operations in orbit and the return to Earth.

There are a number of security challenges associated with recent dual-use space technology developments, particularly those concerned with space debris creation, whether intentional or not, close-proximity-operations-capable satellites and on-board laser communications. Obviously, there is a need to prevent the creation of space debris through mechanisms that damage or destroy artificial satellites in order to make sure that the use of outer space remains sustainable. Satellites that can orbit near another in low-Earth orbit often will not possess sufficient fuel to approach satellites in more distant orbits. However, those that do will have forms that will be indicative of this function. Likewise, apertures used for communication will be significantly different from those capable of harming another satellite at range. Thus, space-based weapons capable of damaging or destroying other space objects will likely possess functionally related observable differences that can be used to distinguish them from more benign dual-use satellites.

It is therefore possible for us to think of a ranking system for satellites, or a “harm index”, to determine whether they can cause harm to another satellite in orbit. In view of this there are certain additional declarations that we ought to consider, in addition to space traffic management systems, in order to maximize our security gains. Many declarations would focus on the amount of fuel carried onboard a satellite, to determine whether it could reach another satellite. Other declarations would be associated with how much power a satellite could radiate at another space object. Many of these additional declarations could be verified by national technical means available for satellite observation, further increasing confidence in the declared functions of artificial satellites. Additionally, space traffic management systems can provide more position and manoeuvre behaviour information to allay fears of intentional damage or destruction by ordinary dual-use satellites.

However, there are both obstacles and opportunities in this as well. The obstacles include opposition from some governments to space traffic management on security grounds. These concerns, however, can be addressed with managed-access architectures for sensitive data, the natural proliferation of space surveillance systems and through the use of satellite constellations to collect information. Many of the institutions, instruments, infrastructures, proposals and forums already exist to solidify the foundations of space traffic management.

It is important to note that assured access to outer space must preclude violence or accidents that would result in long-lived space debris. All space actors and beneficiaries should support space traffic management for its safety gains. Modest improvements in state declarations for satellites could result in significant security gains. It is possible for all interested parties to participate in space traffic management, given the low-technology means necessary to build such a system.

Discussion

Following the presentations by the panellists the ensuing discussion focused broadly on two issues:

- a code of conduct; and
- space traffic management.

Given the reticence of some states to cooperate within regimes premised on an exchange of information, questions were raised about the likelihood of a code of conduct being fully implemented. Furthermore, the issue of definitions that would be contained in a code of conduct was raised. The likelihood that the United States would adopt such a code of conduct was also questioned. In response, it was argued that a number of such codes have been very successful in regulating activities, such as the Incidents at Sea Agreement. It was suggested that a proper consultative mechanism, including a performance review, was needed. Others stated that since a code of conduct would not be legally binding it could not patch up the loopholes in the existing outer space instruments, therefore such a code could merely act as a supplement to them.

As a response to that comment, it was stressed that, with respect to the United States, a code of conduct could have the force of law if it were an executive agreement. Referring to the issue of definitions to be contained in the code of conduct it was highlighted that the proposal was a draft in progress and therefore it could still be refined. Additionally, another view stated that both a code of conduct and a treaty were needed. In many instances in arms control and disarmament regime creation, a code of conduct indeed preceded the conclusion of a treaty. It was suggested that it would be wise to commence with securing some commitment from states while not discarding the possibility of an arrangement that would be legally binding. Concern was expressed that the proposed code of conduct might not be comprehensive enough, for example concerning certain weapon systems such as directed energy weapons or airborne ASAT weapons.

On the issue of space traffic management it was suggested that one should not forget that such was not limited to managing near-Earth orbits. It was highlighted that with the multiplication of missions to the Moon there was already a problem in the assignment of radio frequencies and that there was a real coordination problem. Furthermore, it was suggested that when talking about space traffic management it would be necessary to include not only geostationary orbits and near-Earth orbits, but also other regions of outer space that are becoming increasingly cluttered. Additionally it was suggested that with respect to liability for damage to satellites, the provisions in the OST were not sufficient as it referred mostly to states and not to commercial operators.

The session concluded with the suggestion that, provided a definition of a space weapon could be agreed upon, the desired behaviour for space security could be achieved with three simple rules: first, do not place weapons in outer space; second, do not test or use any device as a weapon on artificial satellites; and three, do not test or use artificial satellites themselves as weapons.

Session VI
Enhancing space security: creative thinking

A ban on destructive anti-satellite weapons: useful and feasible

Laura Grego, Staff Scientist, Union of Concerned Scientists

Space security can be thought of as being divided into two baskets. The first consists of the sustainable use of outer space for our future generations, that is to say our environmental concerns, and the second, of the strategic issues that can engender instability and exacerbate conflict on the ground. These two baskets are intertwined and it is likely that a regime of arms control measures, rules of the road and TCBMs will yield the greatest amount of collective security as well as preserve the many benefits of outer space for the long term.

However a much more complicated basket of issues is how to manage the likely and inevitable conflicts over the military usefulness of outer space. While conflict may be thought to be inevitable, weaponization of outer space is not. Among the issues to consider are, first, that space operations do not become dangerous or too expensive because of the threat or use of ASAT weapons, and, second, that when the use of outer space is contested the conflict is managed in the most graceful manner possible and does not lead to dangerous reactions on Earth.

It is important to consider a multilateral ban on all testing and use of debris-producing ASAT weapons. If such an agreement could be negotiated and respected the single biggest threat to a sustainable space environment could be mitigated. Another benefit would be making illegal the simple but most immediate threat to satellites—ASAT weapons. The specifics of such a ban should be straightforward and could be embodied in a ban on kinetic-energy attacks on satellites.

Even if such a ban is unlikely to mitigate all threats, given that it might not stop heirloom ASAT weapons from being used in a crisis and the barrier to a breakout capability is only modest, there is measurable value in such an agreement, much like the Comprehensive Nuclear-Test-Ban Treaty (CTBT) in regards to nuclear weapons.

Overcoming institutional inertia

Rebecca Johnson, Director, Acronym Institute

Pragmatic procedural suggestions and creative ideas and strategies are not enough to overcome institutional inertia vis-à-vis a ban on space weaponization. Ultimately, it is the responsibility of countries to identify that there are sufficiently strong interests involved.

Some of the factors that need to be addressed in overcoming the blocks include:

- the different political objectives and perceptions of national security and interests;
- the diversion of attention from what institutions currently regard as their remits;
- concerns about incremental approaches and prohibitional or comprehensive approaches;
- the venue or the institution for negotiations on these issues; and
- questions of timing and how urgent is the need, or the perception of the need, to get something done.

US interests are already being reframed by facts on the ground but more has to be done to change the perception in the United States of security interests, and indeed to change the modes in which some countries deal with the United States in relation to their own security interests. We need to think of how to build an incentive structure into the space security regime, which has not been sufficiently dealt with.

Moving from dialogue to action

Colleen M. Driscoll, Director, Kurtz Institute of Peacemaking

We need to broaden our thinking to realize that we can create a security system that does not depend on newer and more sophisticated weapons but rather on shared actions and an understanding of and common dependence on what we need to do to protect and preserve our planet and resources. Since outer space surrounds us all, this plan must depend on a joint system for using technology to assure the national security of every country. A large part of the problem has been that there is no clear delineation of what constitutes the positive use of outer space versus the negative use. Neither is there real clarity as to what national security means or what it requires; or what might be accomplished through global security.

We need to redefine and identify our goals for human use of outer space and we need to have a wider dialogue that involves all. There are many ways that one could promote dialogue and education, insistence on transparency and controls within states on budgetary expenditures are just two examples. Immediate actions that states can take include encouraging all states to ratify the OST, increasing the number of joint space projects, issuing declarations not to be the first to deploy weapons in outer space and continuing discussions in all UN bodies dealing with the issue. Among the long-term plans, further development of the principle of non-use of force to include non-use of force against space objects, the declaration of a space preserve with a treaty-based management plan, an international satellite monitoring agency and a treaty banning weapons from outer space are just a few of the possible and necessary steps.

Discussion

The ensuing discussion focused mainly on preventative strategies regarding space weaponization. Referring to possible budget controls, questions were raised on the role of parliaments in controlling budget allocations as a way of helping direct activity on preventative steps against space weaponization. Additional questions were raised if space tourism, or other civilian and peaceful projects, could be an incentive towards promoting plans for the non-weaponization of outer space.

The response was that, at least in the United States, NGOs and civil society forums have access to the legislature and can or do exert pressure. Even though this process takes time, change does come in the long run. Furthermore, it was suggested that transparency in budgets is a step in the right direction and that commercial space actors are very much part of the community whose interests are at stake and will be taken into account. Additionally, it was suggested that there was a need to move forward on a PPW. Also mentioned was the need to concentrate on a strategy that would engage the United States through its commercial sector and civil society, suggesting that its national security interests lie somewhere other than in keeping open the potential for the weaponization of outer space.

The session concluded with the observation that rules of procedure were tools of institutions and those institutions were themselves a tool of the international community to manage decision-making and relations among states with different, even competing, interests.

SPUTNIK AND RUSSIA'S OUTER SPACE ACTIVITIES

Vladimir Putkov

Activities in outer space, or what we also refer to as "astronautics", are now part of mankind's everyday life. People no longer can do without telecommunications, navigation and the information provided by remote sensing based on space systems.

Manned flights by cosmonauts and astronauts in near space are now commonplace. Space exploration has greatly accelerated scientific and technological progress. Space research has given life to new branches of modern science and technology, and has stimulated the development of existing ones. Astronautics has presented numerous challenges to science, has required urgent solutions to many scientific and technological problems and has put forward new research methods as a priority. Not so long ago, the most important task of a manned mission was to learn to survive in outer space, later it was to work in conditions of weightlessness, and now the task is to get the maximum benefit for mankind from outer space.

Russia stands out by right as a pioneer in space exploration. On 4 October 1957 it was the first in the world to place an artificial satellite into orbit.

There are three Russian names that the world well remembers, for they made history in development of cosmonautics:

- Konstantin Tsiolkovsky—the founding father of theoretical astronautics, the theory of interplanetary communications, and space philosophy;
- Sergey Korolev—a scientist and an organizer, chief designer of the first space launch vehicles, spacecraft and space complexes, as well as a pioneer of space exploration. Under his leadership, the Soviet Union began to realize its space programme during the late 1950s; and

- Yury Gagarin—the cosmonaut who completed the first space flight on 12 April 1961.

Even the initial successful steps into outer space raised the challenge of its practical use. Under the programme of research on upper atmospheric layers and outer space, the Soviet Union was the first to achieve the successful launch of a space system consisting of two satellites—Elektron-1 and Elektron-2—on 30 January 1964.

In 1967 Russia developed the space communications system Orbita using the Molnia-1 satellite. In 1971–1972 this system was placed into high elliptical orbit, which allowed international exchanges of television broadcasts.

In March 1969 the development of the first Soviet meteorological system began with the Meteor series of satellites.

Space missions created the possibility for the detailed study of celestial bodies in the solar system. The Moon, Mars and Venus were the first priorities. Lunar research by spacecraft began in the Soviet Union with the successful launch of Luna-1 on 2 January 1959. This was followed by a continuation of the series, from Luna-2 to Luna-24, automatic stations of the Zond type, and the self-propelled Lunohod automatic vehicle.

Exploration of Mars began with the mission of the Mars-1 interplanetary station which approached the planet on 19 June 1963. This work was continued with Mars-2 to Mars-7, and future exploration is intended in the framework of international projects.

Exploration of Venus began in 1961 with the flights of the Venera-1 to Venera-16 spacecraft, which determined the composition of the planet’s atmosphere and delivered probes to the surface. Halley’s Comet attracted special interest in 1986, which was studied by spacecraft of the Venera and Vega types. Investigation of the Sun also commanded great interest.

On 17 July 1975 the world witnessed the docking of spaceships of the two leading space powers—the Soviet Union and the United States. For about two days, Soyuz and Apollo continued their orbit around the Earth as an integrated space system. This was the first example of space cooperation, which continues to this day in multilateral space projects, including the construction and operation of the International Space Station (ISS).

Today, four and a half decades after the first flight of man into outer space, the number of cosmonauts and astronauts totals in the hundreds. Space missions with international crews are now commonplace.

At present, the Russian Federation is one of the leading space powers because of the existence, effective development and utilization of:

- its space systems, complexes and means (including orbital spacecraft groups and ground space infrastructure—cosmodromes (space centres), mission control centres, systems for collecting, processing and distributing information, etc.);
- its technical, technological, industrial and experimental foundation;
- its system of specialist training; and
- its support of science and technology, enabling and ensuring further exploration of outer space.

There is a limited number of countries that possess such comprehensive space potential. Maintaining the position achieved by Russian astronautics is one of the main goals of our Federal Space Agency.

During the 1990s, the intensity of "space life" of Russia declined noticeably. However, after that came a period of stabilization and, later, advancement.

The first years of this century were critical in the development of astronautics due to the implementation of the Russian Federal Space Programme for 2001–2005 (FSP–2005). Over this period, state financing of relevant activities increased by more than two and a half times. This created favourable conditions for building up our space potential. A great success of recent years was the increase in the inventory of our spacecraft (from 31 to 39) and the qualitative improvement of the Russian orbital group of spacecraft used for scientific and socio-economic purposes. Existing launch systems were modernized and new systems were developed. Soyuz-FG, Soyuz-2 and Proton-M launch vehicles successfully delivered payloads into orbit. We are also developing the Angara space rocket complex.

The space industry completed the FSP–2005 with good results, showing significant growth in production and productivity.

The prospects for Russia's space activities through 2015 include implementation of the Russian Federal Space Programme for 2006–2015 (FSP–2015) to meet the growing requirements of state entities, regions, businesses and the people for space systems and their services, as well as enhancing efficiency of the use of outer space, expanding international cooperation and fulfilling international obligations with regard to outer space.

Today, we have been able to reverse the reduction of our orbital groups, which are being increased along with the expansion of the services provided.

The Russian communications and television broadcasting orbital group, which is now operational, already makes it possible to offer up to 30% of orbital capacity to foreign markets. By 2015 we are planning to deploy 26 fixed communications and broadcasting satellites and 12 spacecraft for mobile personal communications. Realization of this programme will ensure a tripling of the total orbital capacity compared to 2005. National mobile and personal communications systems will be created and the potential to provide services to foreign customers will be even greater.

According to our plans, seven upgraded spacecraft of the Express-AM series will be launched, replacing the Gorizont and Express-A. In particular, in 2007–2009 we expect to launch the Express-AM33 and -AM44, which will have a greater number of transponders and an active life cycle of 12 years.

In parallel to developing the Express-AM series, we are developing the smaller Express-MD. The launch of four of these spacecraft, with an active life cycle of 10 years, is scheduled for 2008–2011.

The development of the orbital group after 2010 involves launching two upgraded Express-AMU communications and broadcasting satellites, and two Express-AT television broadcast satellites, developed from the Express-2000 heavy platform. Their active life cycles are 12 and 15 years respectively.

By 2015 we plan to develop an advanced remote-sensing satellite group that would ensure effective monitoring of the environment, and contribute to work in hydrometeorology, ecology, the control and management of emergencies, and the rational use of natural resources.

At present, The Resource-DK spacecraft has been put into operation to provide detailed photography with a resolution of up to 1m for the mapping and monitoring of the environment in the interests of Russian and foreign customers. Quick access to information from the Resource-DK craft is particularly important to manage emergencies and to conduct relief operations. The spacecraft Monitor-E and Kompas-2 have also been placed into orbit. In the future, remote sensing of the Earth will be continued using specialized satellites of the series Resource-P (from 2010). It will provide images with a resolution of 1.5–2m in the visible spectrum and a resolution of 5 to 10m in the infrared, and will also collect data from various meteorological platforms. The latter is a technical product that Russia plans to offer to the world market.

Next, two meteorological space complexes will be developed based on the geostationary meteosatellite Electro, which will be part of the international satellite network of the World Meteorological Organization (WMO), and the mid-altitude meteorological spacecraft Meteor-M.

The task of short-term earthquake forecasting is becoming increasingly important for all mankind. In 2004 the world was shocked by the catastrophe in Asia that took a huge human toll—the tsunamis that occurred as the result of the earthquake killed more than 125,000, while 5 million lost their homes. Starting from 2007, we are planning to launch the Kanopus satellites equipped with sensors registering abnormal physical phenomena in the atmosphere, ionosphere and magnetosphere resulting from seismic activity, which can be detected before earthquakes occur. If this programme is implemented, it will be possible to use it as the basis for pulling together the efforts of various countries in finding effective methods for forecasting natural and technogenic disasters.

A group of scientific spacecraft will address the tasks of solar and astrophysical observation and planetary, medical and biological research. These efforts will be an important part of FSP–2015. We are planning a number of astronomic and astrophysical projects of which the development of the Spektrum-type observatories is the most important. We are also planning to launch the RadioAstron satellite (Spektrum-R, 2007) to perform observations in conjunction with a network of ground-based radio telescopes, the Spektrum-UF (2010) with a main mirror of 1.7m in diameter, and the Spektrum-RG (2011) performing observations in the X-ray and gamma ray bands. In 2007 and 2014 we plan to launch the Coronas-Foton and Intergeliozond research spacecraft to monitor the Sun. The projects Spektrum-RG and Spektrum-UF are pursued in broad cooperation with foreign partners from Europe, the United States and other countries.

An automatic station Fobos-Grunt will be launched in 2009 for the purpose of interplanetary research. Along with remote sensing, it will collect data from the Fobos satellite orbiting Mars and deliver its surface samples back to Earth. In 2012 we are also planning to establish a space complex to support the Luna-Glob research programme. Broad international scientific cooperation is expected in implementing this project.

As of now, Russia has fulfilled all of its obligations under the ISS programme to provide transportation and technical support to the station. Our foreign partners are participating in scientific and applied experiments on the Russian segment of the station. In 2008–2014 the Russian segment will be augmented with four new modules, the multipurpose laboratory and research modules being the most significant. This will help to expand research on board ISS.

Thus, in 2014 we are planning to complete the deployment of the Russian segment, which will comprise seven modules. This will involve the use of existing transportation and technical support systems. After 2015 we intend to begin flight tests of a new manned spacecraft. Also, work will be continued to develop a scientific and technological basis for the national multipurpose space station, the Moon base and the Martian expedition complex. Implementing the Moon and Mars exploration projects will require joint efforts by many states, and this effort is becoming one of the most important areas in Russia's international space activities.

When its orbital group reaches 18 spacecraft in 2007, the GLONASS system will be available to provide geopositioning data regardless of season, time or weather conditions across the whole territory of Russia, and in 2009 similar functions will be provided on a global scale (with the orbital group then comprising 24 spacecraft). The GLONASS space system is particularly important for the goals of economic development and national security. These goals include the organization of ground traffic; control of hazardous cargo transportation; support of geodetic activities; support of special services operations, emergency and first aid services; and synchronizing energy and transportations systems, etc. India is participating in building the orbital group to the target composition, and will make use of the GLONASS system.

The Russian Federation is taking part in the development and operation of the Cospas–Sarsat international search and rescue satellite system. The Russian segment of the system will include two spacecraft and three ground stations. In 2007–2008 we plan to launch two Sterh spacecraft of the Nadezhda-M system. To date, 5,737 rescue operations have been carried out. These saved the lives of more than 20,000, of whom over 1,000 were citizens of Russia and other countries of the Commonwealth of Independent States.

We will continue work on space materials research, switching from the use of the Foton-M short-life-cycle spacecraft to longer life Oka-T-MKS and Vozvrat-MKA spacecraft, to be serviced within the ISS infrastructure.

The Oka-T-MKS 1 and 2 spacecraft are scheduled for launch in 2012 and 2015 respectively, and the launch of the Vozvrat-MKA in 2014. At present, the European Space Agency is participating in the Foton project. The realization of the Oka-T-MKS and Vozvrat-MKA projects will help strengthen international cooperation in outer space technologies.

By and large, Russia's partners in outer space activities know our potential and products which meet the requirements of other states. These include:

- Mission-oriented objects (those in operation) of the space infrastructure. These include reliable launch systems (above all, the Proton and Soyuz types), the ISS Russian segment, remote-sensing space systems, the GLONASS navigation system, and communications and broadcast systems.
- Rocket and space technologies. State-of-the-art national technologies include rocket motors using various fuels, on-board nuclear power units, docking devices and systems, certain materials (hydrocarbon composite materials, and non-ferrous and other special alloys), and certain technologies for manufacturing rocket and space components.
- Our history of space activities. We have vast experience in long-duration manned flights, remote sensing products, the organization

of experiments in conditions of microgravity, and the management of an orbital group of spacecraft and manned space objects.

The experience of research and use of outer space accumulated by the space powers, including Russia, is a valuable resource for the world community, which can be used to help resolve global problems of sustainable development.

The proper use of outer space could:

- ensure the continued progress of mankind;
- protect mankind and the Earth from asteroid or comet impacts;
- provide renewable energy sources;
- provide a global monitoring system for the environment to address questions of sustainability, pollution, and forecasting and emergency management; and
- aid in understanding the role and place of mankind in the universe, and increase mankind's scientific knowledge.

To these ends, Russia stands ready to take part in implementing the global projects listed below, relying on the existing space systems described earlier and developing national systems to meet its own needs.

A unified space system to explore the natural resources of the Earth and to conduct global monitoring of geophysical processes

This system would provide data on near-Earth outer space, atmospheric contamination, land and water resources, and global meteorological forecasts. This data would help to develop territories, to search for new sources of natural resources, and to make rational use of current resources. The system would be designed also for forecasting and monitoring of natural and technogenic disasters.

Provided that a mutual agreement is achieved and the project partners assume voluntary obligations, the functions of the system could be extended to ensuring and monitoring military security. Availability of international systems for global and regional monitoring could allow various centres, under UN auspices for example, to evaluate objectively the military environment in order for timely measures to be taken to ease tensions and settle arising concerns.

The European Global Monitoring for Environment and Security (GMES) programme could be used as a basis for this system.

An international communications, broadcasting and retransmission space system

Such a system would provide direct broadcasting (including to home receivers) to help reinforce political stability, provide timely warning to the population of emergency situations and measures to mitigate their consequences, hold teleconferences, ensure global multiprogramme television and radio broadcasting, transmit programmes in native languages, and organize the exchange of broadcasts among states.

The system's main functions would be to ensure diplomatic communication "hot lines" and effective and reliable communications for the control and management of international (coalition) forces. The system would also help to organize international telephone communications and would collect data received from automatic environmental sensors, meteorological stations and security alarms.

Currently a number of telecommunications systems of global, regional and national scale are being developed and used.

International integrated navigation system

This system ensures the high-precision real-time positioning of objects, which is needed for the functioning of all means of transport, and especially for the rescue of individuals and installations in emergency situations.

The main elements of the system are the US Global Positioning System (GPS), the Russian GLONASS and their updates, the European Galileo system, certain spacecraft of other space powers and the international Cospas–Sarsat system.

A system of forecasting and neutralizing the danger of asteroid or comet impacts

The purpose of the system is self-explanatory. The development of the programme was spurred by observations showing that in the last 30 years at least five large asteroids or comets passed close to the Earth in astronomical terms. Such objects, were they to impact the Earth, would have the potential to bring an end to civilization.

At the moment, there are no national analogues of the proposed system. Nevertheless, there is a certain arsenal (tracking systems, for example) of means that would allow the project to be developed once the need to do so is realized.

An integrated system for the delivery of payloads to outer space

The purpose of such a system would be to provide for the reliable, economically viable and environmentally friendly delivery of payloads (manned or unmanned) to outer space.

Currently, a fleet of single-use launch systems for payload delivery to near-Earth outer space is available and is being operated and further developed (although there is need for some form of regulation). Multiple-use systems have been developed as well.

However, the systems being used at present and that will be used in the near future do not provide an acceptable level of confidence for missions into deep space, the reliability of interplanetary flight systems being insufficient. Within the framework of the project, single- and multiple-use international launch systems should be developed.

Operating the International Space Station for civil use

This project is being implemented and the partners recognize that cooperation within the framework of the ISS is necessary and extremely important for the whole of mankind. Scientific and applied studies on the ISS will enable the considerable expansion of knowledge about the properties of the space environment and its impact on humans. The unique environment provided for experiments in physics, biology, medicine and other fields will allow for the development of the fundamental technologies and expertise necessary for future extended space flights.

Fundamental space research programme

Solar research is among the highest scientific priorities. The implementation of individual projects would pave the way for the creation of a terrestrial and space-based system for monitoring the Sun, as well as deep and near outer space, throughout the entire electromagnetic spectrum.

It is a matter of global importance to study the way natural crisis situations occur and evolve, as well as to obtain a better understanding of the models underpinning the processes in question. This can be done by conducting simultaneous observation of the surface, atmosphere and magnetosphere of the Earth, as well as of solar activity and the interplanetary environment.

The use of space assets will increase the reliability and utility of measures taken to monitor and forecast natural phenomena and disasters. Today there is no doubt that changes in the electromagnetic environment in circumterrestrial space are indicators of a coming earthquake, and practical conclusions should be drawn from that.

The programme could also include a project based on the idea of supplying energy to the Earth by using space-based solar power stations. The project is obviously an urgent one, given that the terrestrial energy resources are not endless.

Conclusion

Today, space assets are an indispensable component of world civilization. Ensuring safe operation of the outer space infrastructure is one of the main priorities in the activities pursued by the UN and by the leading space powers.

In particular, there is an urgent need to ensure the prevention of an arms race in outer space (PAROS). It is necessary to work persistently to reinforce international treaties, legal regimes and international regulations of issues pertaining to outer space security.

The existing legal regime for outer space does not guarantee the prevention of placement of arms of any kind in space.

The coordination of efforts among international organizations and states with a view to preventing the placement of weapons in outer space could ensure a comprehensive solution of the problems of outer space security. Therefore, in addition to the expansion of international cooperation aimed at the peaceful use of outer space, the prevention of the weaponization of outer space is a priority for Russia. In recent years, Russia has put forward a series of initiatives to this end.

In particular, in October 2004 in the First Committee of the fifty-ninth session of the General Assembly, Russia made a unilateral and unconditional statement that it would not be the first to place weapons of any kind in outer space. Russia has also stated in the Conference on Disarmament that it has not developed outer space weapons and does not have plans to do so in the near future. Russia appealed to all space-faring states to follow its example. This statement demonstrates that Russia does not intend to pose a threat in or from outer space.

It is also noteworthy that on 8 December 2006 the General Assembly adopted by an overwhelming majority two resolutions introduced by Russia with a view to curbing a possible arms race in outer space.

The General Assembly approved the Russian draft resolution on developments in the fields of information and telecommunications in the context of international security by the majority of 176 votes. The objective of that document is to prevent dragging mankind into a new kind of arms race and to put a stop to the use of information and communications technologies to ends which are incompatible with the national security interests of states.

Another Russian draft resolution—on transparency and confidence-building measures in outer space activities—was supported by 178 countries.

The Russian Federation hopes that the approval of the international legal instrument, proposed by China, Russia and other countries, on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Space Objects (PPW) will be the next step on the road to assuring security in outer space.

Russia has prepared the draft PPW Treaty and after consultation with its partners intends to formally table it in the Conference on Disarmament. Adopting this treaty would be a major success for the Conference.

Here we cannot help mentioning the results of efforts aimed at mitigating the threat posed by technogenic debris in near-Earth outer space, and in this regard we might be witnessing the beginning of a new stage of development of international space law, in terms of the regulation of traffic and the use of space technologies in near-Earth outer space.

Today various international organizations, such as the Interagency Coordinating Committee on Space Debris, the Science and Technology Subcommittee of the UN Committee on the Peaceful Uses of Outer Space (COPUOS), the International Organization for Standardization (ISO) and others, are working on putting together international legal documents to regulate space objects and space activities as regards technogenic debris. For example, the Guidelines for Reducing the Production of Space Debris were prepared and adopted by the International Coordination Committee on Space Debris, and a similar document was prepared and adopted by the COPUOS Science and Technology Committee. In the framework of the ISO TC20/SC14 Working Group, already some 20 international standards have been established (for example, control of space activities in the context of technogenic debris in near-Earth outer space, curbing of emergence of space debris from launchers and space craft, limiting emergence of space debris as a result of collisions, space craft utilization procedures, and so forth).

All future-oriented programmes for the sustainable development of mankind can only be fulfilled in conditions of stable and comprehensive international cooperation. At the same time, in case of an arms race in outer space, resources would be used to build space weapons, and the implementation of national and international programmes aimed at, inter alia, global security and sustainable development would be delayed and many of them would simply be cut short. Therefore, mankind should do everything possible to avoid even the possibility of the weaponization of outer space for the sake of preserving civilization and its development. Russia is aware of its own responsibility in this process.

THE OUTER SPACE TREATY: THEN AND NOW

Sergey Batsanov

It might be interesting to recall that we are living through a series of anniversary celebrations: last September we were celebrating the tenth anniversary of the approval of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) by the General Assembly and of its opening for signature, although in a few months we were discussing what to do about its entry into force. In less than a month we will mark the tenth anniversary of the Chemical Weapons Convention (CWC) and its implementing agency, the Organisation for the Prohibition of Chemical Weapons (OPCW), and at that same time we expect the OPCW Executive Council in the Hague to take up the issue of how to manage the accidental non-achievement of the 10-year deadline for the destruction of chemical weapons by one state party. One should add, however, that the CWC state of health is good, and there is every reason to celebrate that anniversary. Next year we will be celebrating the fortieth anniversary of the Nuclear Non-Proliferation Treaty (NPT), while busily preparing for the crucial 2010 Review Conference, with a view to upholding the already damaged authority and integrity of the treaty. It is to be hoped that by that time the two current acute crisis situations within the NPT system, which have required the involvement of the Security Council, will be satisfactorily resolved. And, finally, let us not forget that this year will mark the thirty-fifth anniversary of the first Soviet–American treaties limiting strategic arms build-ups and anti-missile defence systems. There is no reason to go into detail regarding those other treaties, but as a brief background this list might be useful for the discussion of the 1967 Outer Space Treaty (OST).

In fact, the OST was and still remains an outstanding and very progressive treaty, which laid legal foundations for a wide range of activities in a new, limitless environment, and at a time when comparatively little was known about it. It addresses issues of general jurisdiction, states' responsibilities, regulation of economic activities, environmental law, and liability for damage. It embodies such principles as exploration and use of outer space for the benefit and interest of all countries; the freedom to explore, use and scientifically investigate outer space; it proclaims outer space as the province of all mankind and prohibits its appropriation by any actor. In fact, no country can claim a monopoly over or the right to govern outer space. The treaty has an important security dimension, as it prohibits placing in orbit, or stationing in any other way in outer space, weapons of mass destruction and provides for non-militarization of the Moon and other celestial bodies. But the security dimension does not end there. The treaty clearly discourages activities and experiments that could cause potentially harmful interference with the activities of other states parties. This makes the treaty much more relevant than one may first think to the whole question of the militarization of outer space, in a manner not limited only to weapons of mass destruction.

A number of principles stipulated in the treaty were later translated into a series of follow-up understandings and legally binding agreements, such as the Convention on the International Liability for Damage Caused by Space Objects, the Convention on the Registration of Objects Launched into Outer Space, and the Agreement on the Rescue of Astronauts and the Return of Objects Launched into Outer Space, to mention just a few. Thus we have a constellation of international agreements and conventions, standing on their own feet, but grouped around the OST. This is an interesting precedent, especially since the potential of the treaty in this respect is not yet exhausted.

The OST was concluded four decades ago, when the political, military and scientific landscape was very much different from what we see today. Then, we had the Cold War, that fierce competition for supremacy between the two superpowers, and, especially after the Cuban Missile Crisis, a growing realization that such a competition could not be allowed to get out of control. In fact, many security and arms control treaties of the Cold War-era were designed to avoid extremes and help preserve the status quo. Many things have changed since then.

After the end of the Cold War, the world entered a period when the competition between two superpowers for military supremacy ceased to be the primary source of potential nuclear conflagration; thus disarmament and non-proliferation in their traditional forms could no longer be considered as vital instruments for maintaining the over-all status quo, reducing the risk of a global war and mitigating the risks of an uncontrolled arms race. More importantly, the status quo itself has been replaced by the current transitional phase, characterized by a complicated mix of unipolarity and multipolarity, intensive processes of geopolitical reconfiguration, the emergence of new centres of power, the consequent crisis in traditional international institutions, and the erosion, or perhaps evolution, of norms of international law (such as the inviolability of borders and non-interference in another state's internal affairs). Globalization—and more specifically the gradual redistribution of the powers of nation-states in favour of super-state and sub-state (or non-state) actors—adds to an increased sense of national insecurity, as does the emergence of new threats of a military or non-military nature, including that of terrorism. As a result, more and more states, large and small, are manoeuvring to secure or improve their geopolitical situation, obtain or preserve access to vital natural resources and gain better protection from external influences or pressures. Regrettably, despite the mounting evidence that military power alone cannot solve today's problems, the complexity and the unpredictability of the present world pushes many political leaders in the direction of military build-ups and often makes them reluctant to consider limitations on existing or potential military programmes. Among the many political victims of these dangerous tendencies are often arms control, non-proliferation and disarmament, as well as multilateralism in general. In more practical terms, we are living through a period of increased risk of nuclear weapons proliferation, which, if not prevented, will have adverse effects on outer space security.

Globalization and the rapid development of science and technology have made their impact on outer space matters. The number of space powers and especially users of outer space has increased dramatically. The global economy is becoming more and more dependant on space-based assets (recall what the treaty says about potentially harmful interference with space activities). In parallel, outer space has become vital to deployment of military assets for war on the ground, especially by the major powers, and, potentially, for anti-missile defence systems. These space-based military assets, on the one hand, are great force multipliers for more technologically advanced states, but at the same time they present soft targets that are difficult to protect and that can become attractive targets of opportunity that could be neutralized with less technologically sophisticated, yet still advanced, means. Such means may not discriminate between military or civilian assets, or between friendly, hostile or neutral states. This is a nightmare scenario with multiple negative consequences—from further proliferation of nuclear weapons to the assignment of space warfare functions to such weapons. Thus the deionization of space or the development of anti-ballistic missile (ABM) systems would hardly improve the security of any state, and at some point the OST may itself become a victim of such developments. All this was not really foreseen at the time of the conclusion of the treaty. Indeed, the Soviet–American dialogue on the destabilizing effects of ABM systems, which resulted in the now defunct ABM treaty, started shortly after the conclusion of the OST.

All this underlines the need for a new, urgent and comprehensive reassessment of all aspects of space security—a reassessment that would allow us to look at issues from more than one security perspective and with the realization that an arms race with a view to control space, and thus to secure over-all military preponderance, will be a futile, terribly expensive and dangerous exercise. And it is naive to think that any country has enough resources that it would be in a position to pursue this course indefinitely without undermining its own interests in other vital areas. This is all the more true since such an arms race would probably be asymmetrical and would not be a repetition of the action–reaction cycles which had been typical of the arms race between the two superpowers of the second part of the last century. This time around there would be more actors and, hence, a wider variety of threats to respond to, thus making it more difficult to find equitable solutions.

There have been many proposals aimed at preventing a space-related arms race, including confidence-building measures, codes of conduct, the prevention of incidents and dangerous or provocative activities, transparency measures, cooperative risk reduction steps and comprehensive agreements. A genuine process of consultations, pre-negotiations, and multilateral and bilateral dialogue should start without delay.

Where does this bring us with regard to the OST? On one hand, it can be part of the solution, since its constructive potential has not yet been exhausted. A number of its basic principles can help find the correct approaches and, perhaps, be developed into additional self-standing agreements, as has been the case in the past. On the other hand, the dramatic changes that have occurred since its conclusion require that states parties pay more attention to preserving its authority and relevance. It is striking in this regard that that the treaty has no built-in system for consultations and regular interaction among its parties. No comprehensive reviews of the treaty are taking place. This is, by the way, one of the important observations of the Blix Commission. There is no need to change or amend the treaty to start more intensive and structured dialogue among its parties regarding different aspects of its implementation, and a review process is not a synonym for revision. There are precedents for additional mechanisms to assist treaty implementation to emerge through agreements among parties without changing a word in the treaty itself. And if we look at some other multilateral agreements, we can easily identify several rather uncontroversial areas to start with, for example working towards universality (participation in the treaty is only about half of the UN membership) which, as we know today, needs to be promoted. Another example would be national implementing legislation—are all parties equipped with the necessary laws, enabling them to be real, and not just nominal, parties? I wonder if anybody knows the answer.

The fortieth anniversary of the OST offers a timely opportunity to think about how to better utilize its potential, and strengthen its role and authority. A General Assembly resolution this autumn could be a good way to launch this process.

CHINA'S SPACE ACTIVITIES: PRESENT AND FUTURE

Xu Yansong

Space activities around the world have been flourishing during the first few years of the twenty-first century. The leading countries in the arena of spaceflight have formulated or readjusted their development strategies, plans and goals in this regard. The role of space activities in a country's overall development strategy is becoming increasingly salient, and their influence on human civilization and social progress is increasing.

China has set the strategic goal of building itself into a well-off society in an all-round way, in order to rank among the states with the best innovative capabilities during the first 20 years of the twenty-first century. The development of the space industry in China now faces new opportunities and increased requirements. In this new stage of development, China will adhere to the scientific outlook on development as guidance, centre its work on the national strategic goals, strengthen its innovative capabilities and do its best to make the state's space industry develop faster and better.

The aims of China's space activities are to explore outer space and enhance understanding of the Earth and the cosmos; utilize outer space for peaceful purposes; promote human civilization and social progress, and benefit the whole of mankind; meet the demands of economic growth, scientific and technological development, national security and social progress; and raise the scientific quality of the Chinese people, protect China's national interests and rights, and comprehensively build up the national strength.

From 2001 to 2005, China's space industry developed rapidly, making many achievements. A group of state-of-the-art research, development and testing bases has been built, and the system of research, design, production and testing has been further improved, markedly enhancing the state's basic capabilities in space science and technology. With breakthroughs in important key technologies, the overall level of China's space technology has been improved remarkably. Having made a historic breakthrough in manned spaceflight, China has embarked on a comprehensive lunar exploration project. Various space systems have taken shape, the range of application has been further expanded, the benefits have been noticeably enhanced, and important achievements have been made in space science research in this regard.

Satellites

Over the past five years, China has independently developed and launched 22 different types of satellites, upgrading its overall level in this field markedly. On the basis of the four satellite series initially developed, China has developed two more satellite series, to bring the total to six—recoverable remote-sensing satellites, DFH (Dongfanghong, or "The East is Red") telecommunications and broadcasting satellites, FY (Fengyun, or "Wind and Cloud") meteorological satellites, SJ (Shijian, or "Practice") scientific and technological research satellites, ZY (Ziyuan, or "Resources") natural resource satellites, and Beidou (or "Plough") navigation and positioning satellites. In addition, the oceanic satellite series will soon come into being. China has sped up the implementation of the plan to establish "a constellation of small satellites for environment and disaster monitoring and forecasting." Research and development of the payloads for some new, high-performance satellites have been successful, and many satellites have begun regular operation. The Fengyun I and Fengyun II meteorological satellites have been listed by the World Meteorological Organization in the international satellite series for meteorological services. Important breakthroughs have been made in key technologies related to the common platform for geostationary satellites. Periodic achievements have been made in the research and development of large-capacity telecommunications and broadcasting satellites. Substantial progress has been made in the research, development and application of small satellites.

Launch vehicles

Over the past five years, the "Long March" rockets independently developed by China have made 24 consecutive successful flights, and their major technological functions and reliability have been notably upgraded. From October 1996 to the end of 2005, these rockets have made 46 consecutive successful flights. Important breakthroughs have been made in key technologies of the next generation of launch vehicles. Research and development of the 120-ton-thrust oxygen–kerosene engine and the 50-ton-thrust oxygen–hydrogen engine are proceeding smoothly.

Manned spaceflight

On 20–21 November 1999, China launched and retrieved the first Shenzhou unmanned experimental spacecraft. It then launched three more not long afterward. On 15–16 October 2003, it launched and retrieved the Shenzhou V manned spacecraft, China's first of its kind. Having mastered the basic technologies of manned spaceflight, China became the third country in the world to develop manned spaceflight independently. From 12–17 October 2005, the Shenzhou VI manned spacecraft completed a five-day flight with two astronauts on-board. This was the first time for China to have men engage in experiments in outer space, another major achievement in the sphere of manned spaceflight. In addition, advanced studies and engineering work for the lunar project has been conducted, making important progress.

Satellite remote-sensing

The fields where, and degrees to which, satellite remote-sensing are used have been constantly expanded. Breakthroughs have been made in a large number of key application technologies, infrastructure facilities have been strengthened, the technological level and operational capabilities of the application systems have been notably improved, and a national satellite remote-sensing system has taken shape. China has built and improved the National Remote-Sensing Centre, the National Satellite Meteorology Centre, the China Resources Satellite Application Centre, the National Satellite Oceanic Application Centre, the China Remote-Sensing Satellite Ground Station, as well as satellite remote-sensing application and certification institutes for relevant state departments, provinces and cities. An optical remote-sensing satellite radiation calibration station has also been completed and put into operation. Many remote-sensing products and services are provided by using data obtained from observation of the Earth by both Chinese and foreign satellites. Remote-sensing application systems have been put into regular operation in many important fields, particularly in meteorology, mining, surveying, agriculture, forestry, land mapping, water conservancy, oceanography, environmental protection, disaster mitigation, transportation, and regional and urban planning. They are playing an important role in the nationwide land resources survey, in ecological construction and environmental protection, and as well as in major state projects, such as the South–North Water Diversion Project, the

Three Gorges Project and the Project to Transmit Natural Gas from West to East.

Satellite telecommunications and broadcasting

Satellite telecommunications and broadcasting technologies are developing rapidly, their application is becoming more extensive and an application industry in this field has taken shape. By the end of 2005, China had more than 80 international and domestic telecommunications and broadcasting ground stations, and 34 satellite broadcasting and television link stations. Dozens of departments and some large corporations have established altogether some 100 satellite communication networks and more than 50,000 very small aperture terminals (VSATs) for satellite communications on a smaller scale. The development and application of satellite radio and television broadcasting services has increased the coverage and improved the quality of the programmes all over China, particularly in the vast countryside. Satellite telecommunications and broadcasting technologies play an irreplaceable role in the projects "to give every village access to broadcasting and TV" and "to give every village access to telephones". A satellite tele-education broadband network and a satellite tele-medicine network have been established. As a member of the International Maritime Satellite Organization, China has established a maritime satellite communication network covering the whole world, ranking it among the most advanced states in the application of international mobile satellite communications.

Development targets

The major policies and measures for China's space industry at present and in the near future are as follows:

- To make overall plans for the rational deployment of space assets. To give priority to the development of applied satellites and satellite applications, develop in a proper way manned spaceflight and deep-space exploration, and give active support to space science exploration.
- To muster strength in implementing key scientific and technological space projects, strengthen basic research and make plans for frontier technologies in advance. To muster superior forces to make leapfrogging development in space science and technology by making breakthroughs in core technologies and resources

integration. To increase the sustainable innovative ability of space science and technology through strengthening basic research in the space field and developing several frontier technologies in advance.

- To promote space application and accelerate the industrialization of space activities. To strengthen the development of space application technologies, promote resource sharing and expand the scope of applications. With an emphasis on telecommunications satellites, satellite telecommunications, satellite remote-sensing, satellite navigation and carrier rockets, to vigorously construct a comprehensive space industry covering satellite manufacturing, launching services, ground equipment production and operational services. To strengthen the spread, transformation and secondary development of space technology, and transform and upgrade the traditional industries.
- To attach importance to infrastructure construction for space science, technology and industry. To strengthen the building of infrastructure facilities for developing, producing and experimenting with spacecraft and carrier rockets. To give support to key laboratories and engineering research centres for space science and technology, and strengthen the work on intellectual property rights and standardization of space activities.
- To promote the building of a space technology innovation system. To guide the reform, restructuring, transformation and updating of space science, technology and industry, and accelerate the building of large world-class space corporations. To integrate production, education and research, with space science and technology enterprises and national scientific research institutes at the core.
- To improve the scientific management of space activities. To adapt to the progress of the socialist market economy, actively make innovations in the system and mechanisms of scientific management, improve the sense of quality and profit among personnel, apply systems engineering and other modern management tools to promote scientific management, increase system quality, minimize system risks and enhance comprehensive benefits.
- To strengthen legislation. To formulate laws, regulations and industrial policies for guiding and regulating space activities, increase the level of administration by law, and create a legislative environment favourable for the development of space activities.

- To guarantee funds for space activities. The Chinese government will increase input to the space industry, and at the same time encourage the establishment of a diverse, multi-channel space funding system, so as to guarantee the sustainable and stable development of the space industry.
- To encourage people of all walks of life to participate in space-related activities, including encouraging industrial enterprises, scientific research institutes, commercial corporations, institutions of higher learning and social organizations, under the guidance of national space policies, to give full play to their advantages, take an active part in space activities, and participate in international space-related exchanges and cooperation. To encourage satellite operation enterprises and application units to use Chinese satellites and satellite-application products.
- To strengthen the fostering of talented people for the space industry. To spare no effort for the education and cultivation of personnel, and give attention to whetting their sense of innovation through practice. In particular, it is necessary to pay more attention to fostering a rationally structured contingent of young and highly qualified space scientists and engineers. To make efforts to publicize space knowledge and culture, and attract more outstanding personnel into the space industry.

The Chinese government continues to strengthen its administration and policy making concerning space activities. The China National Space Administration (CNSA) is the country's governmental organization responsible for the management of space activities for civilian use and international space cooperation with other countries, and responsible for implementing corresponding governmental functions.

The Chinese government holds that outer space is the commonwealth of all mankind, and each and every state in the world enjoys equal rights to freely explore, develop and utilize outer space and celestial bodies; and that all states' outer space activities should be beneficial to the economic development and social progress of nations, to the security, subsistence and development of mankind, and to friendly cooperation among people of different countries.

International space cooperation should adhere to the fundamental principles stated in the Declaration on International Cooperation in the

Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries. China maintains that international space exchanges and cooperation should be strengthened on the basis of equality and mutual benefit, peaceful utilization and common development.

The Chinese government has adopted the following policies with regard to developing international space exchanges and cooperation:

- Adhering to the principle of independence and taking the initiative in our own hands, carrying out active and practical international cooperation in consideration of the overall, rational utilization of domestic and international markets and resources to meet the needs of the national drive for modernization.
- Supporting activities regarding the peaceful use of outer space within the framework of the United Nations. Supporting all intergovernmental activities for promoting the development of space technology, space applications and space science, as well as those conducted by non-governmental space organizations.
- Attaching importance to space cooperation in the Asia–Pacific region, and supporting other regional space cooperation around the world.
- Reinforcing space cooperation with developing countries, and valuing space cooperation with developed countries.
- Encouraging and endorsing the efforts of domestic scientific research institutes, industrial enterprises, institutions of higher learning, as well as social organizations, to develop international space exchanges and cooperation in different forms and at different levels under the guidance of relevant state policies, laws and regulations.

Over the past five years, China has developed bilateral space cooperation with a host of countries. It has successively signed 16 international space cooperation agreements and memorandums with 13 countries, space agencies and international organizations. China has propelled multilateral cooperation in space technology and its applications in the Asia–Pacific region and is in the process of establishing a space cooperation institution for the region. China has joined relevant activities sponsored by the United Nations and other relevant international organizations, and has supported international commercial space activities. These measures have yielded positive results.

China continues to promote the Asia–Pacific Region Multilateral Cooperation in Small Multi-Mission Satellites Project, engaging in research and manufacturing with Bangladesh, Iran, Mongolia, Pakistan, the Republic of Korea and Thailand.

China takes a positive part in activities organized by the UN Committee on the Peaceful Uses of Outer Space (COPUOS) and its Scientific and Technical Subcommittee and Legal Subcommittee. China has acceded to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies; the Agreement on the Rescue and Return of Astronauts, and on the Return of Objects Launched into Outer Space; the Convention on International Liability for Damage Caused by Space Objects; and the Convention on the Registration of Objects Launched into Outer Space; China strictly fulfils its responsibilities and obligations. China actively participates in the relevant activities organized by COPUOS to implement the recommendations made by the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III). In particular, China, alongside Canada and France as co-chairs, has propelled the work of the space-system-based disaster mitigation and disaster management of the Action Team (AT-7) joined by 40 member states of COPUOS and 15 international organizations, and has actively taken part in the work of an ad hoc expert group to study the possibility of creating a coordination mechanism for disaster mitigation and management. China has acceded to a disaster mitigation mechanism consisting of space organizations from different countries in light of the Charter on Cooperation to Achieve the Coordinated Use of Space Facilities in the Event of Natural or Technological Disasters. In cooperation with the UN, China has hosted basic space science workshops and a workshop on tele-health development in Asia and the Pacific. China has also hosted, in collaboration with the Multilateral Cooperation Secretariat of the Asia–Pacific Space Cooperation Organization and the UN Economic and Social Commission for Asia and the Pacific, training courses and symposiums on space technology applications, and has provided financial support for these activities. China has also taken part in a programme promoting the application of outer space for sustainable development in Asia and the Pacific, organized and implemented by the UN Economic and Social Commission for Asia and the Pacific.

China has actively participated in activities organized by the Inter-Agency Space Debris Coordination Committee, started the Space Debris Action Plan, and strengthened international exchanges and cooperation in the field of space debris research. It has participated in the relevant activities organized by the Committee on Earth Observation Satellites (CEOS), and hosted the eighteenth CEOS plenary and twentieth anniversary activities in Beijing in November 2004. In May 2005, China officially became a member of the ad hoc inter-governmental Group on Earth Observations (GEO), and an executive committee member as well. In July 2006, China held in Beijing the thirty-sixth Committee on Space Research (COSPAR) Scientific Assembly and the eighth International Lunar Exploration Working Group (ILEWG) International Conference on the Exploration and Utilization of the Moon. In addition, China has taken part in the relevant activities of the International Telecommunications Union, World Meteorological Organization, International Astronautical Federation and the Committee on Space Research.

PEACE IN SPACE: BUILDING ON THE OUTER SPACE TREATY

Gérard Brachet

The Committee on Peaceful Uses of Outer Space (COPUOS) was established by the General Assembly in 1959. Today, it gathers 67 member states and addresses the applications of outer space such as scientific research, exploration, monitoring of the health of our planet, communications, navigation, etc. Its terms of reference include the promotion of international cooperation and developing an adequate legal framework for the use of outer space. As is well known, this mandate has been fulfilled by the development of the Outer Space Treaty of 1967, the main pillar of international law relative to outer space activities, complemented by four other treaties in the following years, all of them produced by COPUOS and transmitted for approval to the General Assembly before their signature and ratification—for the first four treaties—by most major space-faring nations. They are recalled below:

- 1967—Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (the Outer Space Treaty, which entered into force the same year);
- 1968—Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects launched into Outer Space (entered into force the same year);
- 1972—Convention on International Liability for Damage Caused by Space Objects (entered into force the same year);
- 1975—Convention on Registration of Objects Launched into Outer Space (entered into force in 1976); and
- 1979—Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (entered into force in 1984 but signed and ratified by only 13 countries).

In addition to these international treaties, COPUOS has addressed other issues over the years which led to the development of "Declarations" which were submitted for approval by the General Assembly, seeking whenever possible unanimous approval. These texts do not carry the same legal weight as international treaties but do carry political weight as they seek to encourage a practice resulting from in-depth consultation among member states of COPUOS. They are listed below:

- Declaration on Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space (1963), the principles of which were later incorporated into the Outer Space Treaty;
- Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting (1982);
- Principles Relating to Remote Sensing of the Earth from Outer Space (1986);
- Principles Relevant to the Use of Nuclear Power Sources in Outer Space (1992); and
- Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries (1996).

COPUOS also elaborates for approval by the General Assembly a number of resolutions which reinforce and clarify certain aspects of the international legal framework for space activities:

- Resolution 1721 (XVI) B of December 1961 on the Registration of Satellite Launches; and
- Resolution 59/115 of 10 December 2004 on the notion of "Launching State".

It is to be noted that its activity in this respect has accelerated recently. In 2007, two additional resolutions are foreseen to be presented to the General Assembly—one on Space Debris Mitigation Guidelines and one on Registration of Space Objects.

Recent achievements

The Space Debris Mitigation Guidelines adopted in February 2007 by the Scientific and Technical Subcommittee during its forty-fourth session are an excellent example of recent COPUOS work to develop a consensus-based code of conduct aimed at minimizing the production of space debris and the risk of collisions in outer space. In view of the demonstration by China of the destruction of one of its meteorological satellites in a heliosynchronous orbit by a ground-based missile, and the consequent generation of a large amount of debris, it is worthwhile to recall that the Space Debris Mitigation Guidelines (reproduced in the annex) include guideline number 4 which states very clearly, "Avoid intentional destruction and other harmful activities", with the following additional comment: "Recognizing that an increased risk of collision could pose a threat to space operations, the intentional destruction of any on-orbit spacecraft and launch vehicle orbital stages or other harmful activities that generate long-lived debris should be avoided. When intentional break-ups are necessary, they should be conducted at sufficiently low altitude to limit the lifetime of resulting fragments." It is hoped that the adoption of these guidelines by the UN General Assembly will discourage experiments such as the Chinese test of 11 January 2007.

Another illustration of this pragmatic approach adopted by COPUOS is the work plan for developing safety standards for nuclear power sources in outer space. The Working Group on the Use of Nuclear Power Sources in Outer Space of the COPUOS Scientific and Technical Subcommittee has established, in cooperation with the International Atomic Energy Agency (IAEA), a three-year work plan with the objective of adopting a joint COPUOS–IAEA safety framework by 2010. The working group started in 2006 with a technical workshop organized jointly with the IAEA, followed by extensive inter-session consultations within the working group and with the IAEA. The work achieved so far, and the three-year work plan adopted, are good illustrations of how new standards relating to outer space activities and their future safety can be elaborated by relying on actual technical and operational experience, rather that by a purely academic and theoretical approaches.

Future directions

Although there are proposals to consolidate the five space-related treaties, there is no consensus within COPUOS to reopen the Outer Space Treaty of 1967, nor to develop new international conventions relating to outer space activities. For many member states of COPUOS, the priority should be to encourage ratification of these treaties where a large consensus exists, these being the first four treaties (the "Moon Treaty" has been ratified by only 13 states). Beyond the international conventions framework, there is within COPUOS a shared feeling that bottom-up, technically-based guidelines and recommendations are powerful means to develop rules-based behaviour and keep outer space as safe as possible. The principles that would eventually be adopted following such an approach would be based on technical and operational considerations, not on a delicate political balancing act, as was the case during the Cold War. However, this bottom-up approach remains firmly based on the Outer Space Treaty of 1967 in that it maintains the founding principles of freedom of space exploration and utilization (article 1) and of non-appropriation of outer space and celestial bodies (article 2).

In June 2007, during its fiftieth plenary session, COPUOS will address, among many other agenda items, its future role and activities. One suggestion I will put forward as chairman of the committee is to develop "rules of the road" for the long-term safety of space operations. The recommended approach will be to rely heavily on the actual operational experience of the principal actors, commercial operators and government agencies, and try to develop—from the analysis of current space traffic requirements and how they may evolve in the future—a consensus-based set of rules and recommended practices. It is too early to know if the committee will take up this suggestion, but if it does it would be an indication that it is ready to play fully the role that the General Assembly has assigned to it—to help formulate a global framework for the safe and secure use of outer space, not only for the space-faring nations, but for all nations to benefit from space technology.

Now, let us be clear, COPUOS does not address the "military uses of outer space" nor the issue of "weapons deployment in space"—which are addressed at the Conference on Disarmament—but these issues are understood by member state delegations to COPUOS as they may impact the safety of all activities in outer space. Notwithstanding the above, non-aggressive military uses of outer space are considered as peaceful activities and are within the purview of COPUOS. This is in line with a well known fact: most space systems and applications are dual use, for example the Global Positioning System, mobile communications satellite systems, meteorological satellites, many high-resolution Earth imaging satellites, and so forth. Only a few military satellite systems do not have an equivalent in the civilian world, such as, for example, early warning satellites, and, obviously, anti-satellite weapons.

Because we all share the use of the same environment, namely outer space, and because the technologies we rely on are often identical, I believe that

COPUOS and the prevention of an arms race in outer space (PAROS) agenda item of the Conference on Disarmament would benefit from a much more active exchange of information on their activities. Each body has its own terms of reference, which I do not suggest to modify, and both report to the UN General Assembly—COPUOS via the Fourth Committee and the Conference on Disarmament via the First Committee. It is up to the General Assembly to decide if this reporting on space issues through two different committees could not be improved.

In the meantime, regular exchanges of information between the two bodies are useful, I would even say indispensable. This conference is an excellent opportunity to facilitate this communication.

Let me conclude that in my current position as Chairman of COPUOS, I am committed to facilitate and encourage such communication.

ANNEX

Space debris mitigation guidelines of the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space

1. Background

Since the Committee on the Peaceful Uses of Outer Space published its Technical Report on Space Debris in 1999, it has been a common understanding that the current space debris environment poses a risk to spacecraft in Earth orbit. For the purpose of this document, space debris is defined as all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional. As the population of debris continues to grow, the probability of collisions that could lead to potential damage will consequently increase. In addition, there is also the risk of damage on the ground, if debris survives Earth's atmospheric re-entry. The prompt implementation of appropriate debris mitigation measures is therefore considered a prudent and necessary step towards preserving the outer space environment for future generations.

Historically, the primary sources of space debris in Earth orbits have been (a) accidental and intentional break-ups which produce long-lived debris and (b) debris released intentionally during the operation of launch vehicle orbital stages and spacecraft. In the future, fragments generated by collisions are expected to be a significant source of space debris.

Space debris mitigation measures can be divided into two broad categories: those that curtail the generation of potentially harmful space debris in the near term; and those that limit their generation over the longer term. The former involves the curtailment of the production of mission-related space debris and the avoidance of break-ups. The latter concerns end-of-life procedures that remove decommissioned spacecraft and launch vehicle orbital stages from regions populated by operational spacecraft.

2. Rationale

The implementation of space debris mitigation measures is recommended since some space debris has the potential to damage spacecraft, leading to loss of mission, or loss of life in the case of manned spacecraft. For manned flight orbits, space debris mitigation measures are highly relevant due to crew safety implications.

A set of mitigation guidelines has been developed by the Inter-Agency Space Debris Coordination Committee (IADC), reflecting the fundamental mitigation elements of a series of existing practices, standards, codes and handbooks developed by a number of national and international organizations. The Committee on the Peaceful Uses of Outer Space acknowledges the benefit of a set of high-level qualitative guidelines, having wider acceptance among the global space community. The Working Group on Space Debris was therefore established (by the Scientific and Technical Subcommittee of the Committee) to develop a set of recommended guidelines based on the technical content and the basic definitions of the IADC space debris mitigation guidelines, taking into consideration the United Nations treaties and principles on outer space.

3. Application

Member States and international organizations should voluntarily take measures, through national mechanisms or through their own applicable mechanisms, to ensure that these guidelines are implemented, to the greatest extent feasible, through space debris mitigation practices and procedures.

These guidelines are applicable to mission planning and operation of newly designed spacecraft and orbital stages and, if possible, to existing ones. They are not legally binding under international law.

It is also recognized that exceptions to the implementation of individual guidelines or elements thereof may be justified, for example, by the provisions of the United Nations treaties and principles on outer space.

4. Space debris mitigation guidelines

The following guidelines should be considered for the mission planning, design, manufacture and operational (launch, mission and disposal) phases of spacecraft and launch vehicle orbital stages:

Guideline 1: Limit debris released during normal operations

Space systems should be designed not to release debris during normal operations. If this is not feasible, the effect of any release of debris on the outer space environment should be minimized.

During the early decades of the space age, launch vehicle and spacecraft designers permitted the intentional release of numerous mission-related objects into Earth orbit, including, among other things, sensor covers, separation mechanisms and deployment articles. Dedicated design efforts, prompted by the recognition of the threat posed by such objects, have proved effective in reducing this source of space debris.

Guideline 2: Minimize the potential for break-ups during operational phases

Spacecraft and launch vehicle orbital stages should be designed to avoid failure modes which may lead to accidental break-ups. In cases where a condition leading to such a failure is detected, disposal and passivation measures should be planned and executed to avoid break-ups.

Historically, some break-ups have been caused by space system malfunctions, such as catastrophic failures of propulsion and power systems. By incorporating potential break-up scenarios in failure mode analysis, the probability of these catastrophic events can be reduced.

Guideline 3: Limit the probability of accidental collision in orbit

In developing the design and mission profile of spacecraft and launch vehicle stages, the probability of accidental collision with known objects during the system's launch phase and orbital lifetime should be estimated and limited. If available orbital data indicate a potential collision, adjustment of the launch time or an on-orbit avoidance manoeuvre should be considered.

Some accidental collisions have already been identified. Numerous studies indicate that, as the number and mass of space debris increase, the primary source of new space debris is likely to be from collisions. Collision avoidance procedures have already been adopted by some Member States and international organizations.

Guideline 4: Avoid intentional destruction and other harmful activities

Recognizing that an increased risk of collision could pose a threat to space operations, the intentional destruction of any on-orbit spacecraft and launch vehicle orbital stages or other harmful activities that generate long-lived debris should be avoided.

When intentional break-ups are necessary, they should be conducted at sufficiently low altitudes to limit the orbital lifetime of resulting fragments.

Guideline 5: Minimize potential for post-mission break-ups resulting from stored energy

In order to limit the risk to other spacecraft and launch vehicle orbital stages from accidental break-ups, all on-board sources of stored energy should be depleted or made safe when they are no longer required for mission operations or post-mission disposal.

By far the largest percentage of the catalogued space debris population originated from the fragmentation of spacecraft and launch vehicle orbital stages. The majority of those break-ups were unintentional, many arising from the abandonment of spacecraft and launch vehicle orbital stages with significant amounts of stored energy. The most effective mitigation measures have been the passivation of spacecraft and launch vehicle orbital stages at the end of their mission. Passivation requires the removal of all forms of stored energy, including residual propellants and compressed fluids and the discharge of electrical storage devices.

Guideline 6: Limit the long-term presence of spacecraft and launch vehicle orbital stages in the low Earth orbit (LEO) region after the end of their mission

Spacecraft and launch vehicle orbital stages that have terminated their operational phases in orbits that pass through the LEO region should be removed from orbit in a controlled fashion. If this is not possible, they should be disposed of in orbits that avoid their long-term presence in the LEO region.

When making determinations regarding potential solutions for removing objects from LEO, due consideration should be given to ensure that debris that survives to reach the surface of the Earth does not pose an undue risk to people or property, including through environmental pollution caused by hazardous substances.

Guideline 7: Limit the long-term interference of spacecraft and launch vehicle orbital stages with the geosynchronous Earth orbit (GEO) region after the end of their mission

Spacecraft and launch vehicle orbital stages that have terminated their operational phases in orbits that pass through the GEO region should be left in orbits that avoid their long-term interference with the GEO region.

For space objects in or near the GEO region, the potential for future collisions can be reduced by leaving objects at the end of their mission in an orbit above the GEO region such that they will not interfere with, or return to, the GEO region.

5. Updates

Research by Member States and international organizations in the area of space debris should continue in a spirit of international cooperation to maximize the benefits of space debris mitigation initiatives. This document will be reviewed and may be revised, as warranted, in the light of new findings.

6. Reference

The reference version of the IADC space debris mitigation guidelines at the time of the publication of this document is contained in the annex to document A/AC.105/C.1/L.260.

For more in-depth descriptions and recommendations pertaining to space debris mitigation measures, Member States and international organizations may refer to the latest version of the IADC space debris mitigation guidelines and other supporting documents, which can be found on the IADC website (www.iadc-online.org).

CURRENT CD DEVELOPMENTS REGARDING PAROS

Paul Meyer

This conference, which has become an annual feature of the Geneva disarmament calendar, provides an opportunity to bring together diplomats, UN and non-governmental organizations, the private sector and research institutes to exchange views on how we can enhance our cooperative efforts to safeguard the outer space environment.

The world in which we live is increasingly dependent on space-based technologies. Along with the benefits that we gain from the peaceful uses of outer space also comes a responsibility on the part of the international community to preserve the benign nature of outer space and to regulate activities to this end.

The 1967 Outer Space Treaty has provided the basic framework of international space law. However, the record of implementation as well as new developments and technological capabilities have demonstrated that the treaty does not offer a comprehensive solution to current and future challenges to space security, and additional measures may be required to ensure its goals. There are many avenues through which we can build on the existing space security architecture. One of which is the work of the Conference on Disarmament (CD), of which I will speak today.

CD discussions on the prevention of an arms race in outer space

As many of you are aware, the prevention of an arms race in outer space (PAROS) has been on the CD agenda since the first UN Special Session on Disarmament. The termination of the Ad Hoc Committee on PAROS in 1995 has not prevented worthwhile discussion and proposals from being generated in the intervening years, both in formal plenary sessions and in informal meetings.

In 2006, following an initiative of the six CD presidents, the CD held in mid-June a full week of focused, structured discussions on PAROS with the participation of several experts from capitals. This “space week” was an important step forward in enabling the CD to resume some of its substantive work on space security.

This year, the six presidents have worked together to build on the structured discussions of 2006. Coordinators for each of the CD agenda items were appointed by the presidents to conduct informal meetings during the first session of 2007 (a total of six informal meetings per agenda item). I presided as coordinator for agenda item 3 on PAROS.

The objective of these informal meetings was to identify proposals relevant to PAROS that could have the potential to become eventually multilateral agreements of the CD. On that basis I structured the work of the informal meetings along three main themes:

- consideration of the adequacy of the existing international legal regime for providing security in outer space and possible means of enhancing it;
- transparency and confidence-building measures (TCBMs) regarding outer space activities relevant to international security; and
- elements of a treaty on the non-weaponization of outer space.

The discussions built on the previous work of the CD in these areas, but also introduced some new ideas. I will outline some of the main themes that emerged from these informal meetings.

Adequacy of existing international legal regime

While there is broad support for existing accords relevant to outer space security, there is recognition that strengthening their implementation and promoting their universalization could lead to an overall improvement in space security.

At the same time, there is also recognition of some gaps in the existing space security architecture that are not addressed by existing mechanisms. To fill these gaps additional agreements and measures can be considered to ensure the continued unthreatened access to space for peaceful uses.

TCBMs

TCBMs can make a contribution in this regard. There is scope for the CD to develop measures that will address the security/military side of our space environment. Such measures could help reduce threat perceptions and increase confidence and security among states.

Ideas that were discussed included codes of conduct that could be based on the principles of non-interference and non-aggressive activities in space, and which might embrace elements such as the avoidance of collisions, minimum distance between satellites and avoidance of dangerous manoeuvres.

A multilateral moratorium by which space-faring states agreed not to test anti-satellite (ASAT) weapon systems that would produce permanent, irreversible or widespread effects, or which would produce debris, was another option raised. Regulating such restraints on state behaviour through a multilateral arrangement could help establish "rules of the road" for all countries.

It would also be beneficial to strengthen the implementation of existing accords, such as the Hague Code of Conduct, that already include TCBMs such as pre-launch notification or annual declarations of policies, sites and actual launches.

It was acknowledged that TCBMs would be valuable not only in terms of enhancing the safety of space assets, but could also serve as useful complementary measures to an eventual treaty banning space-based weapons.

Elements of a treaty

The informal meetings also built on previous discussions in the CD of a treaty preventing the placement of weapons in outer space and prohibiting the use or threat of use of force against space objects. This round of informal meetings focused primarily on the Russian–Chinese text on "draft elements" contained in CD/1679 of 2002 and allowed for further elaboration and clarification of key concepts, such as definitions, verification and scope.

Some considerations that were discussed in relation to scope were whether the treaty would prohibit the testing of ASAT systems on Earth and against objects in space, the distinction between deployment and placement, and the interpretation of the right to self-defence in the event of an aggressive act against one's space objects.

On definitions, there was consideration of whether any treaty would need to clearly define key terms such as "weapon" or "space object" or even "outer space", and if so what would be the parameters for such basic concepts. By way of an example, the Russian–Chinese paper CD/1779 on definitions suggests that the definition of a weapon should not only cover something that can "eliminate and damage", but also "disrupt normal functions" of a space object.

There was some initial discussion of verification, again based on earlier working papers, with recognition that, while difficult, the inclusion of verification was indeed possible and much would depend on the precise scope and elements of an eventual treaty.

As was announced by Russian President Putin at the Munich Conference on Security Policy held in February 2007, Russia is working on a draft treaty banning the placement of weapons in outer space. Suffice it to say, in our opinion the CD would be an appropriate place to negotiate a legally binding ban on space-based weapons as part of an effort to strengthen the multilateral architecture of space security.

Cooperation among relevant forums

A frequent theme in the informal discussions was that the work of the CD in the area of space security would be well served by enhancing dialogue among the various UN bodies with an interest in outer space, including the Committee on the Peaceful Uses of Outer Space (COPUOS), the International Telecommunications Union and the First and Fourth Committees of the General Assembly.

In particular, with cross-cutting issues such as space debris in which the CD and COPUOS have major roles to play and expertise to offer in keeping with their distinct mandates, such a dialogue could help to identify areas for cooperative activity and avoid duplication. Several delegations proposed that the Chairman of COPUOS or his representative should brief CD members on its work.

Future of PAROS at the CD

So what is the future of PAROS in the CD following these informal meetings? As many of you will be aware, the six CD presidents have proposed a draft decision on a work plan for the rest of this year for the Conference. The decision was formulated on the basis of the outcomes of the informal meetings for all agenda items, as well as the results of extensive bilateral and regional consultations.

The draft decision would start informal negotiations on a Fissile Material Cut-off Treaty (FMCT), with separate structured discussions on nuclear disarmament/prevention of nuclear war, PAROS and negative security assurances. Consideration of each issue would be led by a coordinator, appointed by and reporting back to the Conference. It will then be up to the individual coordinators to structure the work for what the president has characterized as the equivalent of subsidiary bodies pursuant to the CD's rules of procedure. I am honoured that the six presidents have once again proposed that I be entrusted with presiding over work on PAROS.

The membership of the CD has not yet made a decision on the proposal. There is a possibility that a decision could be taken during a special session of the CD that may be convened during the period prior to the start of the CD's second session on 14 May 2007.

Whatever the fate of this particular diplomatic initiative, the global community needs to work together to ensure that we all benefit from continued access to and use of space by all, free from threat of attack. In my view, the CD is well placed to play a leading role in addressing the security dimensions of outer space and I can only hope that the collective membership will authorize us to take up this responsibility before more time is lost.

SPACE SECURITY: PERSPECTIVES OF DEVELOPING COUNTRIES

Hewa Palihakkara

I have been asked to speak on the topic of space security from the perspective of developing countries. Two questions would immediately come to mind to a taxpayer of any developing country. Firstly, is not space security principally a concern for, and an interest of, space-capable or space-faring states rather than a worry for developing nations whose economic and social mobility, even on Earth, leaves much to be desired? And secondly, are not developing countries wasting their time and energy on cosmic concerns such as space security, whereas they should rather be focusing on terrestrial urgencies such as food security, social justice, security from poverty, health care, sanitation, and so forth?

To my mind, answers to both of these questions must necessarily be in the negative. This is even more the case in a time when exciting opportunities, as well as looming dangers, that can come from state and private activities in space, irrespective of whether such are conducted in a competitive or cooperative manner, have become more actual than conjectural.

As we meet in Geneva, 2007 marks half a century of space faring since the launch of Sputnik I. We also have 40 years of space treaty history behind us since the adoption of the landmark 1967 Outer Space Treaty. As we all know, this has been four decades of attempted multilateral work, rather than achievements. This is also the twenty-fifth year of the prevention of an arms race in outer space (PAROS) issue on the agenda of the Conference on Disarmament (CD) in Geneva, the most representative multilateral arms control treaty-making body in the world. I am reluctant to call the CD the single or sole multilateral negotiating body, as one may find such designations rather undemocratic! If the CD is unable to do something which is patently desirable, then other multilateral bodies or forums should be found or enabled to perform the task.

This historical perspective brings into sharper focus the significance of this conference and the negative answers which I must give to the two questions above. Developing countries have, through their consistent and persistent words as well as deeds at the national and international levels, worked purposefully to promote and conclude a treaty and other barriers against the weaponization of outer space. In the CD, the United Nations, and peace research and civil society forums, the developing countries have strongly and cohesively advocated a number of constructive ways forward on peace, security and the rule of law in outer space. These include strengthening the current legal regime for space security, examining and filling its obvious gaps and inadequacies; developing confidence-building measures (CBMs); improving transparency and record-keeping for space activities; and developing and implementing behavioural benchmarks or codes of conduct for activities in outer space. In fact, while preparing for this presentation, a search of the internet for "space security diplomacy" revealed that the developing countries and China had made six times more interventions than others on this subject at the UN. Indeed, the prime movers of the initiative to have PAROS on the CD agenda nearly a quarter of a century ago were a group of developing countries. Thereafter, Argentina, Egypt and Sri Lanka alternated in piloting the PAROS resolution in the General Assembly every year. This resolution, together with the work of the CD, or what remains of it, continue to be the principal, if not the only, body of collective intergovernmental thinking relevant to "space security diplomacy".

These efforts ran in parallel and were complementary to the valuable contributions by others who advocated diplomacy rather than weaponry for space security, such as Australia, Canada, New Zealand and some European Union states. What is even more striking is that contributions made at the UN on the space security issue by these states and developing countries together outnumbered those made by the major space-faring nations by 14 times!

I would submit that the reason for this consistent advocacy by developing countries is two-fold. Firstly, the developing countries would like to ensure the principle of free and unimpaired access to the "global commons" or "the common heritage of mankind" or whatever we agree to call the last frontier of resources—that is, outer space. In its broadest sense, this rationale was encapsulated in the New Zealand representative's statement at the CD a few weeks ago. Although not a developing country, New

Zealand articulated the valid premise that preventing the weaponization of outer space was fundamental to safeguarding all countries' ability to access space resources, both now and in the future. Therefore the preservation of a weapon-free outer space is a principal task for the CD. The future opportunities for peaceful development must not be compromised by militarization. That the Conference should look at the feasibility of a more comprehensive legal regime preventing weapons in space appears to command general agreement, but the trouble is that this remains a virtual state without transforming into a functional consensus. As suggested by many CD members, identifying gaps in the existing legal regime would provide a good starting point from which to explore whether there was agreement before proceeding with the debate on how best to fill them.

The word "militarization" would immediately trigger a familiar debate. This is well known to developing countries as a pretext for a "do-nothing" or "do-little" approach. As many in the CD have correctly pointed out, we seem to have come full circle in this debate. When restraints on militarization were attempted over 40 years ago it was said that space was already militarized with so-called 3C (command, control and communication) space assets which are needed for maintaining the stability of highly nuclearized and technology-driven security policy. Thereafter we have had a long and continuous debate on what constitutes "peaceful" and "non-aggressive" uses of outer space. Then, honest but unsuccessful attempts were made to conceptualize these efforts and harmonize these views into an approach for pre-empting the weaponization, as opposed to militarization, of space. Now we have a broader conceptualization in the form of "space security", coupled with or beginning with CBMs and transparency measures. Canada has done some very constructive work on this. The interest of developing countries is to start multilateral work on any one of these starting points, or a combination thereof, before it is again too late. As pointed out earlier, this is fundamental to the freedom of access to outer space resources, whether you call that environment the common heritage of mankind, the global commons, or even the cosmic commons!

If this does not happen soon enough, the inevitable weaponization of space security will take place in the same way that terrestrial security was weaponized. This is evident from the progression from stone age weapons to machine guns to thermonuclear bombs, along with the bewildering array of doctrines thrown into the bargain.

This brings me to my second point of the two-fold rationale for interest of developing countries in the space security issue. The developing countries are concerned that they will once again be called upon to carry the burden of nurturing and sustaining a "non-proliferation regime" for space weapons.

We have enough earthly experience in nuclear and missile proliferation to tell us that once we lift the human habit of weaponizing security into orbit and possibly beyond, we will find the feeble attempts of non-proliferation woefully inadequate to maintain our usual "international wish list" of stability, security and so forth. As it so happens, once the so-inclined space-capable countries perfect their weaponization programmes, the urge to deploy and develop doctrines for them will follow. The responsibility of non-proliferation will naturally fall on the developing countries that have no security umbrellas. History is replete with failed non-proliferation attempts in such situations. Non-proliferation cannot sustain itself in a disarmament/arms-control vacuum.

Space-lift capability, guidance and propulsion technologies have all spread very quickly. Some states that were developing countries at the onset of the space age are now space farers. More such capabilities will emerge and we all should applaud that. And more qualitative improvements will also take place. Those who argued that militarization was a reality, that the existing legal regime was adequate and that nothing more is feasible or desirable, now face the imminent danger of weaponization of space. Like its terrestrial counterpart, once space security is weaponized, proliferation will follow.

Developing countries do not want this non-proliferation burden to fall on them. They therefore advocate and want to contribute to a less expensive and more equitably enforceable prevention regime to keep outer space free of weapons as well as debris.

Let me conclude on a personal note. Having participated in multilateral arms control and disarmament efforts both at the CD in Geneva and the UN in New York since the early 1980s, even before PAROS became a CD agenda item, I was struck by the contrast between the stand-still in the arena of preventive diplomacy and the breathtaking dynamism in exploration and technological development relating to outer space. Space technology in all fields—propulsion, guidance, remote sensing, communications, orbital construction, life support systems and so forth—has shown wonderful progress and advance. This capability has not only grown qualitatively, but has also contributed to socio-economic progress and prosperity for many countries and peoples. This is a true tribute to human endeavour, ingenuity and the quest to know more.

In contrast, when I began to prepare for this event I was dismayed to discover the depressingly familiar static diplomacy of harping on the adequacy of the existing legal regime. Outer space diplomacy seems frozen in time although technology and the dangers of weaponization seem to accelerate at full throttle!

Nearly a decade ago, on 26 February 1998, as the Sri Lankan Permanent Representative to the CD, I spoke there on PAROS and said "if we do not take collective preventive action in outer space now, we will be talking about non-proliferation in space a few years down the road."

My friend and colleague Ambassador Li Changhe of China, who was the Permanent Representative of China to the CD, echoed this caution when he spoke later and said that those who are against a CD Ad-Hoc Committee on PAROS should heed this "prudent advice" (Sri Lanka was the coordinator on PAROS in the CD at that time). Ambassador Changhe's words many years ago resonated in my mind while I was preparing these comments, not least because the Chinese anti-satellite weapon test of 11 January 2007 was indeed a stark reminder that the warnings 10 years ago were not heeded by those who believed the danger of weaponizing space security was a figment of the imagination of delegates frequenting Geneva and New York! One must remember that China's test was not the first such test and it was targeted on its own satellite. Other space powers had conducted similar or bigger tests before. It is also gratifying that China remained committed then and now to starting multilateral work on PAROS. It is still not too late to bring to fruition a multilateral process to prevent what was cautioned against 10 years ago. What was said in words of caution at that time was perhaps demonstrated in deed on 11 January. Rather than calling for explanations, the space powers will be well advised to join China and other countries to commence a multilateral process for graduated and progressive de-weaponization of space security. If we do not do this now, the UNIDIR conference on the fiftieth anniversary of the Outer Space Treaty may have to discuss non-proliferation in outer space.

ALTERNATIVE APPROACHES FOR ENSURING SPACE SECURITY

James B. Armor, Jr.

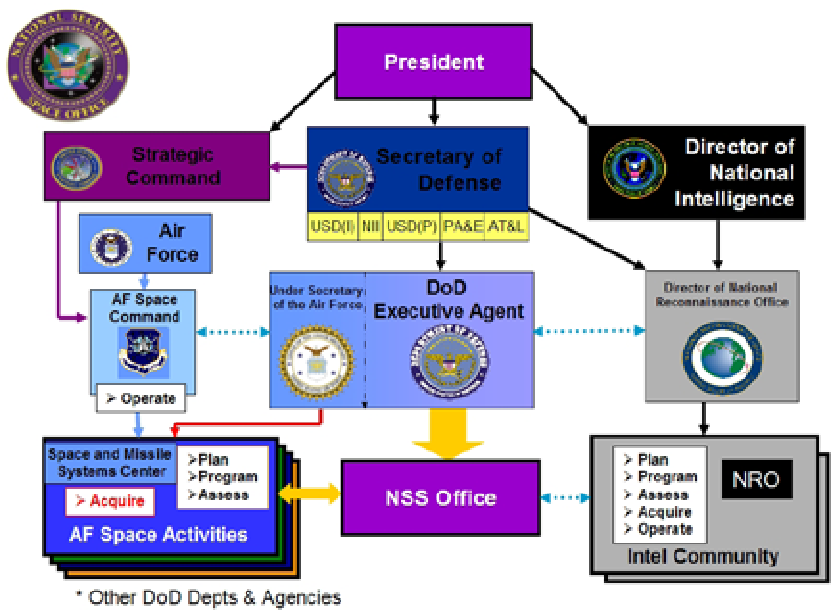
This presentation presents my personal views on approaches to space security. It represents the evolution of my thinking on space security based on 34 years of service as a space and missile systems officer. In keeping with the fundamental goal of the new US National Space Policy to "encourage international cooperation with foreign nations and/or consortia on outer space activities that are of mutual benefit",[1] this presentation emphasizes my belief that the most effective cooperative approaches to space security will emerge through thoughtful and sustained dialogue among all major space actors in a number of venues. The time is now ripe for a number of primarily incremental, pragmatic, and technical steps forward on space security. It is in this spirit of building and sustaining a dialogue that I offer these thoughts.

It is important to provide a context before turning to my specific recommendations on approaches to space security. First, a discussion of the major national security space (NSS) bureaucracy within the Department of Defense (DoD) and some less formal structures helps to reveal the roots and foundations for many of my thoughts and provides a sense for where responsibilities may lie within the US government for developing and implementing future approaches to space security. Next, briefly reviewing the growing importance of outer space for military, civil and commercial applications provides perspective on the pathways towards space security that may prove most fruitful. Finally, a discussion of the major elements of the recently released US National Space Policy helps relate my ideas to likely future approaches to space security by the US government.

Organizational structures and conceptual frameworks for NSS

A major insight from the study of bureaucratic politics indicates, "where you stand is where you sit". In other words, the position of an organization on any given issue is usually influenced primarily by the bureaucratic location of the organization. This organizational behaviour reflects Max Weber's "iron law of bureaucracy" and is the expected behaviour flowing from Tip O'Neill's observation that "all politics is local"; organizations must at least survive if not prosper in their local bureaucratic environment in order to advance their broader objectives. As shown in Figure 1, the primary lines of formal authority for NSS flow down from the President through three major paths. The first is an operational military chain of command from US Strategic Command (STRATCOM), the unified (or multi-Service) command responsible for military space, to Air Force Space Command. The second

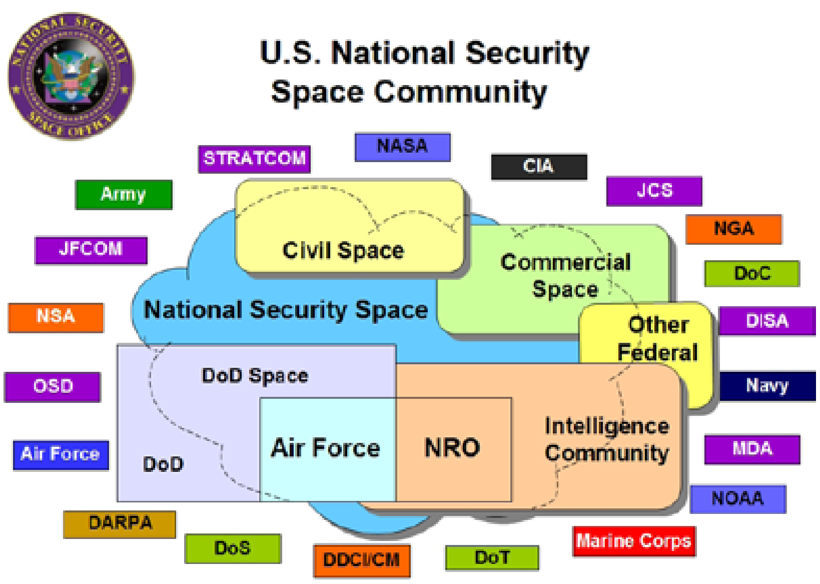
Figure 1. Lines of formal authority for NSS



is the civilian chain of command from the Secretary of Defense into the STRATCOM chain just described, as well as to the Under Secretary of the Air Force in his role as DoD Executive Agent for Space and given his authority over the Space and Missile Systems Center for space system acquisition. The final line flows from the Director of National Intelligence and the Secretary of Defense to the Director of the National Reconnaissance Office (NRO) to plan, acquire and operate NSS systems to support the intelligence community and DoD. The most interesting yet problematic lines of authority or information flow are those between these three paths, represented by the two-way dotted lines in the figure. As emphasized in the 2001 Report of the Commission to Assess National Security Space Management and Organization (the Space Commission), NSS should be managed and organized as a comprehensive enterprise that includes all these elements. Unfortunately, several key Space Commission recommendations were never implemented and other initially implemented recommendations have devolved into a more constricted structure.[2] In short, it has been a daunting challenge to manage and organize NSS as a single enterprise and it is not yet clear whether the range of current efforts in this area will result in a trend toward more integration or less.

In contrast to the clear lines of responsibility and authority depicted above, Figure 2 (informally known as the "cloud chart") is a much better illustration of how things actually "sit" when it comes to NSS issues in the United States. For many NSS issues, there are large numbers of actors floating around without clear lines of authority or responsibility, and coalitions of these actors assemble, reassemble and dissolve depending on the issue at hand.

Figure 2. The "cloud chart"



This highlights that things are far from monolithic when it come to NSS decision-making in the United States and that the actual decision-making structure is probably a lot closer to the consensus- and coalition-building required in structures such as the European Union, the North Atlantic Treaty Organization or the Conference on Disarmament.

Other ways to group and conceptualize space activities focus on what is being done rather than the decision-making structure. One of the most useful of these typologies is dividing space activities into the civil, commercial and NSS sectors. For the United States, major stakeholders within the civil space sector include the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration and the Federal Aviation Administration. Key stakeholders in the commercial space activity sector include communications satellite operators such as Intelsat and Loral Skynet, commercial remote-sensing operators GeoEye and DigitalGlobe, and the major space system developers Lockheed Martin, Boeing, and Northrop Grumman. Finally, the key stakeholders within the NSS sector include the Air Force, NRO, other services and agencies within the DoD and intelligence community, and the Department of State. In today's world, with digital convergence and a growing number of dual-use systems, it has become increasingly difficult to draw clear lines between space activity sectors or to delineate between the roles and missions of the major stakeholders.

A final conceptual approach contains 11 capability categories that comprehensively describe all DoD NSS activities. These categories are missile warning/defense; satellite communications; position, navigation and timing; intelligence, surveillance and reconnaissance; space control; space access; space command and control; environmental monitoring; force application; enabling capabilities (science and technology, human capital and the space industrial base); and satellite operations. This is the most descriptive framework and it is the approach most often used by my office and other DoD offices charged with outer space responsibilities.

The growing importance of commercial and military space capabilities

Thinking about different ways to categorize space activity is helpful but, no matter how those categories are constructed, it is critical to recognize the growing global importance of space activities, particularly in the commercial and military sectors. These short comments can only begin to touch on all the ways space capabilities impact nearly every aspect of modern life. It is also clear that the transparent and ubiquitous nature of space capabilities makes it more difficult to assess the full value of their contributions. Space capabilities are essential enablers of globalization and contribute in important ways to what Thomas Friedman describes as the "flattening" of the world.[3] They have become a foundational and increasingly important component of US and global security efforts and, due to their dual-use nature, have become even more important to and seamlessly woven into the modern global economy. Space capabilities enable the opening and development of new markets, such as direct television and radio broadcasting or space tourism, and bring unprecedented levels of knowledge and precision to traditional activities such as farming or package and vehicle tracking. Measuring these space-enabled economic contributions is difficult, but they are clearly growing. The Futron Corporation found that the world satellite industry generated revenue of US$ 88.8 billion in 2005; the Space Foundation adds government space budgets to these commercial activities and estimates that total space activity was valued at almost US$ 180 billion worldwide in 2005.[4]

As illustrated by the evolution of warfare over the last century, military space capabilities have played an absolutely critical role in modern warfare. This evolution through the First and Second World Wars showed that coupling the increasingly lethal products of the industrial revolution with improved military organizations and doctrine created fearsome war machines. The results of attrition warfare also necessitated development of what Stephen Biddle calls the modern system: a complex combined-arms approach to fire, manoeuvre and concealment that enables survival and military effectiveness but requires an adaptive and well-trained military to produce the skills required for success in the modern battlespace.[5] Operation Desert Storm in 1991 marked the emergence of space-enabled transitional warfare. Space systems designed for Cold War strategic missions, such as the Defense Support Program (DSP) missile launch detection system and systems that were not yet completed in 1991 such as the Global Positioning System (GPS), produced transformational effects on the conduct of the war from the lowest tactical levels up through the highest strategic-level applications. Today's military space capabilities have become so seamlessly integrated into the overall US military structure that commanders can remain focused on strategic objectives and simply call for specific effects on specific targets without having to focus on how those effects will be achieved. For example, during Operation Enduring Freedom in Afghanistan during 2001–2002 and

Operation Iraqi Freedom in 2003, the majority of aircraft took off on their combat sorties without having an assigned target; they were dynamically tasked in flight onto targets that emerged after they took off. This is a highly flexible and capable instrument and it simply would not be possible without all the space capabilities that comprehensively enable the military tool of statecraft. Moreover, it is an instrument that can deliver precise effects while minimizing collateral damage.

The new US National Space Policy

Most students of space policy have already become quite familiar with the new US National Space Policy released in October 2006, so this section moves beyond the policy itself to challenge what I consider to be misinformed, if not disingenuous, interpretations of the policy that have since emerged.[6] It is clear that it would have been helpful had the Bush administration been more proactive in rolling out the policy, especially since most of the critiques ultimately come down to matters of style and tone rather than substance. We should also acknowledge, however, that effective perception management must be a long-term, multidimensional effort, and that any work to set the stage for the arrival of the new space policy, regardless of how proactive it might have been, would still have faced significant challenges given the unpopularity of the Administration in many quarters internationally.

Contrary to what one is likely to glean from far too much of the reporting by the media, the current US National Space Policy is very similar to the 1996 Clinton policy and shows great continuity not only with that policy but with all US space policy going back to the Eisenhower administration. The primary objective of the new policy is to enable and maintain free access to and use of outer space for peaceful purposes for the United States and all states of the world—and for the benefit of all humankind. The new policy also emphasizes that US space capabilities should be protected commensurate with their planned use. In the past, almost every incremental investment in NSS went towards developing more capabilities rather than protecting existing capabilities; finding the resources required to develop protection measures, and institutionalizing the changed mindset needed to implement this part of the policy, will be a significant challenge. One key distinction from previous policy is that the new policy more clearly and publicly articulates the longstanding US position that the existing Outer Space Treaty regime is sufficient and that "[t]he United States will oppose the development of new legal regimes or other restrictions that seek to prohibit or limit U.S. access to or use of space."[7] It is my hope that this public candor on the part of the United States will help to make the most likely and productive paths for forward progress more clear and energize efforts in Vienna, Geneva and elsewhere.

Recommended approaches to space security

Having briefly provided the context above, this section presents several specific approaches to space security in hopes that they will help to generate and sustain a dialogue on these issues. There is much consensus on the broad outlines of where the international space community is heading on many space security issues, but, as in so many other critical issue areas, the devil is in the details concerning how to proceed. As the most important first step, the United States should work harder to achieve more universal adherence to the Outer Space Treaty regime. It simply does not make sense to charge far ahead when this key foundational piece still has significant gaps in terms of compliance with existing rules and norms. The United States should also encourage more frequent but less formalized cooperation and dialogue among like-minded states and major space actors. Ronald Sega, as the DoD Executive Agent for Space, with my office supporting him, has already taken several steps in this direction. For example, he chairs an annual meeting with the chief executive officers of all major commercial satellite communications providers, such as Intelsat and Inmarsat, and this transparent effort is helping to institutionalize a process for the improved sharing of space situational-awareness information and good housekeeping practices in outer space. One specific good housekeeping tool that may be developed from this effort would be a data warehouse for ephemeris and propagation data for all active satellites. Such a warehouse would make freely available information that could be used by satellite operators to plan for and avoid conjunctions.[8]

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 emerge. Consider, for example the role of the UK and US navies in enforcing global norms against slave trading. What are analogous roles in outer space for the US 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 encourage like-minded actors to cooperate on such an initiative? In my view, attempts to create regimes or enforcement norms that do not specifically include and build upon military capabilities are likely to be stillborn, sterile and ultimately frustrating efforts.[9]

In keeping with the preference of the United States for bilateral efforts or informal discussions with like-minded states and major space actors, rather than formal negotiations among all parties, there is a range of informal transparency- and security-building measures that should be explored at this point. The United States should work, primarily with the UN Committee on the Peaceful Uses of Outer Space (COPUOS), to institutionalize the Inter-Agency Debris Committee guidelines among all major space actors. The incremental, pragmatic and technical perspective of COPUOS is well suited to this effort. Development of "rules of the road" or codes of conduct for outer space should draw closely from the development and operation of similar measures in other domains such as sea or air. We should consider the most appropriate times and ways to separate 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 is inappropriately ambitious and is likely to be unhelpful. The DoD requires safe and responsible operations by warships and military aircraft, but these do not always follow all the same rules as commercial traffic and often operate within specially protected zones that separate them from other traffic. Full and open vetting of these ideas along with others will help us to develop space rules that draw from our years of experience in operating in these other domains and make the most sense for the unique operational characteristics of outer space.

Notes

1. United States, *U.S. National Space Policy*, 31 August 2006.
2. United States, *Report of the Commission to Assess National Security Space Management and Organization*, 11 January 2001.
3. Thomas Friedman, *The World is Flat: a Brief History of the Twenty-First Century*, Farrar, Straus, and Giroux, 2005.
4. Futron Corporation, *State of the Satellite Industry Report*, June 2006; The Space Foundation, *The Space Report 2006: the Guide to Global Space Activity*, 2006.
5. Stephen Biddle, *Military Power: Explaining Victory and Defeat in Modern Battle*, Princeton University Press, 2004.

[6] Robert Joseph, "Remarks on the President's National Space Policy—Assuring America's Vital Interests", *Center for Space and Defense Forum*, Colorado Springs, 11 January 2007; see also Marshall Institute, *Policy Outlook: What Do You Leave Behind? Evaluating the Bush Administration's National Security Space Policy*, December 2006.

[7] United States, *U.S. National Space Policy*, 31 August 2006.

[8] For other space security ideas fostered by these meetings see David McGlade, "Commentary: Preserving the Orbital Environment", *Space News*, 19 February 2007, p. 27.

[9] 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*, vol. 1, no. 1, 2006, pp. 29–51.

PUTTING CURRENT SPACE MILITARIZATION AND WEAPONIZATION DYNAMICS IN PERSPECTIVE: AN APPROACH TO SPACE SECURITY

Kiran Nair

Self-interest drives all humanity. It drives commerce, science, technology and other forms of human advancement, as well as conflicts over resources, interests, opinions and so on. Military force structures are primarily extensions of these dynamics and are generally reflective of agendas to further as well as secure one's own areas of interest. These dynamics have ensured that humanity has never been peacefully united. Hence the chances of peaceful coexistence in outer space are also remote, unless the compulsions of common interest overwhelm those of individual interest (or technological advancements reduce the need for warfare over such). With regard to outer space, the compulsions of common interest are building up with every passing day; the utility of outer space becomes increasingly global rather than national. On an optimistic note, the dynamics of common interest have traditionally been instrumental in balancing aspirations as well as in furthering reasonable compromises and solutions.

And yet, it would be too ambitious to assume that these compulsions of common utility would soon lay to rest the multitude of problems related to issues of outer space security, arms racing in outer space and so forth. It would be some time before such a situation could be arrived at and hence, in the meantime, it is imperative to explore the options now available and attempt to obtain solutions to problems within the confines of the prevailing dynamics of space militarization and weaponization. It goes without saying that any approach to space security necessitates an exploration and generic comprehension of the military's established and known perceptions on the utility of outer space, since it is this that finally drives the militarization and weaponization.

General military perceptions on use of outer space

Most military doctrines place extraordinary emphasis on acquisition of the "high ground" for military advantage and it is these doctrinal precepts which drive the quest to go higher and higher for the delivery of ordnance and terrestrial observation. The allure of the high ground makes humankind go beyond horses and elephants to aircraft and spacecraft in the quest for military advantage. Outer space enables a more efficient and safer means for observation or delivering ordnance. As a corollary, as the military advantages of outer space become more promising and increasingly apparent, perceptions that it is a realm worth fighting over also gain currency.

Broadly, as in the case of legislative endeavours wherein legal precedents form a basis for conceiving new laws, operational doctrines also attempt to draw analogous parallels from existing doctrine to formulate the means for gainful military utilization. Military doctrines related to airpower characterized the best means of gainfully employing the high ground. Thus, in spite of technological, environmental and other differences, prevailing military space employment doctrines primarily build upon airpower doctrines (see Table 1). It is fairly well known that these perceptions are largely those of the US Air Force and the rest of the militaries across the globe generally follow the same with minor variations to suit national requirements and capabilities. Following the collapse of the Soviet Union, the United States is the remaining global role model and the operational validation of these concepts during the Gulf War, and every conflict the United States has been involved in thereafter, have only enabled these perceptions to be widely accepted and established.

Table 1. Military perceptions regarding the utility of outer space

Role	Typical airpower mission	Contemporary space mission
Control of environment	Counter air missions	Counter space missions
Applying combat power	Air-based force application	Space-based force application
Multiplying combat power	Airborne combat support	Space-based terrestrial combat support or force enhancement
Sustaining combat force	Support operations	Space support operations

The doctrinal premises and perceptions shown in Table 1 have largely been driving the militarization and weaponization of outer space. This is not a phenomenon of the new millennium, but rather has been the case since the dawn of the space age. For example, almost a decade prior to Sputnik, the German V-2 rockets transited through the lower fringes of outer space to deliver ordnance. By the mid-1950s both the Soviet Union and the United States were engrossed in developing their respective space delivery and, at a lesser pace, space observation platforms. While one would like to believe otherwise, the initial perception of the utility of outer space was in terms of military rather than civilian use.

As a matter of fact, within four years of the 1957 launch of Sputnik I, almost the entire range of capabilities afforded by outer space for conventional military force enhancement were in place. And within the first few years, measures to deny these capabilities and to destroy satellites were in place. This was in addition to developments in ballistic missiles, as well as measures to counter them. Thus, within the first decade of the space age, space-based military missions for ordnance delivery (force application), conventional military force enhancement/multiplication (force enhancement), and control of the environment (space control) were already possible.[1]

The Outer Space Treaty (OST) came at a time when the nuclear superpowers were actively pursuing their agendas of military advancement by utilizing outer space. More importantly, in civilian terms, not much utility or involvement was foreseen. It was perhaps in keeping with the realities of that age that the OST made certain allowances for military uses of outer space. These were exploited then, are exploited now and will continue to be so until a balanced agreement on the military utilization of outer space is arrived at for the greater common good of all humanity. The prevailing reality is that the allure of outer space is irresistible for militaries across the world and this is not likely to undergo drastic change in the near future.

The point is, certain military allowances will have to be made and others will have to be forsaken in view of the greater common good. It will be essential to try to identify workable parameters and push these for a technical and legislative approach to space security. A middle path which allows for the pursuit of certain military capabilities, ensures the interests and aspirations of most countries, and at the same time does not indiscriminately endanger all humanity would need to be explored and developed as a sustainable approach to space security. To arrive at such a middle path, it will be essential to discuss what constitutes an arms race in outer space. Based on this, it would be possible to pursue avenues to contain the impending weaponization of outer space.

What constitutes an arms race in outer space

From a historical perspective, even prior to Sputnik, the world community, including the Soviet Union and the United States, overwhelmingly favoured the use of outer space for peaceful purposes (at least publicly). The first UN resolutions on outer space, which included the phrase "peaceful purposes", were reflective of this. The initial and widespread interpretation of the term in relation to outer space was "non-military". However, soon after the launch of its early satellites, the United States began changing its position, claiming instead that the term meant "non-aggressive". The Soviets initially held on to the first interpretation, but eventually accepted the newer. By this time both had satellites in orbit performing military tasks, and the term soon became understood globally as "non-aggressive". The term continues to lack a precise authoritative definition and hence is open to interpretation.

The interpretation continues to expand according to state interests and practice.[2] The prevailing interpretation is that objects in outer space which have "no direct destructive" capability are not considered as weapons and thus satellites providing military force enhancement are legitimate. Civil satellites as well do this in terms of communication, observation and so forth. As a consequence, non-military satellites have been employed for force enhancement, a variety of states pursue the acquisition of such capabilities, and reverting back to an absolute "non-military" interpretation is not feasible. Most states have great interest in developing such capabilities; none are known to have contested this interpretation.

Most legal attempts to restrict the weaponization of outer space have addressed the placement of destructive capabilities in outer space (specifically weapons of mass destruction), the application of military force from outer space or the use of outer space for war-fighting. Such are circumvented by developing space weaponry which cannot be classified as weapons of mass destruction, yet is equally or perhaps more potent. Global weaponization concerns have heightened following the United States' withdrawal from the Anti-Ballistic Missile Treaty, as well as its development of a range of space war-fighting technologies, such as air-launched anti-satellite (ASAT) missiles, air- and space-based lasers and hypervelocity rod bundles.

It is here that technical and legal approaches would have to be reviewed and further pursued; at least an attempt to maintain the current state affairs must be made. On a more optimistic note, most states aim to use outer space for the protection of their assets, as well as conventional military force enhancement, and not for military force application from outer space or for space-based war-fighting.

Finding an approach to prevent weaponization

There are no easy solutions to the problem of weaponization of outer space. The Conference on Disarmament has been deadlocked since 1998 and yet much has occurred since then to merit a renewed attempt to resolve the issue. Since then, a variety of states have launched satellites for dedicated military use or have leased capabilities from civil or commercial satellites. Going back to the military's doctrinal precepts, the number of states interested in missions of space-based force enhancement has increased as never before. More significantly, military, civil and commercial space activities have become so strongly intertwined that it is difficult to distinguish and discriminate. Thus, unlike in the Cold War era, target discrimination is now much more complex and difficult.

At the same time, with China's recent ASAT test, the realization that space weaponization would be grossly detrimental to the common good has raised concerns as never before. Unlike the 1960s and 1970s, when ASAT concerns were of decisive interest to two opposing states and of academic interest to most other parties, the situation today has changed drastically, with the number and the variety of stakeholders in outer space having multiplied greatly. Space security issues have become more democratized, affecting a larger number of states as well as non-state actors.

On the other hand, the era of microsatellites has arrived, which are more dispensable and easily replenishable than larger types. The point being made is that in the near future it would no longer make much military sense for states to destroy each others' satellites during crises or conflicts. Not only will ASAT-evasion and -survivability measures have matured, but the complexities of discrimination would multiply and, even considering a hypothetical scenario wherein a satellite is destroyed, other military assets would provide enough redundancy to make destroying satellites pointless. In the present and near future, the possibility of non-state actors posing a threat to space-based assets is remote. Nevertheless, it will be essential to guard against complacency and measures would need to undertaken to pre-empt the dangers and secure against such possibilities well ahead of time. Along with broader changes in geo-politics, security and technology, the dynamics of space security have undergone tremendous change. The challenges are more diverse and significant, but so are the opportunities. Levels of global concern are much higher, and a larger number and variety of interested parties must endeavour to find solutions to the issue of weaponization.

Looking for solutions within dynamics of counter space operations

Nevertheless, it would be too ambitious to assume that states with considerable interests could be dissuaded from attempting to exercise control over the realm of outer space. It is therefore essential to explore a middle path within this military mission so as to enable an achievement of military aspirations without compromising the common interest of humankind. Narrowing down to specifics,

> Offensive counterspace operations involve the use of lethal or nonlethal means to neutralize an adversary's space systems or the information they provide. … [O]ffensive counterspace operations are designed to achieve five major purposes:
>
> - Deception—manipulate, distort or falsify information
> - Disruption—temporary impairment of utility
> - Denial—temporary elimination of utility
> - Degradation—permanent impairment of utility
> - Destruction—permanent elimination of utility.[3]

Of these five "Ds", military force structures aimed at the first four are already in place in some cases. States do have overt and covert capabilities for achieving the first four goals and a most desirable situation (yet unattainable during the last four decades) would be the total elimination of such missions. The dynamics of human self-interest preclude the possibility of any such proscription, especially if the experiences of the last five decades are taken as any indication. The fifth, which relates to permanent elimination, is the most damaging to the common good and is also the least sensible in military terms; hence, such missions could be targeted for prohibition. Unlike aircraft and ships, the resulting debris from the destruction of a space-based asset would become an indiscriminate threat. Secondly, as pointed out earlier, the dynamics of redundancy will soon make the permanent elimination of capabilities near impossible. The reduction of capabilities in most cases would be of a temporary nature only. Unmanned vehicles, ballons and other aircraft would enable gaps to be filled in little time. The point is, if achieving the first four D's can make a system unusable, then going for a mutually damaging destructive strike would not make much military sense. Hence, if states could be prevailed upon to abstain from the latter on account of the physical, military, as well as other, challenges, and if technological and legislative approaches could be undertaken for permanent elimination of destructive missions, at least the emergent threat of an ASAT race in outer space could be contained.

Ballistic brouhaha

The next major problem relates to ballistic missile defence (BMD). Historically, BMD has always been a fantastic, albeit not very workable, concept. It has never been very convincing and if the operational military experiences of the recent past are any indication, the concept appears even more militarily incredible now than ever before. Apart from the usual challenges of target detection, discrimination and destruction due to multiple vehicles, decoys and so forth, the components of a BMD system (for example sensors and data links) are quite fragile and could be targeted in order to degrade of the entire BMD apparatus. For example, ASAT weapons of the type China recently tested may not be effective against incoming missiles, but they can certainly temporarily degrade the components of the BMD system. Attempts to target space-based sensors and tracking systems, which effectively are the spine of the BMD, could theoretically be undertaken, though the worth and effectiveness of this approach would be highly suspect. Apart from the other challenges, keeping the BMD "umbrella" securely in place would itself be a great challenge, as demonstrated by the recent Chinese ASAT test and the unstoppable barrage of Katyusha rockets during the Hezbollah–Israel conflict. No known effective defences against terrain-hugging cruise and other kinds of long-range missiles presently exist. The classic BMD umbrella concept continues to be enormously desirable, but whether it is presently (or even in the near future) viable and vital to national defence is a moot question, notwithstanding the attention given to the subject. By extension, the possibility of confining these endeavours to the atmosphere, rather than extending them into space, could be explored.

Looking for solutions in force application missions

The above mission relates to creating assets for the application of military force from outer space. While enormously logical and appealing in military terms, in physical terms it is extraordinarily challenging. Fantastic visions have been put forth, monetary allocations made and yet use of these is enormously suspect. Left open to technical or economic audit, these visions might not be truly convincing and hence perhaps are cloaked in secrecy. Missions of space-based force application are characterized by enormous scientific, economic and legislative challenges. As of now, these have not gainfully matured and are already controversial. The point is, these visions and technologies have been “emerging” for decades and are yet to debut in any credible manner wherein extraordinary decisive military advantage accrues. Thus, time and opportunities do exist in the present for studied, deliberate attempts to try and hold the clock and even push back programmes in this area.

Conclusion

It goes without saying that there are no easy solutions and approaches to the issue of disarmament in outer space. Approaches to exploit new opportunities and mitigate challenges would need to be undertaken. A comprehensive solution has not been forthcoming in the last five decades and hence it would be too ambitious to expect one within the next five years. Nonetheless, the compulsions of human self-interest demand solutions for the fulfilment of military, commercial and civilian goals. The quest for solutions is therefore bound to continue and solutions not entirely satisfying and yet agreeable could be arrived at and it would be in the common interest of all to strive for this.

Notes

1 As a matter of fact, projects aimed at denying the realm of space were contemplated ever since it became possible to insert objects into outer space. For example, the US Project Argus in 1958 was aimed at

creating an artificial radiation belt around near-earth by detonating a nuclear device in space. The Soviets also followed suit and conducted nuclear blasts in outer space in 1962. However, the passage of the Limited Nuclear Test Ban Treaty in 1963, made such detonations in outer space unlawful and simple verification measures made them easily detectable

2 Whereas the results of the attempts in interpretation remain unfinished to this day as per the 1969 *Vienna Convention on the Law of Treaties*, the words in a treaty must be interpreted in accordance with their ordinary meaning. In general the term peaceful is defined as disposed or inclined to peace; aiming at or making for peace; friendly, amicable, pacific. It is obvious that this description cannot be applied to any current or past military use of outer space.

3 For details, see Space Commission Threat Annex, p. 5, available at <www.globalsecurity.org/space/library/report/2001/nssmo/article05.pdf>.

FUNDAMENTAL WAYS TO ENSURE OUTER SPACE SECURITY: NEGOTIATING AND CONCLUDING A LEGALLY BINDING INTERNATIONAL INSTRUMENT

Zhang Ju'nan

Over the past half century, humankind has made great achievements in the exploration and use of outer space, which has helped to advance the evolution of civilization. Today, just like the land, ocean and sky, outer space has become an indispensable part of everyday life, and our reliance on outer space is increasing. Foreseeably, the twenty-first century will witness a growing number of states participating in and benefiting from the exploration and use of outer space.

Lasting peace in outer space is closely linked to the security, development and prosperity of every state. Security in outer space impacts global security in all other realms. Given this, what effective measures can we take to safeguard peace and security in outer space? It is an important and urgent question for the international community.

As we all know, with the growing exploration and use of outer space, the international community has been haunted by the increasing possibility of weaponization and an arms race in outer space. More and more governments, non-governmental organizations and research institutes are very much concerned with this.

Facing this threat, what should we do? For one, we may just neglect it and stand by without taking any action. Or, we can amend the existing international legal instruments and try to solve the problem. A third option is to establish confidence-building measures and a code of conduct to increase transparency and guide our activities in outer space. Another option would be to negotiate and conclude a new legally-binding international instrument, so as to completely avoid the danger of weaponization and arms racing in outer space.

It goes without saying that no one can bear the consequences of the first choice. Weapons and weapon systems of all kinds would be placed in outer space, which would trigger a new round of arms races. Peace and harmony in outer space would be sabotaged, and what we have achieved through the peaceful use and exploration of outer space would be seriously threatened. The results would be the same for peace and stability on Earth. It is a pity that some governments insist there is no danger of weaponization or arms racing in outer space, hence no need to negotiate a new legal instrument on outer space. However, history has shown that prevention is more effective and less costly than a remedy. We have already witnessed so many difficulties and hardships on the path to nuclear disarmament and non-proliferation; we should not allow humankind to be dragged into another quagmire due to our inaction.

On amending existing legal instruments. This year marks the fortieth anniversary of the entry into force of the Outer Space Treaty. This treaty and other related agreements have undoubtedly played a key role in promoting the peaceful use of outer space. However, they all have limitations. Some are targeted only at weapons of mass destruction, and others are limited in application to certain celestial bodies or areas. Amendments can hardly close the loopholes. Moreover, opening them to revision might arouse a series of political, legal and technical problems. So, amending the existing legal instruments is not feasible.

On transparency and confidence-building measures. Transparency and confidence-building measures could facilitate trust, lessen misunderstandings and prevent conflicts. To a certain extent, they have already played active roles in arms control and disarmament. However, we should see that these measures have their inherent limitations, especially in that they are not legally binding. Such measures rely on the voluntary implementation of governments. Good will is far from enough to keep outer space free from weapons; what we need is a legally binding international instrument.

So, the best choice is to conclude a new legally binding instrument through negotiation to fundamentally prevent weaponization and arms racing in outer space. And we now have a favourable foundation on which to start our work.

First of all, there is extensive political support for negotiating and concluding a new outer space legal instrument. For the past two decades, the General

Assembly has adopted resolutions by an overwhelming majority of votes on the prevention of weaponization of outer space, calling for the negotiation and conclusion of an international legal instrument on preventing such. Last year, 178 countries voted in favour of such a resolution. To negotiate and conclude such an instrument at an early date reflects the will of all peoples.

Secondly, the Conference on Disarmament (CD) has rich experience that could be applied to such an instrument. From 1985 to 1994, the CD had established ad hoc committees for ten consecutive years. In-depth discussions had been carried out on definitions, guidelines and other relevant issues.

In 2002, China, together with Belarus, Indonesia, Russia, Syria, Vietnam and Zimbabwe, submitted working document CD/1679 entitled "Possible Elements for a Future International Legal Agreement on the Prevention of the Deployment of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects". This document made concrete proposals for elements of a future treaty, which could serve as a blueprint for our work in the CD. China and Russia also jointly submitted thematic documents on issues of definition, verification, and transparency- and confidence-building measures. The above documents have gained wide support and favourable comments from many countries and organizations.

All these indicate that through years of effort of the international community, it is time for the CD to start work. What we need now is the political will and resolution of all governments. Time is not on our side. It is time for the international community to take action for the peace and security of outer space, and the interests of humankind.

THE TREATY ON THE PREVENTION OF THE PLACEMENT OF WEAPONS IN OUTER SPACE, THE THREAT OR USE OF FORCE AGAINST OUTER SPACE OBJECTS

Anton Vasiliev

In his speech in Munich on 10 February 2007, President Vladimir Putin announced that Russia had prepared a draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects (PPW). We are now holding consultations on the draft with our partners. After these consultations, we intend to table the draft PPW in the Conference on Disarmament (CD). We hope that we shall be able to do this before the end of the 2007 session.

In the course of recent CD debates on outer space issues, we have already reached a common understanding that all states are interested in keeping outer space from turning into an arena for military confrontation, in assuring security of outer space and in the safe functioning of outer space objects. It is important that we all share these interests. The issue is how to realize these in practice.

Russia is open to all ideas and proposals in this respect. We do not rule out any possibility. But we believe that the best way to meet these goals is to elaborate and adopt a new treaty, namely the PPW.

Why a new treaty?

Why is a new treaty needed? First, because new obligations, covering the well-known gaps (and ever-expanding with the development of technology) in international law, must enjoy the same status as the norms and rules currently in force. Second, because new obligations will entail inevitable limitations on national military activities and on national business, which should be regulated by domestic legislation, including liability in case of violations. Third, because such obligations should be a reliable factor of national security for all states.

One of the possible options for the new treaty is working out an additional protocol to the Outer Space Treaty, banning the stationing in outer space not only of weapons of mass destruction, but weapons of any kind. We are not against this option in principle. But it is hard to imagine a situation where, at the same time, we would have consensus on such a protocol, on the one hand, and no consensus on PPW, on the other. If we reach agreement in principle that outer space must not be weaponized, it is better to fix it by an option (that being the PPW) which is stronger, more focused and detailed, and tailored to the realities of today.

Transparency and confidence-building measures are important for strengthening trust in outer space activities, for enhancing safety in outer space manoeuvring, for decreasing motivation for the weaponization of outer space and for obtaining the necessary climate for negotiating a new treaty on the prohibition of weapons in outer space. Through a General Assembly resolution, Russia has initiated in the United Nations a new round of updating recommendations on TCBMs in outer space activities. Such may also become a part of the new treaty. But they cannot substitute for a legally binding PPW. Thus they should not weaken our efforts and attention on a PPW in the CD, although reaching agreement on TCBMs could be a relatively easy way to support such work.

Weaponization of outer space is not an option

Using weapons placed in outer space to assure outer space security, in our view, is not an option, as it will bring less, not more, security. Why is this our position?

First, it would be difficult to predict the development of the strategic situation in outer space and on Earth due to the global operating range of space weapons. It would be impossible to prove that space weapons were not targeted at a given nation. Moreover, space weapons would enable states to discreetly tamper with outer space objects and disable them.

Second, the international situation would be seriously destabilized due to the possibility of unexpected and sudden use of space weapons. This alone would provoke preemptive acts against space weapons and, consequently, present the danger of an arms race.

Third, space weapons, unlike weapons of mass destruction, may be applied selectively and discriminately, thus they could become "real-use" weapons.

Fourth, the placement of weapons in outer space would arouse suspicions and tensions in international relations and destroy the current climate of mutual confidence and cooperation in exploration of outer space.

Fifth, attaining a monopoly on space weapons is an illusory goal—all kinds of symmetrical and asymmetrical responses would inevitably follow, which in substance would constitute a new arms race.

To be sure that no one is preparing to place weapons in outer space—and Russia, the United Kingdom and the United States have already made specific political statements that they were not doing so—the non-weaponization of outer space should become a universal legally binding norm.

How will a PPW enhance security in outer space?

We are not proposing a treaty on the prevention of an arms race in outer space (PAROS). But we intend to resolve the issue before it is a problem. If we prohibit the placement of weapons in outer space and everyone observes this ban, there can be no arms race in outer space. In other words, by addressing the issue of non-weaponization of outer space we are at the same time averting the danger of a possible arms race in outer space. However, this alone is not enough. The normal functioning of outer space objects can be disrupted without space-based weapons, but with weapons based elsewhere or by other actions not related to the use of weapons. In order to protect outer space objects from such threats and to prevent any other force-related actions in outer space, we propose to supplement the non-weaponization obligation by another one—that of non-use of force or threat of force against outer space objects. Thus, in a certain sense, a PPW would be a solution to the threat of arms racing in outer space.

What would be and what would not be prohibited by a PPW?

We are proposing a treaty which is realistic and practicable. No weapons are placed in outer space now. We want to keep this status quo. We are proposing prevention, which is easier than elimination or limitation or non-proliferation. Nothing of what the states now possess in outer space will be affected in any way. On the contrary, the main purpose of PPW is to assure that safety and security of outer space assets is guaranteed. This fully applies to the satellites which provide information services in the interests of national defence of the states.

Compared to CD/1679, the draft PPW will provide some basic definitions which could be useful for the clarification of the specific scope of a treaty, but will not set precedent for the discussions on terms and definitions of international outer space law, which have been going on in the UN Committee on the Peaceful Uses of Outer Space (COPUOS) for decades. These definitions were elaborated in a joint working paper by Russia and China (CD/1779). They are "outer space", "weapon in outer space", "outer space object", "placement" and others. These definitions will answer some important questions. For example, ballistic missiles flying through outer space will not qualify for being "placed" in outer space, and thus will not be limited. On the other hand, these missiles will not qualify as "outer space objects" and thus will be exempt from the rule of no use of force against outer space objects. This means that ballistic missile defences will not be limited by the PPW, except for the prohibition of placing their "striking" components in outer space, because then they would qualify as "weapons".

The no-use-of-force obligation is an application to outer space activities of article 2(4) of the UN Charter. It covers a wide range of possible hostile actions against outer space objects: destruction, damage, injuring normal function, disruption of channels of communication with ground command and control centres, deliberate alteration of the parameters of orbit, and so on. In any case, it implies the prohibition of such *actions* against outer space objects, and not the prohibition of the *means* (the hardware) to exercise such actions. It is understood that it would be impractical to create tools for the use of force in outer space if the use there of force itself is banned. This obligation, while not prohibiting directly the development of non-space-based anti-satellite weapons, bans their testing and use against outer space objects. This obligation seems to be more verifiable than a ban on the development of such systems, which would be hard to control.

Taking into consideration recent developments, we believe that the window of opportunity for negotiating a PPW is not very wide. That is why we cannot wait too long. To speed up work on a PPW, we are not going to provide for a verification mechanism, which for the time being may be substituted for by a set of confidence-building measures. A special verification protocol can follow the treaty at a later stage. This does not mean, however, that compliance with a PPW's provisions is unverifiable and that verification is not needed. A special study of this issue by our Canadian colleagues (CD/1785) has proved that verification of non-placement of weapons in outer space is possible in principle. We agree with their conclusions. But they have also clearly shown how difficult the practical realization of verification procedures can be.

No doubt, at this stage it is premature to discuss further details of a PPW before it is formally tabled. Some details of its contents may be altered in the course of ongoing consultations. Nevertheless, we have had two rounds of very useful and productive discussions on the topic during the focused thematic debates in the CD in February–March 2007. These discussions have revealed some additional facets of PPW scope which may require further careful consideration.

Generally speaking, we are driven by the belief that, in the final count, a PPW would serve the security interests of all states and will contradict the interests of none. We expect that after the draft PPW is formally introduced, the CD will focus its substantive work under agenda item 3, PAROS, on the issue of the prevention of the placement of weapons in outer space, threat or use of force against outer space objects.

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

Jessica West[1]

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 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.

DEVELOPMENTS IN BALLISTIC MISSILE DEFENCES

Peter Hays

Understanding key interrelationships between space and missile defences is an issue of growing importance. Space capabilities empower modern life in fundamental yet transparent and ubiquitous ways. During the Cold War, outer space was primarily the domain of the superpowers, but today space capabilities shape, and are shaped, by global politics among almost all actors ranging from individuals up through states. The role of missile defences in global politics has changed even more radically since the end of the Cold War, moving away from focusing on strategic stability between the superpowers and towards potential contributions to dissuading rogue actors from acquiring weapons of mass destruction and ballistic missiles and defending against those that do. Yet the role of missile defences in the structure and stability of the relationships among nuclear-armed states remains an issue of critical importance and growing complexity due to a number of factors, including declining numbers of offensive systems and the increasing potential of space systems to contribute to defences. This paper briefly examines these issues by describing the US space-enabled reconnaissance strike complex, reviewing the current state of US missile defence developments, and evaluating key dimensions of the interrelationships among these elements.

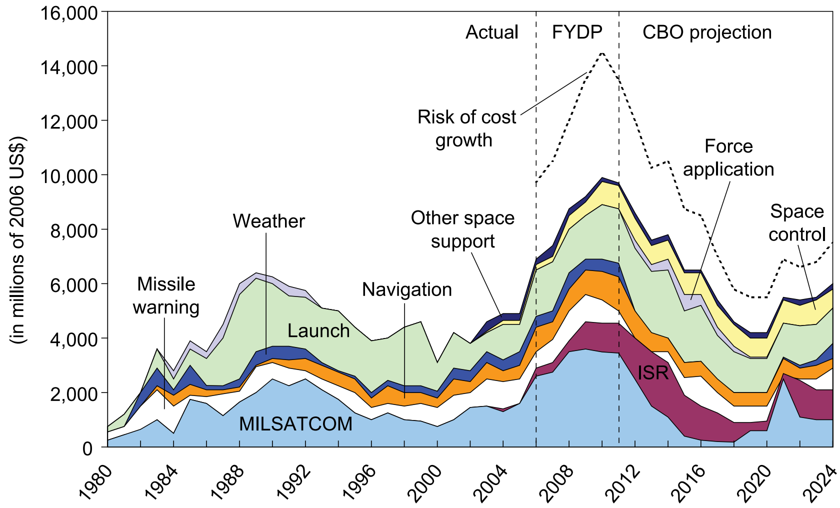
Empowered by a space-enabled, global reconnaissance, precision-strike complex, the United States and coalition forces achieved rapid and decisive conventional military successes during Operations Desert Storm in the Persian Gulf in 1991, Allied Force in Serbia in 1999, Enduring Freedom in Afghanistan in 2001 and Iraqi Freedom in 2003. These decisive victories in conventional combat illustrate how space capabilities have enabled transformation and created a new American way of war. The Department of Defense (DoD) is seeking to continue and accelerate this military transformation by developing even lighter and more easily deployable forces that can be defended globally and strike more precisely from greater distances. Space capabilities often provide the best, and sometimes only, way to pursue these ambitious transformational goals. There are, however, many difficult and fundamental issues related to space and missile defences, including the role of dual-use space capabilities in enabling the information revolution and modern life, the potential for space and missile-defence capabilities to dissuade and deter emerging military competitors and defend against new threats, and the proper place of diplomacy, spacepower, and missile defences in the changed geopolitical environment following the end of the Cold War and the 11 September 2001 attacks. These complex factors contribute to uncertainty about the utility of investments in space and missile defence capabilities versus other enabling military capabilities or diplomatic initiatives. The United States faces major challenges in its current plans to modernize, improve or replace almost all major military space systems because most of these acquisition programmes have encountered significant cost overruns and deployment delays. In addition, further development of missile-defence capabilities must contend with domestic and international political opposition, technological and testing challenges, and growing costs. It is not clear how the political support and opposition to these developments will evolve, whether the United States will be able to sustain the political will and resources required to continue these modernizations, if the technology required for these future systems can be developed and integrated on cost and on time, and how these new capabilities may accelerate military transformation and affect geopolitics. In short, the potential of space and missile-defence capabilities continue to grow much faster than our ways of thinking about them and it is unlikely that Cold War mindsets will be a sound foundation for building the conceptual frameworks needed for the future.

The US reconnaissance–strike complex and analytical frameworks

The US national security space (NSS) sector includes DoD programmes, conducted primarily by the Air Force, to enhance national security and National Reconnaissance Office (NRO) activities to collect intelligence data from outer space. The NSS sector is also divided sometimes into separate sectors known as the military or defence space sector and the intelligence space sector. Following implementation of one of the recommendations of the January 2001 Commission to Assess National Security Space Management and Organization (Space Commission) Report, the DoD now uses an accounting procedure known as the virtual Major Force Program (vMFP) to track NSS spending.[1] According to the Congressional Research Service, the total DoD request for space spending amounted to US$ 22.12 billion in 2005 and is US$ 22.66 billion for 2006.[2] A Congressional Budget Office

(CBO) study found that unclassified military space acquisition budgets grew from US$ 4.9 billion to US$ 6.9 billion, or more than 40%, between 2005 and 2006.[3] Overall trends in all planned major military space acquisition through 2024 are shown in Graph 1. The most important line on the graph, labelled Risk of Cost Growth, illustrates that space acquisition expenditures will peak at US$ 14.4 billion in 2010, or nearly triple present funding, if current programmes follow the historic trend of an average 69% rise in costs for space research, development, engineering and testing, as well as an average growth of 19% in space procurement costs.[4] Clearly, it will be very difficult for the United States to maintain the scope and timing for its currently planned, nearly simultaneous improvements and modernizations for almost all major NSS systems.

Graph 1. Investment in major unclassified military space programmes



Source: Congressional Budget Office, *The Long-Term Implication of Current Plans for Investment in Major Unclassified Military Space Programs*, Congressional Budget Office, 12 September 2005, p. 3.

Three major analytical frameworks shape most discussions about NSS capabilities—space activity sectors, military space mission areas and military space doctrines. There are four space activity sectors: civil, commercial, military and intelligence; many traditional space activities fall neatly into one of the sectors, although the growing number of dual-use space systems, digital convergence, and growth in the commercial space sector is making it increasingly difficult to delineate the sectors.[5] There are also four military space mission areas: space support, force enhancement, space control and force application.[6] Currently, force enhancement is the most important military space mission area; due to growth in the number and efficacy of space systems, many analysts believe these systems now produce effects that have moved beyond force enhancement and today enable a wider range of military missions to be undertaken or even contemplated. Table 1 shows the major divisions within force enhancement as well as the current and projected space systems to support these missions. Finally, building on the analysis of David Lupton, there are also four major military space doctrines: sanctuary, survivability, control and high ground.[7] The attributes associated with these doctrines—functions, operational characteristics and desired organizational structures—are shown in Table 2.

Almost all US space capabilities help to enable the reconnaissance–strike complex, but the discussion below focuses on the policies and capabilities most directly associated with these capabilities and missile defences. Currently, the Air Force maintains a constellation of geostationary Earth orbit (GEO) satellites, called the Defense Support Program (DSP), to provide warning of ballistic missile launches and some data on the type of attack and the missile's intended target. The most recent launch of a DSP satellite occurred in February 2004 and the launch of the last DSP satellite (DSP-23) has been delayed several times but is now scheduled to take place during the fourth quarter of 2007. DSP's successor is the Space-Based Infrared System (SBIRS), a programme designed to satisfy operational military and technical intelligence overhead non-imaging infrared requirements, provide improved detection, and supply foundational assessment capabilities for ballistic missile defence. Lockheed Martin is the prime contractor for SBIRS. The operational SBIRS constellation was envisioned originally to include four GEO satellites, two highly elliptical orbit (HEO) payloads on classified host satellites, and one spare GEO satellite. In addition, the Missile Defense Agency (MDA) is considering a Northrop Grumman system formerly known as SBIRS-Low and now named the Space Tracking and Surveillance System (STSS). MDA plans to launch two demonstration satellites in 2007. If these demonstrators work well in tracking missile launches and warheads, an operational STSS system could follow, with a first launch in the 2016–2017 timeframe.

Table 1. Force enhancement mission areas, primary orbits, and associated space systems[8]

Environmental Monitoring	**Communications**	**Position, Navigation, and Time**	**Integrated Tactical Warning and Attack Assessment**	**Intelligence, Surveillance, and Reconnaissance (ISR)**
Polar Low-Earth Orbit (LEO)	Geostationary Earth Orbit (GEO)	Semi-synchronous Orbit	GEO and LEO	Various
Current Defense Meteorological Support Program (DMSP)	**Current** Defense Satellite Communications System (DSCS) II, DSCS III, Ultra-High Frequency Follow-on (UFO), Milstar, Global Broadcast System (GBS), Iridium, commercial systems	**Current** Global Positioning System (GPS) GPS II GPS IIR GPS IIR-M	**Current** Defense Support Program (DSP), GPS	**Current** Imaging (IMINT) Satellites, Signals Intelligence (SIGINT) Satellites, commercial systems
Projected National Polar-Orbiting Operational Environmental Satellite System (NPOESS)	**Projected** Advanced Extremely High Frequency (AEHF), Wideband Gapfiller System (WGS), Mobile User Objective System (MUOS), Polar Military Satellite Communications System, Transformational Communications System (TSAT)	**Projected** GPS IIF GPS III	**Projected** Space-Based Infra-Red System (SBIRS), Missile Warning Satellite Systems Program, Space Tracking and Surveillance System (STSS)	**Projected** Future Imagery Architecture (FIA), Integrated Overhead SIGINT Architecture (IOSA), Space Radar

Table 2. Attributes of military space doctrines

	Primary Value and Functions of Military Space Forces	**Space System Characteristics and Employment Strategies**	**Conflict Missions of Space Forces**	**Appropriate Military Organization for Operations and Advocacy**
Sanctuary	Enhance Strategic Stability Facilitate Arms Control	Limited Numbers Fragile Systems Vulnerable Orbits Optimized for National Technical Means (NTM) verification mission	Limited	National Reconnaissance Office (NRO)
Survivability	Above functions, plus Force Enhancement	Terrestrial Backups Distributed Architectures	Force Enhancement Degrade Gracefully	Major Command or Unified Command
Control	Control Space Significant Force Enhancement	Autonomous Control Hardening On-Orbit Spares Crosslinks Manoeuvre Less-Vulnerable Orbits	Control Space Significant Force Enhancement Surveillance, Offensive, and Defensive Counterspace	Unified Command or Space Force
High Ground	Above functions, plus Decisive Impact on Terrestrial Conflict Ballistic Missile Defence	Stealth Attack Warning Sensors 5 Ds: Deception, Disruption, Denial, Degradation, Destruction Reconstitution Capability Active Defense Convoy	Above functions, plus Decisive Space-to-Space and Space-to-Earth Force Application Ballistic Missile Defence	Space Force

The first SBIRS HEO payload was delivered in August 2004 and the first GEO satellite is expected to launch in 2008. SBIRS is probably the most troubled NSS acquisition effort—a Defense Science Board report called it "a case study for how not to execute a space program."[9] Total cost estimates have jumped to nearly five times the original estimates, and the programme has triggered four required reports to Congress for breaching limits on cost overruns.[10] In December 2005, Under Secretary of Defense for Acquisition, Technology, and Logistics Kenneth Krieg and DoD Executive Agent for Space Ronald Sega restructured the programme significantly. Current plans call for no more than three GEO SBIRS spacecraft in the restructured programme and purchase of the third satellite will be contingent on performance of the first. In addition, the restructuring called for Krieg to retain milestone decision authority over the SBIRS programme and for Sega to develop alternative infrared satellite systems (now known as the AIRSS programme). The intent is to generate competition for SBIRS GEO 3, exploit alterative technologies and be ready for launch by 2015. Under the 2006 Future Years Defense Program (FYDP) and CBO's projection of its implications, investment spending for DSP and SBIRS would total about US$ 11 billion through 2024.[11]

Fundamental US policy goals for position, navigation and time (PNT) were reiterated by a Space-Based PNT Executive Committee Fact Sheet dated 15 December 2004. These objectives call for the United States to maintain uninterrupted PNT services for all user needs, remain preeminent in military PNT, provide civil services that exceed or are competitive with foreign PNT services and continue as an essential component of internationally accepted PNT services, and promote US leadership in PNT.[12] One of the most difficult challenges, mandated by Navigation Warfare requirements, is to operate the Global Positioning System (GPS) effectively despite adversary jamming; deny use to adversaries; not unduly disrupt civil, commercial or scientific uses outside an area of military operations; and identify, locate and mitigate interference on a global basis.[13] The Air Force acquires and operates the GPS constellation, which currently contains 30 satellites developed through a series of block upgrades. In September 2005 the Air Force began launching Lockheed Martin block IIR-M satellites, which incorporate two new military signals and a second civilian signal. It plans to start launching Boeing block IIF satellites, which will broadcast a third signal for civilian use, in 2007. The first block III satellites, originally scheduled for launch in 2013, will include improvements such as better anti-jam capability and satellite crosslinks for more accurate signals. As part of the "back-to-basics" approach to space acquisition, and as a result of current on-orbit GPS satellites exceeding their design lifetimes, Air Force Under Secretary Sega decided not to award a GPS III contract as originally planned during 2006 and indicated that the contract award may be delayed for more than one year.[14] Based on the 2006 Budget, the CBO projected that the total investment spending on the GPS would be US$ 12.5 billion through 2024.[15]

Space control capabilities are key enablers of all NSS activity. These programmes focus on developing ground- and space-based sensors to enhance space situational awareness (SSA, meaning knowledge of activity and events in, or that could affect, circumterrestrial space), improve capabilities to protect friendly space assets from enemy attack, and develop capabilities to negate enemy space capabilities. SSA programmes include Spacetrack, which is developing radar and optical sensors, and the Space-Based Surveillance System and other ground systems designed to track objects of interest in outer space. Other space control programmes—such as the Rapid Attack Identification, Detection, and Reporting System (RAIDRS) and the Counter Communications System (CCS)—focus on developing technology to protect friendly systems or to disrupt, deny, degrade or destroy enemy space capabilities. Joint Publication 3-14, *Joint Doctrine for Space Operations*, discusses ways to gain or maintain space control by providing freedom of action through protection and surveillance or to deny freedom of action through prevention and negation.[16] Air Force doctrine, by contrast, aligns space control doctrine, like air doctrine, as offensive counterspace (OCS) and defensive counterspace (DCS). OCS missions would disrupt, deny, degrade or destroy space systems, or the information they provide, if these systems are used for purposes hostile to US national security interests. DCS missions include both active and passive measures to protect US and friendly space-related capabilities from enemy attack, interference or use for purposes hostile to US national security interests.[17] Funding for the Orbital Deep Space Imager, a space-based system designed to track objects in GEO, was eliminated from the president's budget request in 2007. Under current plans, research, development, testing and evaluation funding for space control programmes would increase from US$ 195 million in 2006 to US$ 768 million in 2011.[18] SSA and space control are areas of particular concern in Congress, as indicated by the tasking of the Secretary of Defense in the 2006 National Defense Authorization Act (NDAA) to report to Congress about these topics in April and July 2006, respectively.[19] The overarching goals in the SSA Strategy and Roadmap report to Congress call for the development of a data-enabled user-defined operational picture and the ability to attribute all activity in circumterrestrial space to man-made or natural causes. The House Armed Services Committee (HASC) mark-up of House Resolution 1585 (the NDAA for 2008) calls for an additional US$ 130 million for SSA and space control programmes.

Development of systems with the potential to apply force to, in, or especially from, outer space is of even greater congressional, public and international concern. These concerns are exacerbated by significant difficulties in distinguishing between concepts and technologies being developed for ballistic missile defence, protection, space control and force application, as well as the development of some of these systems in classified programmes. Domestic groups opposed to space weaponization, such as the Center for Defense Information (CDI) and the Stimson Center, argue that momentum created by experiments testing space control and force application concepts in outer space will create "facts in orbit", driving US policy toward space weapons without debate by either Congress or the public.[20] The programmes of greatest concern to these groups include the MDA's Space-Based Interceptor Test Bed, and Near Field Infrared Experiment (NFIRE); as well as the Air Force's Experimental Satellite System (XSS) and Autonomous Nanosatellite Guardian for Evaluating Local Space (ANGELS).[21] It is difficult, however, to see how the United States could continue improving its space protection and ballistic missile defence capabilities without the data provided by conducting these relatively small-scale experiments, how the experiments could appreciably change any facts in orbit, or how they might lead to full-scale space weaponization without triggering significant public debate, especially given all the space acquisition woes the United States faces. Indeed, the cumulative effect of current NSS acquisition problems has contributed to a small but perceptible shift in priorities away from space control and force application. Comparison of the most recent Space Posture statements to Congress by the Under Secretary of the Air Force shows the greater emphasis that Peter Teets placed on assured access to and freedom of action in outer space while his successor, Ronald Sega, has not focused on this area but has emphasized consistently a "back-to-basics" approach to acquisition.[22]

The Common Aero Vehicle (CAV) programme is the primary effort by the United States to develop force application capabilities, but this programme is not very robust and it is doubtful whether it will result in any fielded hardware. Under the joint Air Force–Defense Advanced Research Projects

Agency (DARPA) programme office created in December 2002, the CAV programme was envisioned originally as a conventional warhead that would be launched from an intercontinental ballistic missile (ICBM), or potentially from an orbiting space platform, and was part of the Force Application and Launch from Continental United States (FALCON) programme. However, the FALCON portion of the CAV programme was restructured. Now known as Falcon (lower case), the programme is focused on the development and transition of more mature technologies into a future weapon system capable of delivering and deploying conventional payloads worldwide from and through outer space. Within the Falcon programme, CAV has been redesignated the Hypersonic Technology Vehicle and all weaponization activities have been excluded. The 2006 FYDP calls for total funding of less than US$ 100 million per year for those programmes through 2011. The CBO's projection assumes the limited deployment of 40 CAV-equipped ICBMs in about 2015, at which point the demand for investment resources would peak at US$ 600 million.[23]

US missile defence developments

The George W. Bush Administration publicly announced its policy on ballistic missile defence on 20 May 2003. This policy emphasizes that changes in the global security environment caused by the end of the Cold War and the 11 September 2001 attacks, as well as a growing number of missile and weapons of mass destruction (WMD) threats, "requires a different approach to deterrence and new tools for defense."[24] Among the most worrisome recent events are the North Korean Taepodong-2 launch in July 2006 and the nuclear weapon test in October 2006, continuing Iranian testing of a number of increasingly longer-range missiles such as the Shahab-3 and major efforts to develop nuclear weapons, and the close cooperation between these rogue actors in developing these systems.[25] Even more disturbing is Pyongyang's demonstrated willingness to sell every weapon it has developed to any actor able to pay. The Bush Administration also stresses the consistency of its policy with the National Missile Defense Act of 1999 which stated, "It is the policy of the United States to deploy as soon as it is technologically possible an effective National Missile Defense system capable of defending the territory of the United States against limited ballistic missile attack (whether accidental, unauthorized, or deliberate)".[26] In light of these changes in the geostrategic environment and its greater enthusiasm towards missile defences, the Bush Administration has taken several incremental but significant steps towards improving United States ballistic missile defence capabilities, including withdrawing from the 1972 Anti-Ballistic Missile (ABM) Treaty, increasing missile defence funding and fielding the first dedicated missile defence interceptors on US soil since the 1970s. The request for missile defence funding submitted to Congress in February 2007 for the 2008 budget is US$ 8.9 billion, a decrease of US$ 500 million from the amount appropriated the year before. "Within this budget, the Missile Defense Agency (MDA) has allocated $4 billion for the development of new capabilities, $2 billion for testing of new and existing capabilities, $2 billion for fielding of existing capabilities, and $900 million to sustain fielded assets."[27] To implement the policy, MDA is taking a three-part approach "[to m]aintain and sustain an initial capability to defend the U.S., allies, and our deployed forces against rogue attacks; close the gaps and improve this initial capability; and develop options for the future."[28]

MDA's plans call for a number of actions over the FYDP to maintain and sustain its initial capability to defend the United States, allies and deployed forces against rogue attacks. Continuing deployment of two interceptor missile systems, the Standard Missile-3 (SM-3) aboard Aegis cruisers and Ground Based Interceptors (GBI) in Alaska and California, is one of the most important steps to attain this initial capability. Plans call for taking delivery of up to 40 SM-3 and 30 GBI by the end of 2008. Additional planned actions to maintain and sustain initial capabilities include enhancing early warning radars in Alaska, California and the United Kingdom; fielding a sea-based X-band radar in the Pacific and a forward-transportable radar in Japan; and expanding command and control, battle management, and communications capabilities. To close gaps and improve its initial capabilities over the FYDP, MDA plans to add more Aegis interceptors, field four transportable Terminal High Altitude Area Defense (THAAD) units, introduce land and sea variants of the Multiple Kill Vehicle (MKV) programme, upgrade the early warning radar in Greenland, and establish a GBI site and corresponding radar capability in Europe. Finally, to create options for the future MDA plans to continue development of the Space Tracking and Surveillance System (STSS); maintain two programmes, the Kinetic Energy Interceptor (KEI) and the Airborne Laser (ABL), one of which is to be selected as the boost-phase missile defence element by 2010; and develop a Space Test Bed to examine space-based options for expanding the coverage and effectiveness for future missile defence systems.[29]

Many concepts and programmes associated with missile defences have been highly charged politically and strategically since before the Reagan Administration announced the Strategic Defense Initiative in 1983, and elements of the Bush Administration's programme are no exception. It is likely that reenergized political debates over the efficacy and wisdom of missile defences will arise following the capture of both houses of Congress by the Democrats in November 2006. Thus far, however, most Democratic critiques of missile defences in the 110th Congress have been somewhat restrained and centered more on technical issues such as cost and test performance rather than broader strategic issues. Among many controversial issues, several stand out including the third European site for the GBI and associated radar. Congress cut the funding for this site last year, and so far this year the HASC mark-up has eliminated the US$ 206 million requested for 2008 and would require the DoD to complete a comprehensive independent study on the implications of developing a third site. In addition, there have been numerous high-level objections raised by the Russians and there are political issues in Poland and the Czech Republic, the proposed host states for the 10 GBI and associated radar.

Another perhaps less politically charged but more technologically challenging programme is the ABL. The ABL has recently made some technical progress, including a successful airborne test of the target illuminator lasers in March 2007 that demonstrated an ability to track an airborne target and measure and compensate for atmospheric distortion, but the initial airborne attempt to intercept a boosting missile has been pushed back again and is now scheduled for late 2009. The ABL was fully funded at US$ 632 million in 2008 and the 2008 request is US$ 549 million, but the HASC mark-up has reduced this by US$ 250 million. There is also some controversy surrounding the Kinetic Energy Interceptor (KEI) and the MKV. Both programmes had funding cuts last year and it is not clear whether the KEI would offer a significant new capability such as boost-phase intercept capability or a mobile launcher. Testing issues have been a perennial concern for all missile defence systems and many elements of the current defence architecture have endured multiple test failures or only partial successes, even under less than stressful testing scenarios. Recently, many elements of the defence architecture have had far greater success, and MDA had 13 successful tests out of 14 attempts during 2006, but concerns remain, particularly among Democrats in Congress, about the breadth and scope of future testing and certification requirements. Finally, perhaps the most controversial issue of all directly relates to the interrelationship between space and missile defences and concerns the proposed Space Test Bed. Opponents argue this test bed is unnecessary, will weaponize space, and will destabilize relations with other major nuclear-weapon states such as China and Russia. Supporters believe the test bed is needed to subject space-based interceptors (that could be similar to the Brilliant Pebbles concept first discussed in the late 1980s) to testing under operational conditions and that such interceptors are required to build a capable global boost-phase intercept capability. They also point to China's 11 January 2007 anti-satellite (ASAT) test to show that threats are growing and that "space weapons" need not be stationed in outer space. The request for the Space Test Bed for 2008 is US$ 10 million and requested funding is projected to grow to US$ 15 million for 2009, but the HASC mark-up provided no funding for test bed.

Contentious space and missile defence issues

As outlined above, there are many controversial programmatic issues associated with space and missile defences. Unfortunately, however, these programmatic controversies pale in comparison to strategic and diplomatic contention over their proper role. Probably the broadest and most important point of contention concerns the quest to find a "sweet spot" where US missile defences are robust enough to assure allies and dissuade, deter and defend against rogue actors, without becoming powerful enough to have the potential to neutralize a significant portion of Chinese and Russian nuclear forces, thereby undermining concepts of strategic stability. These are complex and intangible values to be balanced and it is no surprise that sophisticated conceptual models capable of fully expressing this multidimensional problem have not yet emerged. Finding this balance is made more difficult by the growing number of nuclear- and missile-armed, and potentially rogue, actors, the decreasing numbers of deployed nuclear forces of the former superpowers, the growing accuracy of nuclear and conventional long-range strike systems, and the increasing potential of defensive systems and space-based defences in particular. Other analysts question whether it is possible or desirable to find this sweet spot because they do not wish to delay robust defences against rogue actors for a quixotic quest for balance and stability or to replicate Cold War paradigms based on mutual vulnerability with every emerging WMD actor. Given these difficulties, it seems unlikely that a balance acceptable to all major nuclear-weapon states can be found unless the number of potential rogue actors with WMD and ballistic missiles can be reduced or the perceived need for mutual vulnerability among nuclear-armed actors can be lessened.

A second set of highly contentious issues relates to the operational benefits and drawbacks of space-based, boost-phase missile defences versus concerns over weaponization of outer space and creation of space debris. Space basing would provide a number of potentially significant advantages for global boost-phase defence including always-deployed global coverage that precludes the need for crisis deployments into contested areas, rapid reaction times, and equal access to all potential launch sites. Boost-phase intercept allows engagement of missile targets during their slowest, most visible and most vulnerable phase of flight, and has the additional benefit that any WMD aboard the missile may fall back onto the territory of the attacker. Of course, there are also daunting technical and programmatic challenges associated with boost-phase defence including the requirement to engage targets very rapidly and the potential need to predelegate engagement authority to the defensive systems rather than being able to maintain human decision makers in the loop under certain conditions, the costs and technical capabilities of the defences, the absentee ratio of defences and the potential ability of attackers to saturate defences via salvo launches or other techniques, and the costs to boost, maintain and replenish such a system. At the strategic level, space-based defences raise concerns about weaponizing outer space due to the latent anti-satellite capability that any missile defence system is likely to have. Satellites are generally fragile and travel along predictable orbital paths; any defensive system capable of engaging missiles in the boost, post-boost or midcourse phases of flight will very likely have considerable latent ASAT capabilities and it is difficult to see how such capabilities could be engineered out of a defensive system. Moving towards resolution of this strategic-level concern will require balancing the costs and benefits of defences, especially against potential rogue actors or new and unexpected threats, with concerns about space weaponization and satellite vulnerabilities. As in the case of the sweet spot issue above, it is unlikely that major actors will value these concerns in the same ways or be able to resolve these issues easily. In addition, there is also the potential that testing or use of space-based defences could create space debris. The kinetics of interception for boost-phase defences are not likely to lead to orbital debris, and are especially unlikely to create long-lived debris, since neither the target nor interceptor is travelling on an orbital trajectory. Engagement of satellites or otherwise testing against objects with orbital velocities may create long-lived debris and the need for such actions should be balanced against the hazards to all space actors created by such debris.

A final set of contentious issues regarding space and missile defences concerns the definition of a space weapon and the potential utility of controlling or regulating such weapons versus the ability of a wide range of systems to produce significant weapons effects in outer space or against ballistic missiles, even if they are not based in outer space. Simply put, since so many systems in a variety of basing modes can have effects against ballistic missiles and especially space systems, it will be very difficult to define what a space weapon is or to control such systems. The United States is developing dedicated missile defence systems that are land-, sea- and air-based, and, as discussed above, the Bush Administration wishes to test space-based defensive systems. Are all of these systems space weapons? Does the basing mode matter and, if so, how? These issues are unclear, but the basing mode of a system does not seem to be nearly as important as the effects it can create and the ways in which it might be used. Of course, as illustrated by the 11 January 2007 Chinese ASAT test, the United States is not the only actor creating such dedicated capabilities. Probably even more significant are all the residual ASAT capabilities possessed by a wide range of systems that were not designed for this purpose. Every space object that can transmit or manoeuvre has some potential to interfere with, damage, or even destroy, other space objects by colliding with them. Problems in controlling residual ASAT capabilities would seem to be exacerbated by a number of trends, including rapid growth in the number of commercial assets in outer space, movement towards smaller satellites that are more difficult to find and track, and wider development of autonomous rendezvous and docking capabilities. In addition to all these problems, there are also numerous ways to cause interference with or disrupt satellite up- and downlinks or to attack or otherwise disrupt satellite telemetry, tracking and control facilities on the ground. Finally, even if all these definitional issues and problems with residual and latent ASAT capabilities could be addressed with some sort of controls, it is not clear that such controls would necessarily produce greater stability. In 1986, Ashton Carter explained the paradox of ASAT arms control—the idea that because space systems cannot be divorced from the strategic balance on Earth or the natural dialectic between offensive and defensive forces, an effective ban on ASAT weapons might make outer space safer for the development of major space-to-Earth strike systems and result in less strategic stability.[30] More recently, Michael O'Hanlon has questioned the need for space arms control and the desirability of granting sanctuary status to targeting systems that operate from outer space.[31] Cumulatively, these factors indicate that movement toward effective and stabilizing control of space weapons and missile defences will remain a daunting challenge and that it is an act of hubris to believe otherwise.

Notes

1 Unfortunately, programmes within the vMFP have not remained constant from year to year and have not always covered all major space systems, reducing the utility of this measure for tracking NSS expenditures over time.

2 Marcia S. Smith, *U.S. Space Programs: Civilian, Military, and Commercial*, Congressional Research Service, 9 August 2005.

3 Congressional Budget Office, *The Long-Term Implication of Current Plans for Investment in Major Unclassified Military Space Programs*, Congressional Budget Office, 12 September 2005, p. 1.

4 Ibid., p. 5.

5 Most US government documents list three rather than four space sectors. See, for example, the National Space Policy's discussion of civil, national security (defence and intelligence), and commercial sectors. Office of Science and Technology Policy, *Fact Sheet: National Space Policy*, the White House, 31 August 2006. For discussion emphasizing the four sectors see *Report of the Commission to Assess National Security Space Management and Organization*, Commission to Assess National Security Space Management and Organization, 11 January 2001, pp. 10–14.

6 Joint Staff, *Joint Doctrine for Space Operations*, Department of Defense, 9 August 2002.

7 David Lupton, *On Space Warfare: A Space Power Doctrine*, Air University Press, June 1988.

8 Satellites in low-Earth orbit (LEO) operate from less than 100 miles to several hundred miles altitude and complete each orbit in approximately 90 minutes. Polar LEO is ideal for many intelligence and weather applications because it covers all parts of the Earth several times each day as the Earth rotates and it also can be aligned in sun-synchronous orbits that arrive at the same location at the same time each day. Satellites in semi-synchronous orbit are located at approximately 12,500 miles altitude and complete an orbit every 12 hours. Geostationary Earth orbit (GEO) is located approximately 22,300 miles above the equator, a location where the satellites' orbital velocity matches Earth's rate of rotation and the satellite appears to

remain motionless above the same spot—a valuable attribute for communications and some signals intelligence satellites.

9 *Report of the Defense Science Board/Air Force Scientific Advisory Board Joint Task Force on Acquisition of National Security Space Programs*, Defense Science Board, May 2003, p. 6.

10 Government Accountability Office, *Assessments of Selected Major Weapon Programs*, 2006, pp. 101–2. Through the end of 2005, the SBIRS programme had triggered four reports to Congress under the Nunn–McCurdy Act; the programme breached its cost estimates by 25% in 2001, by 15% in 2004, and by 25% twice during 2005.

11 Congressional Budget Office, *Investment in Major Military Space Programs*, 2005, p. 12.

12 Office of Science and Technology Policy, *Fact Sheet: US Space-Based Positioning, Navigation, and Timing Policy*, the White House, 15 December 2004, p. 3.

13 Ibid., pp. 6–7.

14 Breanne Wagner, "Aerospace World", *Air Force Magazine*, vol. 89, no. 7, July 2006, pp. 21–2.

15 Congressional Budget Office, *Investment in Major Military Space Programs*, 2005, p. 9.

16 Joint Staff, *Joint Doctrine for Space Operations*, Department of Defense, 9 August 2002, pp. iv-5–iv-8.

17 US Air Force, *Counterspace Operations*, Doctrine Document 2-2.1, Air Force Doctrine Center, 2 August 2004, pp. 25–34.

18 Congressional Budget Office, *Investment in Major Military Space Programs*, 2005, p. 16.

19 Section 911 of the 2006 National Defense Authorization Act, "Space Situational Awareness Strategy and Space Control Mission Review".

20 Theresa Hitchens, Michael Katz-Hyman and Victoria Samson, *Space Weapons Spending in the FY 2007 Defense Budget*, Center for Defense Information, 8 March 2006.

21 Ibid. The NFIRE programme, in particular, has been the object of a great deal of attention and criticism after MDA revealed that the satellite would include a sensor-projectile that would approach and likely strike a target missile in space. This portion of the experiment was eliminated but Congress, in language accompanying the 2006 Defense Appropriations Act, encouraged the MDA to reconsider. MDA has said it will begin planning in 2007 to study the feasibility of adding a projectile to an NFIRE satellite. MDA requested US$ 10.8 million for NFIRE in 2007 and the 2006 budget for the effort was US$ 13.5 million.

[22] See the Space Posture statements presented to Congress by the two Under Secretaries of the Air Force in March 2005 and March 2006, respectively. Peter Teets resigned in March 2005 and was replaced by Ronald Sega in July 2005.

[23] Congressional Budget Office, *Investment in Major Military Space Programs*, 2005, p. 16.

[24] Office of the Press Secretary, *National Policy on Ballistic Missile Defense Fact Sheet*, the White House, 20 May 2003.

[25] Bruno Gruselle, "The Final Frontier: Missile Defence in Space?", *Disarmament Forum*, no. 1, 2007, pp. 53–7; and Independent Working Group, *Missile Defense, the Space Relationship, and the Twenty-First Century: 2007 Report*, Institute for Foreign Policy Analysis, 2006, pp. 2–4.

[26] Ibid.

[27] *Policy Outlook: Missile Defense Issues in the 2008 Budget Request—Issues and Background*, George C. Marshall Institute, February 2007.

[28] Ibid.

[29] Ibid.

[30] Ashton Carter, "Satellite and Anti-Satellites: The Limits of the Possible", *International Security*, vol. 10, no. 4, 1986, pp. 46–98.

[31] Michael O'Hanlon, *Neither Star Wars Nor Sanctuary: Constraining the Military Uses of Space*, Brookings Institution, 2004.

"HIT-TO-KILL" AND THE THREAT TO SPACE ASSETS

Jeffrey Lewis

Discussions about anti-satellite (ASAT) weapons often emphasize the motives for attacking space assets and the likely implications of doing so. Such discussions may overlook the role that technological factors play in the development of new military capabilities, as well as obscure measures that might be useful in managing the spread of such capabilities.

Although discussions about ASATs often focus on a variety of capabilities including direct-ascent weapons, lasers and microsatellites, the principal threat to satellites arises from missiles that use their kinetic energy to destroy an object in orbit—a technology called "hit-to-kill."

I want to argue for three premises. First, once uncommon hit-to-kill technologies are now at the early stages of spreading around the world. Second, the broad focus on space weapons and ASAT technologies, many of which are quite unrealistic and exotic, distracts from the technological challenge posed by the proliferation of hit-to-kill systems. Third, partial arms control measures, such as a ban on kinetic ASAT testing, may mitigate the most threatening aspects of hit-to-kill technology while avoiding some of the difficulties associated with more comprehensive agreements.

The spread of hit-to-kill technologies

China's January 2007 ASAT test was very different from the Soviet ASAT system tested during the Cold War. The Soviet system was a co-orbital anti-satellite that gradually manoeuvred into the same orbit as the target satellite, destroying it with a explosive charge.

The Chinese system, in contrast, used a technology similar to US ASAT and missile defence programmes where an interceptor strikes a target, using the kinetic energy of the impact to destroy the target. This was a tremendous technological achievement—only a few decades ago, hit-to-kill technologies were seen as extremely exotic.[1]

My account of the Chinese test is based on open source accounts largely provided by the US intelligence community, which US policy makers believe successfully monitored the development of the Chinese system.

Shortly after the test became public, National Security Council spokesman Gordon Johndroe told reporters the ASAT test used “a ground-based medium-range ballistic missile” that might have been a DF-21 (known to NATO as the CSS-5) or another missile developed specifically for the mission.

According to the National Air and Space Intelligence Center, the DF-21 has a range of about 1,800km with a 600kg payload.

We have very little information about the kill vehicle itself. Geoffrey Forden at the Massachusetts Institute of Technology has calculated that the mass of the kill vehicle, payload fairing and whatever structure held the interceptor to the missile was less than 600kg, possibly much less.

Given the challenges associated with hit-to-kill interception, Forden believes that the Chinese system would have used an optical tracking system to guide the kill vehicle to its target. Assistant Secretary Paula DeSutter stated that two previous Chinese ASAT tests did not result in an intercept. In earlier Chinese tests, the interceptor may have merely flown by the target, which may have been used to test the optical tracking system.

The target was FY-1C, an obsolete meteorological satellite launched by China in 1999. The satellite was typically in an 870km sun-synchronous orbit.

The intercept occurred approximately 700km north by northwest of the Xichang Satellite Launch Centre at 22:26 GMT, 11 January 2007. The satellite was travelling in excess of 7km/s; the interceptor at nearly 2km/s. The closing speed, therefore, would have been in excess of 8km/s.

The technology associated with the Chinese ASAT system is essentially similar to the technology that the United States has pursued for its ASAT and missile defence programmes. These programmes include the Ground-Based Midcourse Defense system in Alaska, which has not yet been declared operational. Although the Chinese and US systems have very different missions, the underlying technologies are identical. In 1999, John

Peller, then programme manager for what was called the National Missile Defense programme at Boeing, testified before the US Congress that the US anti-satellite and missile defence programmes used “the same type of vehicle, same type of intercept velocities.”

Moreover, the United States and China are not the only countries developing hit-to-kill technology. In November, India used a kinetic interceptor mounted on a Prithvi missile to intercept another Prithvi missile at 50km. India’s Defence Research and Development announced the test as the first step in developing an exoatmospheric interceptor. Although India’s kill vehicle intercepted the Prithvi at a much lower closing speed than the Chinese or US interceptor, if India were to develop a more capable interceptor and mate it to the Agni missile, it would be a system essentially similar to the Chinese ASAT. In addition to China, India and the United States, many US allies including Israel, Japan and our European partners are conducting research on hit-to-kill technologies in the context of cooperative missile defence programmes with the United States.

Interest in kinetic technologies in China, the United States and other states reflects a basic interest in developing a militarily relevant technology, but it is a technology in search of a mission. In the United States, we have variously emphasized ASAT missions and missile defence, moving money between programmes as our rationale evolved. Missile defence supplanted ASAT missions as the primary use of hit-to-kill technologies, in large part because of the debris risk that exoatmospheric kinetic intercepts might pose to US assets.

Whereas the United States has emphasized missile defence, it is understandable that China has emphasized ASAT applications that might be used to counter space-based components of a US missile defence system. It is possible that states such as India and Israel will reposition their hit-to-kill capabilities for ASAT missions.

Discouraging states from investing in kinetic technologies may be very difficult because many will want to master an advanced military technology, if only to understand how to counteract it.

Focusing on the threat from hit-to-kill technologies

Despite provocatively named programmes and the enthusiasm of a few die-hards, the United States is not moving to develop space-based strike weapons or destructive ASAT weapons. In any case, the technical and operational challenges facing the current Ground-Based Midcourse Defense system suggest that the United States remains very far from deploying space-based missile defence interceptors.

Moreover, few countries are interested in developing ASATs. In the most recent assessment for the US Congress, the Defense Intelligence Agency concluded that only China and Russia are likely to invest in ASAT weapons due to the financial and technical barriers.

However, some countries, including China and the United States, are developing hit-to-kill programmes that could support ASAT programmes. These technologies will largely threaten reconnaissance satellites in low Earth orbit. The most valuable assets—for navigation, communications and missile warning—are at much higher altitudes, between 20–40,000km and will remain invulnerable for a somewhat longer period.

If we change the way we think about this problem to emphasize the spread of hit-to-kill technology and the challenges it poses, I think the challenge facing the international community becomes much more straightforward. The spread of such technologies could result in very destabilizing relationships among states with nuclear weapons and space assets—a dynamic that I worry is emerging between China and the United States.

An effective US missile defence system would be destabilizing if Chinese leaders were to worry that defences would be used to shield the United States in the event of a strike against China. Similarly Chinese ASATs would be destabilizing if US leaders believed they were part of a strategy to blind the United States at the onset of a crisis.

The US military will not respond to the Chinese ASAT test by developing its own ASATs or emphasizing defensive measures. I believe the primary result of the deployment of a significant number of capable ASAT weapons would be to press the United States further toward pre-emptive strategies. General Cartwright, head of US Strategic Command, recently stated quite clearly that the United States did not need to respond "in space" to the Chinese test, but rather discussed using conventionally armed Trident missiles to strike launch facilities in China in a crisis.

This opens the possibility of a very dangerous escalation scenario—indeed, unclassified descriptions of US wargames suggest that efforts to mount a limited conventional strike against Chinese ASATs in an effort to discourage escalation may actually further escalate a crisis.

A second, less dramatic, but perhaps more everyday threat from the development of ASAT weapons is the opportunity cost. This is to say that efforts to mitigate the creation of debris, control traffic and manage the development of other space activities will be much harder to manage in a situation where states are pursuing ASAT weapons. Although China and the United States are central actors in this scenario as well, our colleagues in India, Russia and other states have a role to play in building a more stable, orderly environment in outer space.

Emphasizing space weaponization or other ASAT technologies distracts from the principal threat posed by the spread of hit-to-kill technologies—crisis instability—which will initially manifest itself the relationship between Chinese and US strategic forces.

Restricting ASAT testing?

Several partial measures have been proposed which would mitigate the danger to space assets from the spread of hit-to-kill technology without attempting to prevent what appears now to be an inevitable development in military affairs.

- One proposal, under discussion at the Union of Concerned Scientists, is a ban against debris-creating kinetic energy tests, which would limit hit-to-kill testing against sub-orbital objects.
- A second proposal, raised initially by Donald Hafner and Bhupendra Jasani in the late 1980s, would be to ban “high-altitude” ASAT testing.[2]
- A third proposal, by Geoff Forden, would places limits on the speed at which one object in orbit may approach another.[3]

These proposals might not eliminate latent ASAT capability, but they could improve the security of the most vulnerable assets—reducing the escalatory potential of any Chinese–US crisis. An agreement would very likely require a parallel discussion between Washington and Beijing on broader issues concerning the relative impact of strategic modernization programmes in both states.

These agreements have three other practical advantages that are worth considering:

- First, each proposal avoids the problem of restricting US missile defence programmes. Just as ASAT technologies were once seen as a way to circumvent the now-defunct ABM Treaty, prevention of an arms race in outer space (PAROS) negotiations have become seen in the United States as a way to resurrect the ABM Treaty and block the deployment of missile defences. Although I believe the United States should take steps to address concerns among China's leaders about our missile defence programmes, using PAROS as an agenda item is likely to result in agreements on neither the military uses of outer space nor missile defence.
- Second, a ban on debris-creating ASAT tests would be verifiable without intrusive measures. Indeed, US policy makers believe that the US intelligence community was able to monitor the development of China's ASAT programme quite effectively.
- Third, a ban on debris-creating ASAT tests avoids thorny problems of definition that emerge when we conceive of the problem much more broadly.

Although such an agreement resembling one of the proposals listed here would do little to address the underlying security dynamics that often prove decisive in such matters, even a partial agreement would initiate the process of dialogue upon which we could work together to build a more sustainable space environment, perhaps in the form of a code of conduct or "rules of the road".

Notes

1 This section is based on Geoffrey Forden, "An Analysis of the Chinese ASAT Test", *Jane's Intelligence Review*, April 2007.

2 Donald Hofner and Bhupendra Jasani, "An Arms Control Proposal Limiting High-Altitude ASAT Weapons", in John Holdren and Joseph Rotblat (eds),

Strategic Defenses and the Future of the Arms Race: A Pugwash Symposium, MacMillian Press, 1987, pp. 226–39. See also Ashton Carter, "Satellite and Anti-Satellite: The Limits of the Possible", *International Security*, Spring 1986, pp. 46–98.

3 Geoffrey Forden, "After China's Test: Time For a Limited Ban on Anti-Satellite Weapons", *Arms Control Today*, April 2007, pp. 19–23.

ORBITAL DEBRIS PRODUCED BY KINETIC-ENERGY ANTI-SATELLITE WEAPONS

David Wright

Introduction

Space debris can pose a long-term threat to the future use of outer space.[1] One of the biggest sources of such debris would be the intentional destruction of satellites by anti-satellite (ASAT) weapons.

Due to their very high speeds in orbit, even relatively small pieces of debris can damage or destroy satellites. Since debris at high altitudes can stay in orbit for decades or longer, it accumulates with time as more is produced. As the amount grows, the risk of collisions with satellites also grows. If the amount of debris at some altitude becomes sufficiently large, it could become difficult to use that region for satellites.

Since there is currently no effective way to remove large amounts of debris from orbit, controlling the production of debris is essential for preserving the long-term use of outer space.

There are two main sources of debris. The first source is routine space activity. This includes debris released in the process of launching satellites and debris created by the break-up of defunct satellites or booster stages in orbit, either due to explosions from leftover fuel or collisions with a second object.

The international community is attempting to address this issue, in part by developing debris mitigation guidelines to limit the debris created during routine space activities. This includes efforts by the Inter-Agency Space Debris Coordination Committee (IADC),[2] as well as guidelines developed by the UN Committee on the Peaceful Uses of Outer Space (COPUOS), which call for actions such as removing satellites from orbit when they are no longer operational.

The second source of debris is the intentional destruction of satellites in orbit by the testing or use of kinetic-energy ASAT weapons, which are intended to destroy satellites by physically colliding with them at high speed.

The use of such weapons can create enormous amounts of long-lived debris in orbit. While there is a general recognition that the debris created by such events is a problem for the space environment, the scale and severity of this problem does not appear to be widely understood.

This paper provides an introduction to the current debris population in outer space, and presents the results of calculations that show that the destruction of a *single* large satellite, similar to many of the current military reconnaissance and surveillance satellites, could have a significant, long-term impact on the space environment. Such an event could create as much large debris as would be generated in 70 to 80 years of routine space activity under strict debris mitigation measures of the kind mentioned above.

The calculations discussed in this paper use a model developed by the US National Aeronautics and Space Administration (NASA) to describe the break-up of satellites. This model is based on ground tests and historical break-up events, and has become the standard model for estimating the amount of debris resulting from the break-up of a satellite and the characteristics of that debris.

Orbital debris

Table 1 gives current estimates of the amount of orbiting space debris larger than 1mm. Roughly half of the total debris population is in low Earth orbit (LEO), that being at altitudes less than 2,000km.

The US Space Surveillance Network currently catalogues more than 11,000 objects.[3] This number is a small fraction of the total debris population, since for an object to be placed in the catalogue it must be tracked by ground sensors and its origin must be known. The objects in the catalogue primarily include debris particles with size greater than 5–10cm that orbit at relatively low altitude, as well as roughly 850 active satellites.[4]

Table 1. Estimated amount of debris in LEO

	Debris size		
	1mm to 1cm	**1cm to 10cm**	**> 10cm**
LEO debris	16 million	270,000	14,000
Total debris at all altitudes	150 million	650,000	22,000

Source: European Space Agency MASTER 2005, plus estimate of debris from the January 2007 Chinese test.

Since any object in a circular orbit at an altitude of 500km travels at 7.6km/s, even small pieces of debris can seriously damage or destroy a satellite.[5]

Debris between 1mm and 1cm in size can cause significant damage if it hits vulnerable parts of a satellite. While shielding exists that can protect against objects of this size, adding shielding increases the cost of satellites, and many satellites have minimal shielding.

Debris greater than about 1cm in size is dangerous since it can seriously damage or destroy a satellite in a collision, and there is no effective shielding against such particles. Debris between 1 and 10cm in size is especially dangerous because it is difficult to shield against, and since it cannot be reliably detected or tracked, satellites are unlikely to have warning to allow them to avoid colliding with such objects.

Debris greater than 10cm in size is a concern because it may be massive enough to cause a satellite to break up in a collision, creating large amounts of additional debris.

It is important to recognize that the altitude at which a satellite orbits is closely related to its function. For example, Earth imaging satellites are typically in orbits between about 300 and 1,000km altitude, since orbiting at higher altitudes would lower their resolution, and orbiting at lower altitudes would decrease the ground area they can see and increase the atmospheric drag, which would reduce their lifetime. As a result, creating debris at these altitudes can inhibit the ability to use outer space for these purposes.

Orbital debris is concentrated in those altitude bands that are heavily used, especially the bands from 800 to 1,000km, 1,400 to 1,500km, and the geostationary belt (36,000km). Nearly 3,000 of the 11,000 objects in the US catalogue lie in the altitude band from 800 to 1,000km.[6]

The lifetime of a piece of debris—the length of time it remains in orbit—depends on how strongly it is affected by atmospheric drag. This depends on the object's mass, size, and shape, and on the atmospheric density at the altitude at which it is orbiting. Since atmospheric density drops off roughly exponentially with altitude, orbital altitude has a dramatic effect on drag and debris lifetime. For example, an object with a lifetime of a couple of weeks if it were orbiting at 300km would have a lifetime of a year if it were orbiting at 500km altitude, a lifetime of several decades if it were orbiting at 700km and more than a century at 800km.

Kinetic-energy ASATs

In principle there are many types of weapons a state could use to interfere with the operation of a satellite, some of which are reversible (such as electronic jamming of satellite communications or laser dazzling of imaging satellites) and some of which are intended to damage the satellite (such as kinetic-energy weapons, high-power microwave weapons, or high-power lasers).

However, if attacks on satellites were to become viewed as legitimate acts during a conflict, there are incentives that could push states to use kinetic-energy ASATs for such attacks. In particular, the effectiveness of many of the ASAT weapons mentioned above is uncertain and difficult to verify. For example, the vulnerability of a satellite to a microwave weapon would depend on details of the satellite's design that the attacker is unlikely to know. Moreover, even if such an attack were successful and damaged the satellite's electronics, the satellite might not be completely disabled, and the attacker might not be able to verify how successful the attack was.

A successful attack by a kinetic-energy ASAT weapon, however, would likely cause damage that could be seen by sensors on the ground, and detecting severe physical damage would strongly imply that the satellite was no longer functioning. As a result, if a satellite were deemed an important enough military asset that a state decided to attack it, that country might have a strong incentive to use a kinetic-energy ASAT.

Debris from a kinetic-energy ASAT attack

Computer models developed in the past decade give a good approximate description of the debris resulting from the destruction of a satellite by a high-speed collision. The most comprehensive is NASA's Standard Break-up Model.[7]

We apply this model to the case of a kinetic-energy ASAT weapon with a mass of a few tens of kilograms colliding at velocities in excess of 7km/s with a satellite having a mass of 1 to 10 tons. This calculation gives the number of debris particles created and the size, mass and velocity distribution of these particles. This information, along with data on atmospheric density, can be used to calculate the orbits of these particles and estimate their lifetimes.

A collision of this kind would be "catastrophic", meaning that it would cause the satellite to completely fragment into debris particles (assuming a direct hit on the central mass of the satellite). This fragmentation occurs since the energy of the collision would be equivalent to detonating several hundred kilograms of high explosives.

The NASA model gives a condition for when a collision between a large object and a smaller one will be catastrophic.[8] According to this condition, an interceptor of 20kg striking a large satellite at 7.5km/s could completely fragment a satellite with a mass up to about 14 tons. This situation is relevant to satellites in LEO, since the orbital speed of satellites is roughly 7.5km/s, which sets the scale of the intercept speed for these attacks.[9] Of the nearly 400 active satellites in LEO, more than 200 have a mass greater than 450kg, more than 60 have a mass greater than one ton, and roughly 15 have a mass greater than five tons.

For an attack on a satellite in geostationary orbit (GEO), typical intercept speeds would be roughly 3km/s, which is the orbital speed of a satellite in GEO. At this speed, a 50kg ASAT could completely fragment satellites with mass up to about 5 tons. There are currently well over 300 active satellites in GEO with a mass of 1 to 5 tons; the vast majority of these are communication satellites, but they include US early warning satellites as well.

Number of debris fragments from an attack

The catastrophic break-up of satellites in orbit could produce a dramatic increase in the amount of space debris.

Applying the NASA model shows that the catastrophic break-up of a single 5- to 10-ton satellite would roughly double the total amount of debris currently in LEO greater than 1cm in size (Table 2).

Table 2. Estimated current debris population in LEO compared with the debris created by the catastrophic breakup of a 5- to 10-ton satellite

	Debris size		
	1mm to 1cm	**1cm to 10cm**	**> 10cm**
Current debris in LEO	16 million	270,000	14,000
Debris from the breakup of a 5- to 10-ton satellite	8–14 million	150,000–250,000	3,000–5,000

Note that the 3,000 to 5,000 pieces of large debris listed in Table 2 is two to three times the roughly 1,500 pieces of debris with size greater than 10cm currently in the heavily used altitude band between 800 and 900km. If the satellite that was attacked had its orbit within that band, the resulting debris would be concentrated in that same region and would make the debris problem much worse. At other altitudes, this amount of debris would represent a much larger percentage increase over the existing debris.

Table 3 shows estimates of the debris created by China's destruction of the FY-1C satellite in January 2007. This debris added significantly to debris population between 800 and 900km altitude.

Table 3. Estimated debris from the destruction of the Chinese FY-1C satellite in January 2007

	Debris size		
	1mm to 1cm	**1cm to 10cm**	**> 10cm**
Estimated debris from FY-1C breakup	2 million	40,000	1,500

Debris lifetime

If the targeted satellite was orbiting at an altitude above about 800km, then a large fraction of the debris particles created in such a collision would remain in orbit for decades or longer. The debris lifetime would increase rapidly with altitude.

The only previous test of a kinetic-energy interceptor that destroyed a satellite was conducted by the United States in September 1985.[10] This test created roughly the same amount of debris as the Chinese test since both satellites had masses of roughly one ton. Improvements in the US Space Surveillance System between 1985 and 2007 mean that the system is capable of detecting many more particles today than in 1985.

Because the US test took place at an altitude of roughly 500km, compared to about 850km for the Chinese test, the debris from the US test remained in orbit for a significantly shorter time. Most of the large debris from the US test had decayed within a decade, while a significant fraction of debris from the Chinese test is expected to remain in orbit for decades.

Debris distribution in space

Most of the debris created when a satellite is destroyed in a collision will follow orbits with altitudes that are close to that of the original satellite; this is especially true for large fragments. Over time, the cloud of debris fragments will spread out in a band or shell around the Earth.

The distribution of speeds of the debris particles will cause the debris to quickly spread out along the orbit of the original satellite within several days (see Figures 1 and 2). Once it is spread out, the debris will pose a collision threat to essentially all satellites whose orbits pass through that altitude.

Over time, various forces[11] will cause the particles to spread out of the plane of the original orbit (Figure 3). For debris in a nearly polar orbit, after several years the particles would be essentially uniformly distributed within a shell around the Earth (Figure 4). Debris in an equatorial orbit would slowly spread into a band around the equator.

Figure 1. Cloud of debris of size greater than 10cm after 15 minutes

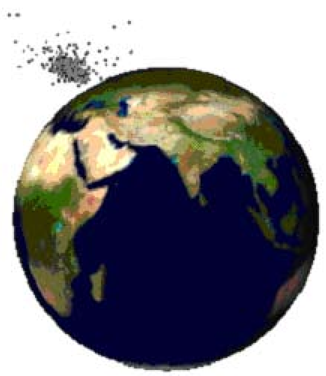


Figure 2. Debris cloud after 10 days

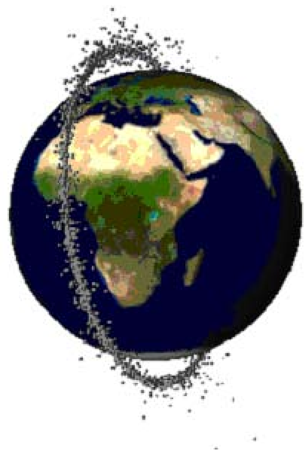


Figure 3. Debris cloud after 6 months

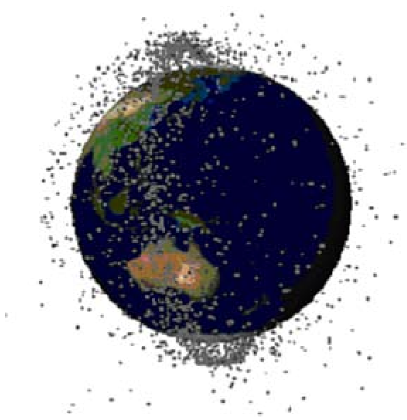
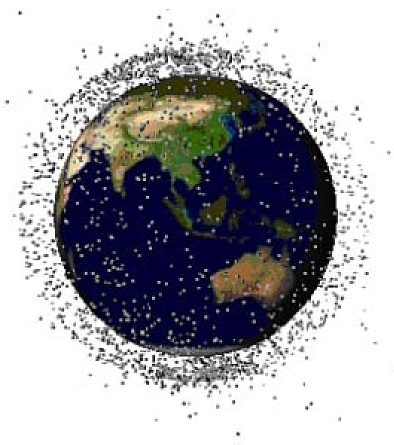


Figure 4. Debris cloud after 3 years



Conclusion

The risk of collision between an individual satellite with a piece of debris large enough to significantly damage or destroy it is currently small, but not negligible. For a medium-size satellite in the altitude band in LEO where the debris density is the largest, this risk is approaching 1% over a satellite's 5- to 10-year lifetime. At that level this risk is likely comparable to other reasons that a satellite might fail.

The debris from the Chinese test may have roughly doubled that probability for the next few years at altitudes near the altitude of the test. But the absolute threat is still small. However, more such events, and especially the break-ups of larger satellites, could significantly increase this threat and could make certain altitude bands unsuitable for use by satellites.

Controlling the production of space debris is therefore crucial for the sustainable use of outer space. Such controls must limit both the debris production by routine space activity and by intentional attacks on satellites.

Some altitude bands in outer space already have such a high density of debris and satellites that collisions will occur among these objects, creating more debris. As a result of this slow-motion chain reaction, the number of debris particles will continue to increase even if no additional objects are launched into these bands.

A recent study showed that the number of debris particles in the heavily used band between 900 and 1,000km altitude is expected to more than triple in the next 200 years, even if no new satellites or debris are launched into this altitude band.[12] The intentional destruction of a satellite at this altitude could add a significant amount of large debris, which could speed up this chain reaction considerably.

Outer space is uniquely suited for a range of important uses, such as communications, Earth observation and navigation. Interfering with the ability to use outer space for those purposes would be incredibly short sighted. An urgent and important step toward this goal is an international agreement to ban the testing and use of destructive ASAT weapons.

Notes

1 Orbital space debris is any human-made object in orbit that no longer serves a useful purpose.

2 See, for example, the Inter-Agency Space Debris Coordination Committee at <www.iadc-online.org>.

3 NASA Orbital Debris Program Office, The Orbital Debris Quarterly News, vol. 11, no. 2, April 2007, <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNv11i2.pdf>.

4 For a database of active satellites, see <www.ucsusa.org/global_security/space_weapons/satellite_database.html>.

5 This speed corresponds to roughly 30,000km/hr (approximately 20,000 miles per hour).

6 NASA Orbital Debris Program Office, The Orbital Debris Quarterly News, vol. 11, no. 2, April 2007, <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNv11i2.pdf>.

7 N.L. Johnson, P.H. Krisko, J.-C. Liou and P.D. Amz-Meador, "NASA'S New Breakup Model of EVOLVE 4.0", Advances in Space Research, vol. 28, no. 9, 2001, pp. 1377–84.

8 The condition given in the NASA model for a catastrophic collision is that the kinetic energy of the smaller object divided by the mass of the larger object must be greater than 40J/g.

9 This is true of ground-based direct-ascent ASATs and orbiting ASATs that lie in orbits that cross the orbit of the target satellite. Co-orbital ASATs would typically have a much lower speed, but may not rely on the kinetic energy of collision as the kill mechanism.

10 Laura Grego, "A History of U.S. and Soviet ASAT Programs", Union of Concerned Scientists Background Paper, 9 April 2003,<www.ucsusa.org/global_security/space_weapons/a-history-of-asat-programs.html>.

11 The primary force that rotates the orbital plane of objects in low Earth orbit arises from variations in the Earth's gravitational field.

12 J.-C. Liou and N.L. Johnson, "Risk in Space from Orbiting Debris", *Science*, vol. 311, no. 5759, 20 January 2006, pp. 340–341.

A CODE OF CONDUCT FOR RESPONSIBLE SPACE-FARING NATIONS

Michael Krepon

Many of us have become somewhat dependent on cell phones. We have plenty of company. The doctor who needs to make an emergency call or to use their pager, as well as the patient in dire need of assistance, rely on satellites. Ambulances that cannot afford to take a wrong turn when every second counts also rely on satellites, if they use Global Positioning System devices. Tens of thousands of police cars in the United States now use satellites to help them get to where they need to go. We need satellites to warn us of dangerous storms that are approaching landfall. We need satellites to help with disaster relief to know the best place to for helicopters to land amidst the chaos of a disaster scene. We need satellites to help those in harm's way, whether they are wearing a military uniform or not. We need these satellites more than we appreciate—every single day. Satellites are life savers. They are also essential for national and economic security. The United States is utterly dependant on satellites, and other countries are becoming more dependent on them. Satellites serve global needs.

These indispensable satellites are also quite vulnerable. It is relatively hard to master the art of making good use of satellites, and relatively easy to damage them. Any nation that can place a marble-sized object in the path of a satellite can kill that satellite. In low Earth orbit, where many vital satellites are located, any marble, or any marble-sized piece of debris, is a lethal weapon, travelling at roughly ten times the speed of a rifle bullet. It is not simple to put a marble in the path of a satellite; this takes roughly the same skills as putting a satellite into a precise orbit.

Debris is an indiscriminate killer. Any satellite collision with a piece of debris travelling in low Earth orbit—having the energy of a one-ton safe falling from a five-story building—will result in catastrophic effects, resulting in far more debris. This helps explain why many people were so upset with China for blowing up an aging satellite in January 2007. Reputable modelling of the debris field created by this anti-satellite test suggests that it created approximately 40,000 pieces of debris of marble size or larger. Because this test was carried out at a high altitude in low Earth orbit, it will probably take a century for this debris to burn up in the atmosphere. In other words, a country that champions a ban on weapons in outer space produced—through a single kinetic-energy anti-satellite test—40,000 weapons in outer space.

The United States conducted a similar test in 1985 during the Reagan administration. Afterwards, many Americans learned that debris-creating tests against satellites were a bad idea. It took just one test to figure this out, and hopefully it will take only one test for China to figure this out. The test that the United States conducted was at a lower altitude than the Chinese test, so the debris field took less than a quarter-century to exit low Earth orbit. One piece of debris from this anti-satellite test came within one mile of the newly launched International Space Station.

Some pieces of debris are so small that they cannot be tracked—even by the United States, which has the world's best space situational awareness capabilities. Usually, these minute objects are not lethal. The US Space Shuttle's windows have needed to be changed 55 times because of small debris hits that caused pockmarks, but thankfully did not crack them, which could have had catastrophic consequences. China's manned spaceflight programme is now endangered by debris of its own making—debris that China cannot track. There are approximately 300 satellites between the debris field created by China's anti-satellite test and the Earth's atmosphere. Three hundred satellites—a huge international investment—have been placed at risk as a result of a single test. Outer space is endlessly vast, so it is possible that no satellites will be struck by man-made debris (although the United States has already found it necessary to move one of its satellites to avoid a potential debris hit from the Chinese test). But why double the odds of a collision, as the Chinese have done with their January 2007 anti-satellite test?

There are other ways to destroy satellites. One way—also quite indiscriminate—is to use a medium-range missile carrying a nuclear weapon. A nuclear detonation in the atmosphere can do great damage to satellites, irrespective of ownership. The United States learned this in 1962 before the Limited Nuclear Test Ban Treaty, which banned atmospheric tests, was signed. The United States conducted a series of tests—the biggest having a yield in excess of one megaton—that created a radiation belt that destroyed or damaged every satellite in low Earth orbit; not all of them were US satellites.

A number of nations could use nuclear weapons and "hit-to-kill" anti-satellite weapons to create a mess in outer space. These technologies are decades old. There are also more discriminate ways to attack, destroy or temporarily disable satellites. Lasers and jammers can perform this mission. The Bush administration and the Pentagon would prefer, if push comes to shove and space weapons are used for the first time in the history of warfare, to use weapons that produce temporary and reversible effects. China is working hard on lasers. Russia certainly knows how to use lasers. Many countries can use jammers to try to interfere with satellites. Of course, if one country uses temporary and reversible effects against another country's satellites in a deep crisis or in a war, the country that has been attacked in outer space may be able to respond in kind. Or the country that has been attacked may decide to fight by different rules, in outer space or on the ground.

Space-faring nations are therefore faced with a dilemma: satellites are indispensable, but they are also extremely vulnerable. The satellites of major powers are also intimately connected with nuclear deterrence because nuclear forces depend on satellites for intelligence and targeting information, weather forecasting data, early warning and communications. An attack against these satellites in any conflict or deep crisis between major powers could result in unintended escalation across the nuclear threshold. If a shooting war in outer space is initiated, it could be very difficult to control the shooting and to dictate tactics. It is hard enough for powerful countries to dictate tactics in ground warfare against far weaker opponents. Would it be any easier to dictate tactics in a space war between major powers? The achievement of "space dominance" is very difficult, while asymmetric warfare in outer space can be relatively simple.

What is the best way to deal with the dilemma that satellites are both indispensable and extremely vulnerable? My analysis suggests that the use of weapons against space objects is not a very satisfactory way to resolve this dilemma. If warfare directed against space objects is the wrong answer, is a treaty banning space weapons the right answer?

China, Russia and many other countries support a treaty banning space weapons. So too do many non-governmental organizations. I have my doubts that such a treaty can be successfully negotiated.

First and foremost, a treaty banning space weapons requires an agreed definition of space weapons. What is it that we seek to ban? Many things can be used as space weapons. As noted above, marbles could be tested, deployed and used as space weapons. Do we ban marbles? Jamming devices can be used as space weapons. Many countries have jammers. Do we ban jammers? Lasers can be used as space weapons. But lasers can also be used as space tracking, range finding, intelligence collection or communication devices. Do we ban lasers?

Medium-range ballistic missiles can be used as space weapons. Intercontinental missiles, based on land or at sea, can be used as space weapons. Certain missile defence interceptors, including those deployed around Moscow and in Alaska and California, can be used as space weapons. Do we ban missile defences in order to ban space warfare?

Many different types of weapons and technical capabilities can be used to interfere with or destroy satellites. Because there is so much residual or latent capability to do so, and because these capabilities are essential for other military missions, they cannot all be banned. An all-encompassing definition of space weapons is militarily, politically and diplomatically unfeasible.

An alternative approach would define space weapons far more narrowly—as devices that are specifically designed and tested to interfere with, or to harm in any way, space objects. By focusing only on "dedicated" space weapons, it is possible to avoid the trap of over-reaching. But this narrow approach does nothing to address the wide range of capabilities that could still do harm to satellites.

It is, therefore, very hard to define that which a space treaty seeks to ban. One definition of space weapons is far too encompassing, the other is far too narrow. The Carter administration encountered this problem in anti-satellite warfare negotiations with the Soviet Union. Back then, the Soviet Union sought an encompassing definition of space weapons, which included the Space Shuttle, because it had an arm that could capture a satellite, put it in the cargo bay and take it back to Earth. Using the Space Shuttle as an anti-satellite weapon would be extremely hazardous and unlikely, but by the definition advanced by the Soviet Union in the 1970s—and by the definition of a space weapon now advanced by Beijing and Moscow—the

Space Shuttle would be an anti-satellite weapon. It will take a very, very long time to negotiate a treaty banning space weapons.

Because negotiating a treaty banning space weapons would be so hard, does that mean that we are doomed to lose indispensable satellites in warfare? No. We are now in the fifth decade of the space age. In the past half-century, no weapons have been used against space objects in a deep crisis or in warfare. Not one. There have been a modest number of tests of anti-satellite weapons, and for short periods of time, "dedicated" anti-satellite weapons were deployed by the United States and the Soviet Union. But tests of anti-satellite weapons are a rare occurrence, and major powers have not been eager to deploy or use them.

There were many reasons for this uncommon restraint during the Cold War, when the superpowers tested thousands of nuclear weapons, deployed hundreds of new ballistic missiles every year, and maintained their nuclear forces on hair-trigger alert. One reason for restraint was the connection between nuclear forces and the satellites they relied upon. Moscow and Washington knew that to attack satellites would risk unwanted escalation. Indeed, both superpowers negotiated "non-interference" clauses protecting satellites used to monitor each other's nuclear forces in bilateral nuclear arms control and arms reduction agreements. A second reason for restraint was that the superpowers believed that they would both lose in the event of warfare against space objects. A third reason was that, with so much latent anti-satellite capability, neither country felt it particularly necessary to repeatedly test or deploy weapons dedicated to this role.

All of these reasons still apply in crises or limited wars between major powers. Every nation that depends on satellites will lose if those satellites are used for target practice, since vulnerabilities to attack and disruption will continue to exceed protective measures. If major powers repeatedly test and deploy dedicated anti-satellite weapons, their security will diminish and the global economy will be placed at risk. A form of deterrence between major powers continues to exist in outer space, just as during the Cold War. Deterrence against space warfare has held for half a century. This form of deterrence has been relatively inexpensive: unlike nuclear deterrence, it does not require repeated testing, expensive deployments and hair-trigger alerts. The nation that seeks to upend this deterrence will do lasting damage to itself as well as to others. Because of the enduring indispensability and vulnerability of satellites, the future testing and deployment of dedicated space weapons is not inevitable. If it were inevitable, it would have occurred during the Cold War. The reasons why it did not occur then remain valid today. If national leaders are wise, they will not translate military plans into flight tests and deployments of weapons designed to harm space objects.

How, then, do we ensure that invaluable but extremely vulnerable satellites remain available for use when needed? If the use of weapons against space objects and a treaty banning space weapons are not good answers, then what is? How can we continue a five-decade-long record of uncommon restraint that allows nations to fulfil the vision of the Outer Space Treaty?

The Henry L. Stimson Center has been working with non-governmental partners in Canada, China, France, Japan and Russia to develop a Code of Conduct for Responsible Space-Faring Nations. Many codes of conduct already exist. Imagine the chaos that would result if there were different rules for air travel across regions or borders. We rely on codes on conduct for vehicular traffic, ships and planes. The US military and others abide by codes of conduct. Moscow and Washington have signed codes of conduct governing military interactions at sea, on the ground and in the air. The Incidents at Sea Agreement (1972) and the Dangerous Military Practices Agreement (1989) are model codes of conduct that include provisions that could also be applicable for outer space.

The outline of a Code of Conduct for Responsible Space-Faring Nations is beginning to come into view. One key element of such a code is debris mitigation similar to the guidelines agreed upon in the Committee on the Peaceful Uses of Outer Space in 2007. There is, however, no holistic approach to a Code of Conduct that is being undertaken by governmental authorities. This is why the Stimson Center and its non-governmental partners have focused on this initiative.

A Code of Conduct is needed because “rules of the road” for outer space are no less important than rules of the road on the ground, at sea or in the air. Rules of the road make driving safer; without rules, there would be chaos, and chaos in outer space is not in the interest of military, business and scientific establishments. Rules become norms, and norms can become treaties. While rules during peacetime and rules during warfare can be quite different, even warfare has rules. If the analysis presented here is sound, then protections for satellites should also be respected even in the event of warfare. Rule breakers can still be expected, but their presence does not negate the need for rules. Indeed, without rules, there are no rule breakers; having rules helps to isolate and penalize such actors.

A Code of Conduct is needed for outer space because, while some rules already exist, there are many loopholes. The use of outer space is expanding, and the potential for friction is growing. The absence of a Code of Conduct and growing concerns over military doctrines for space warfare encourage hedging strategies. These strategies are reflected in the flight testing of multipurpose technologies by China and the United States—technologies that could be used for peaceful as well as offensive purposes in outer space—as well as in the Chinese "hit-to-kill" anti-satellite test in January 2007. Hedging strategies are reinforced by the absence of regular discussions or negotiations on space security. This equation means more hedging, less security and a growing interest in devices that can interfere with or otherwise harm space objects.

A Code of Conduct would serve to increase space security and promote the peaceful uses of outer space—the same general purposes served by a treaty to ban space weapons. Treaty negotiation—especially one carried out in the Conference on Disarmament, which operates by consensus, and which has been tied to a very challenging negotiation for a fissile material cut-off treaty—would take a very long time to complete and could result in a lowest-common-denominator outcome. Even then, the treaty might take many years to enter into force. A Code of Conduct could be produced much sooner, and could be pursued in many different forums. A small group of stakeholders could work together to produce a higher-common-denominator result, which might then be considered by a wider group of countries.

The outlook for a treaty banning space weapons is poor. The outlook for a Code of Conduct is much brighter. The European Union has, in principle, endorsed this idea. The governments of Canada and Switzerland have as well. The chief executive officer of Intelsat, the largest multinational satellite service provider, has endorsed this idea. Two key publications of the trade press in the United States, *Aviation Week and Space Technology* and *Space News*, have also endorsed a Code of Conduct.

What key elements might be included in a Code of Conduct for Responsible Space-Faring Nations? The proposed Code of Conduct devised by the Stimson Center and our partners is built around the key element of "no harmful interference" with space objects. This formulation, which is borrowed from other agreements, avoids the traps associated with trying to define what constitutes a space weapon. The "no harmful interference" injunction applies to dedicated anti-satellite weapons, latent or residual anti-satellite capabilities, and multipurpose technologies used in a harmful manner. Participating states would still require common understandings of what constitutes "harm", but this is a far simpler problem than trying to define space weapons. Our proposed Code of Conduct also includes key elements of providing advance notice if there is reason to believe that activities in space may inadvertently cause harmful interference, and consultations when concerned about harmful interference.

What other key elements might be included? The proposed Code of Conduct also includes provisions to share space surveillance data; to adopt and abide by debris mitigation guidelines for space launches and other activities in space; to refrain from the deliberate creation of persistent space debris; to devise, implement and abide by a traffic management system for outer space; and to provide accurate and timely launch notification and registration.

This notional Code of Conduct could certainly be improved upon, and the Stimson Center welcomes such efforts. Careful readers will note that which is not included in this short list of proposed key elements: there is no prohibition against space-based missile defences. This conscious decision reflects several considerations. First, defensive responses to ballistic missile attacks are very different from offensive attacks against satellites. Second, tests of ballistic missile defences have in the past, and can continue to be carried out, in ways that do not create persistent space debris. Third, attempts to prevent space-based missile defences by means of a Code of Conduct are likely to prevent its acceptance in the United States. And fourth, the conclusion and proper implementation of a Code of Conduct is likely to reduce the perceived need to test and deploy space-based missile defences, which have, in any event, encountered sustained political, technical and budgetary roadblocks.

A Code of Conduct for Responsible Space-Faring Nations cannot solve every problem, but it can make many problems less worrisome. A Code of Conduct is no substitute for national means of defence, but it can make the use of force in space less likely. A Code of Conduct does not take away latent or residual means to carry out attacks against space objects. Instead, these means would backstop proper implementation of the Code. Codes of conduct to prevent dangerous activities have proven their worth in many domains, including military activities on the ground, at sea and in the air. A Code of Conduct for Responsible Space-Faring Nations could also make significant contributions to international security.

COOPERATIVE MANAGEMENT OF THE SPACE ENVIRONMENT

Richard DalBello

The commercial satellite industry has been providing essential services for almost as long as humans have been exploring outer space. Over the decades, this industry has played an active role in developing technology, worked collaboratively to set standards and partnered with governments to develop successful international regulatory regimes. Success in both commercial and government space programmes has meant that new demands are being placed on the space environment. This has resulted in orbital crowding, an increase in space debris, greater demand for limited resources and the proliferation of sometimes conflicting military and commercial activities. The successful management of these issues will require a strong partnership between government and industry and the careful, experience-based expansion of international law and diplomacy.

Throughout the years, the satellite industry has never taken for granted the remarkable environment in which it works. Industry has invested heavily in technology and sought out the best and brightest minds to allow the full, but sustainable, exploitation of the space environment. Where problems have arisen, such as space debris or electronic interference, industry has deployed new technologies and adopted new practices to minimize negative consequences.

In the late 1970s and early to mid-1980s, both the Soviet Union and the United States engaged in the testing of anti-satellite (ASAT) weapon systems. Both abandoned these efforts, in part because the creation of additional space debris threatened their plans for the full exploration and exploitation of the space environment. Similarly, the future preservation of the space environment will rely on every state's appreciation that its own self-interest lies in preserving this precious common good.

All the major commercial satellite operators routinely share information and resources with each other and with governments to help ensure the protection of outer space. Intelsat operates a fleet of more than

50 satellites—the largest geostationary commercial fleet ever assembled. In response to business opportunities and changing market needs, Intelsat regularly replaces satellites and relocates satellites in orbit. To change the orbital location of a satellite, Intelsat must delicately move a minibus-sized multi-ton object, travelling thousands of kilometres per hour, through the crowded geostationary arc while avoiding the potential for collisions with, or disturbing the radio communications of, any of the more than 250 other commercial communications satellites in that orbit.

With the exception of the initial grant of approval by a national regulator, this entire process is managed without governmental regulation or oversight, using rules developed through experience and implemented by consensus among the commercial operators themselves. This process has been used effectively and without incident since the commercial satellite communications era began in the 1960s. This remarkable example of international and inter-company cooperation and self-reliance is premised on a simple realization that the results of a collision could be catastrophic.

In low Earth orbits, objects and debris will slowly, over a decade or so, re-enter the Earth's atmosphere. In the narrow geostationary orbit (in which a satellite's orbit precisely matches the rotation of the Earth, thereby keeping the craft fixed over a single geographic location), the debris from a collision would endure for tens of thousands of years, effectively rendering a portion of this arc useless.

To be sure, the motivations behind the military space activities of states are far more complex than those of the commercial satellite industry. However, the central goal of preserving the operational space environment binds all space participants with a common purpose. Governments should play a leading role in this preservation effort. Specifically, concerned governments should:

Provide adequate funding for space situational awareness. Space situational awareness (SSA) is the ability to monitor and understand the constantly changing space environment. The task of locating and tracking active satellites and space debris is one of the most challenging aspects of SSA. Currently, the US Air Force Space Command's Joint Space Operations Center (JSPOC) plays a key role internationally in tracking, and reporting on, all man-made objects in orbit. JSPOC receives on-orbit positional data from the Space Surveillance Network, which is composed of both optical and radar sensors throughout the world. This allows JSPOC to attempt to maintain accurate data on every man-made object currently in orbit. Today JSPOC is tracking more than 10,000 objects in space.

But the United States is not alone in its SSA efforts. Australia, China, Russia, several European states and others are making investments in such capabilities. But these investments alone are not enough. It is also a critical that states strive to create rapid, reliable and non-bureaucratic institutions for sharing the new data they are collecting.

Follow the model created by the US Commercial and Foreign Entities (CFE) programme for sharing information. Established by the US Congress as a pilot programme, CFE now provides a limited but essential set of US government data on existing space objects for release to certain commercial and foreign entities. Although CFE has been advantageous for governments and industry, the accuracy of the data currently provided is not sufficient for precise collision detection/assessments, support of launch operations, end of life/re-entry analyses or anomaly resolution. The current CFE pilot programme is set to expire in 2009 and efforts are underway within the United States to formalize and expand this programme. Beyond the CFE, it might be extremely valuable if satellite operators and governments would share their collected data in an organized, cooperative fashion. Such a sharing process could result in the creation of a "Global Data Warehouse" for space information. Governments and operators might be encouraged to submit information on the orbital elements of space objects as well as their manoeuvre plans and operational frequencies. If information were gathered in a central depository, warning and alert messages could be distributed automatically in a common format to participating operators, while protecting sensitive commercial or government data.

Begin an international dialogue on "Rules of the Road" for outer space. Although there may be disagreement as to the value of additional laws or space treaties, there seems to be general acceptance that certain guidelines or norms developed by consensus may play a useful role in ordering our activities in outer space. A good example are the space debris mitigation guidelines developed by the Inter-Agency Space Debris Coordinating Committee, an intergovernmental body created to exchange information on space debris research and mitigation measures. The development of other non-binding guidelines should be investigated. Such non-binding guidelines might include a formalization of existing rules regarding the movement of spacecraft between orbital locations, protocols for informing other operators when a spacecraft under their control could potentially cause damage to other space objects, and protocols for managing the loss of control of a satellite.

Within the next decade, many more states will gain the ability to exploit outer space for commercial, scientific and governmental purposes. It is essential that the world's governments provide leadership on space management issues today in order to protect the space activities of tomorrow. Bad decisions and short-term thinking will create problems that will last for generations. Wise decisions and the careful nurturing of outer space will ensure that the tremendous benefits from the peaceful use and exploration of outer space are enjoyed by those who follow in our footsteps in the decades to come.

STUDY ON SPACE TRAFFIC MANAGEMENT BY THE INTERNATIONAL ACADEMY OF ASTRONAUTICS

Petr Lála

Scope and target users of the study[1]

There is already a great deal of space traffic. It seems, however, minuscule with regard to the extent of near-Earth outer space. Around 9,000 man-made objects larger than about 10cm are currently catalogued, out of which only 650 are operational spacecraft. At first glance, the management of space traffic does not appear to be a pressing problem. On closer examination, this judgement has to be challenged. This view is supported by a high and ever growing number of launches from more and more launch sites and spaceports, the participation of non-governmental entities, the positioning of satellite constellations, an increase in space debris and the advent of reusable launch vehicles.

Considering this scenario, conceptualizing space traffic management will turn out to become a relevant task during the next two decades. Space traffic management, however, will limit the freedom of use of outer space. Therefore an international consensus on internationally binding regulations will only be achieved if states recognize the urgency and expect a specific as well as collective benefit—including an economic benefit—from this.

Due to its long-term approach, the study does not provide a specific plan of action to any single target user. In sketching out first steps, however, it addresses or directs decision makers in the UN Committee on the Peaceful Uses of Outer Space (COPUOS), International Telecommunication Union (ITU) and International Civil Aviation Organization—organizations which are building blocks for a future space traffic management regime—to approach specific problems. In addition to that, further questions to be studied have been identified, which might be tasks for the respective committees of the International Academy of Astronautics and the International Institute of Space Law.

Definition of space traffic management

The scale of this task can be assessed when the following working definition of space traffic management is taken as a starting point: space traffic management means the set of technical and regulatory provisions for promoting safe access into outer space, operations in outer space and return from outer space to Earth free from physical or radio-frequency interference.

Since an authoritative definition of space traffic management does not yet exist, this definition has been created for the purpose of this study. Through this definition, the purpose of space traffic management becomes clear: it is to provide appropriate means for conducting space activities without harmful interference. It supports the universal freedom to use outer space as laid down in the Outer Space Treaty of 1967. It should also be clear that for the purpose of achieving a common good, actors have to follow specific rules, which are also in their self-interest.

Dimensions and phases of space traffic

Two dimensions of space traffic are analysed in this study: the scientific and technical, and the regulatory. Then, those two dimensions of space traffic are applied to analyzing the three phases of space traffic: launch, in-orbit operations and re-entry. Below are the findings.

Findings

Space traffic: current status and prospects for 2020

- The motion of space objects is influenced by different forces, which cannot be accounted for precisely. Errors in predictions of space object motion are primarily caused by variations of atmospheric density, and the error in predicted position in orbit increases with the square of elapsed time. For this reason, positions of all objects should be monitored systematically and with high accuracy.
- The large majority of active satellites have no manoeuvring capability and most others have only a limited capacity to change their trajectory.
- There has been a slow but steady decline of launch activities since 1980, but there is a rise in the number of launch vehicles available

(currently 18). There is also a growing number of launch centres (currently 11).

- The prospects for the introduction of fully or partly reusable launch vehicles are still open. In any case, by 2020 they will probably still be limited to supporting missions below 1,000km.
- Manned spaceflight has accounted for 13% of launches during the past 20 years. It might increase with the emergence of new actors in this field, but is likely to increase dramatically only after 2020.
- Following the successful flight of SpaceShipOne, there might be—if safety is guaranteed—a growing number of suborbital manned flights, including with tourists as passengers.
- Technologies such as tethers, stratospheric platforms or space elevators, which might be introduced in the future, will have to be taken into account in particular when rules for the launch and re-entry phases are developed. New concepts for satellites (for example "autonomous nanotechnology swarms") will raise requirements for in-orbit operations.
- Space debris is continuously growing in quantity (currently there are about 100,000 objects larger than 1cm, most of them not catalogued).
- The number of catalogued objects is steadily rising (currently there are about 9,000 catalogued objects larger than approximately 10cm).
- The number of active satellites remains at 6–7% of total catalogued objects.
- The United States' space surveillance capabilities dominate, followed by Russia and Europe. The United States provides data and processed information on a voluntary basis.
- The capacity and accuracy of current space monitoring systems is not sufficient to cover small objects or to provide for orbital avoidance service for all space assets.
- There are two major catalogues of space objects, which is far from the comprehensive system of space traffic monitoring that is required.
- Information on space weather is still limited but is important for the operation of space objects as well as for the prediction of the debris environment.
- The constant monitoring and information on space weather would be a useful tool in implementing a space traffic management system.

The current legal and regulatory framework

- The general principles of space law provide a basis and rationale to establish a space traffic management regime.
- Some unique rules exist in international space law as well as in international telecommunications law, which can be considered as basic elements of a space traffic management system (especially for use of geosynchronous Earth orbit, following ITU rules and regulations). These rules however are neither complete nor harmonized. ITU rules, aiming at the avoidance of radio-frequency interference, are far more advanced than rules aiming at the avoidance of physical interference.
- In this context, the Inter-Agency Space Debris Coordination Committee guidelines of 2002 (not a legally binding agreement) encompass elements of space traffic management (for example use of disposal orbits and notification in case of controlled re-entry) but so far they do not include provisions on the environment, such as the avoidance of pollution of the atmosphere/troposphere.
- Space law, however, lacks many provisions which would be essential for a comprehensive traffic management regime (pre-launch notification, for example). Of particular importance is a legal recognition of the difference between space objects considered as valuable assets by their owners, and space debris that has no value.
- A space traffic management regime has to consider the question of harmonizing national space legislation (much of which has yet to be established), and national licensing standards and procedures, since they may provide the building blocks for assuring technical safety.
- In regard to arms control/disarmament negotiations, notification practices (prior to launch) have been developed through the Hague Code of Conduct against Ballistic Missile Proliferation, thus superseding the status of civilian space law and negotiations in COPUOS.
- The implementation of a comprehensive space traffic management regime would require additional regulation (with regard to the execution of space missions), which could be perceived as limiting the freedom of use of outer space guaranteed by the Outer Space Treaty.

- There are interfering factors, in particular national military and security policies and practices, which might hinder the establishment and operational effectiveness of a space traffic management regime.

Comparable traffic regimes

In international common spaces, such as the high seas—and outer space—no territorial jurisdiction applies. Only personal jurisdiction does. When rules such as traffic management are concerned, this system is far from being efficient. It is the reason why on the high seas, the exclusivity of the flag state is likely to be overruled by an extension of the territorial jurisdiction of one or several states. This solution is not acceptable for space activities as there is no territorial jurisdiction involved. The solution of the port state is not workable, since at present a satellite does not fly back to Earth. The extension of "coastal" jurisdiction is also an impossible solution for obvious technical reasons. These difficulties should be taken into consideration if and when a space traffic management regime enters into force. Nevertheless, there are many interesting elements from the Law of the Sea which could be studied further, in particular as the development of international law for oceans and outer space do have the common basic elements of extra-territorial applications.

The launch phase

- Safety certifications should be introduced.
- A clarification of the term "space object" is needed.
- The question of delimitation of air space and outer space should be revisited.
- The concept of "launching state" has to be clarified.
- A pre-launch notification system is necessary, although the Hague Code of Conduct includes non-legally binding provisions for such notifications of space launch vehicle launches.
- Obligatory information in cases of damage is relevant.
- An international level playing field for transport services should be aimed for, with a balance between public and private/economic interest.

The in-orbit operation phase

- Manoeuvring and in-orbit collision avoidance (with regard to other operational space objects as well as with regard to space debris) is growing in importance.
- Manoeuvring in the geosynchronous orbit is utilized but with little consideration of possible collisions.
- Reliable collision probabilities can be estimated only when reliable information exists, which currently is not guaranteed.
- There is already one-way traffic in geosynchronous orbit, as all satellites there are orbiting eastward in the equatorial plane.
- No systematic zoning (restriction of certain activities in certain regions) of outer space is applied.
- The ITU system of nominal orbital positions is applicable only to satellites in geosynchronous orbit.
- Private/commercial actors have started coordinating (through the Satellite Users Interference Reduction Group and the International Telecommunication Union) to prevent radio-frequency interference.
- Matching spacecraft with radio transmitters on-board could make the problem of "paper satellites" transparent and better understood.

The re-entry phase

- Intentional (reusable launch vehicles, as well as active debris mitigation) and unintentional de-orbiting (natural debris mitigation through decay) is now more frequent but care should be taken that large debris structures will be de-orbited in fragments.
- Responsibility and liability for damages caused by space objects or their components ensue not only from international space law but also from the general provisions in national legislation.
- The generally shared aspiration to reduce space debris raises the question of whether regulation should also set a standard clarifying under which conditions a re-entry activity is considered legitimate, and under which conditions it is not.
- Notification of, and coordination with, local and downrange air traffic, maritime authorities and local government officials are already considered a best practice in coordinating launch activities.

- Space Law and Air Law have to resolve the open issue of passage of space objects through airspace (the Chicago Convention does not apply to space objects in airspace).
- The question arises of whether to introduce certain internationally recognized descent corridors and possibly even impact areas which are not frequently used by other traffic and which could be dedicated to space traffic.

Conclusions

Framework

In the following section, a model is provided for what a comprehensive space traffic management regime for 2020 could look like. An international intergovernmental agreement could be drafted, building on but not replacing the principles incorporated in the existing space treaties. It could include provisions for liability and the basic principle that, while states are the primary actors, provisions of the agreement are applicable to private activities as well through national licensing regimes (certain issues will need to be clarified in the agreement).

This international intergovernmental agreement would comprise a legal text, which could be changed easily, and technical annexes, which could be adapted more easily. The international intergovernmental agreement envisioned would contain three parts:

Securing information needs

- Defines necessary data (on trajectories as well as radio frequencies).
- Sets provision for the data (sources, governmental as well as private, including financing).
- Establishes a database and distribution mechanisms for the data (format of the database, access to data on request, collision warning as a service).
- Establishes an information service on space weather.

Notification system

- Sets pre-launch notification with better parameters than the Registration Convention, as well as other provisions (e.g. ITU and proposed International Institute for Unification of Private Law (UNIDROIT) Protocol)
- Provides information on the end of active/operational life of space objects.
- Provides pre-notification of orbital manoeuvres and active de-orbiting (communication rules and cooperation provisions).

Traffic management

- Clarifies “fault” or liability in case of damage caused in outer space.
- Sets delimitation for the launch phase and clarifies the concept of “launching state”.
- Provides traffic management rules based on the use of the database for the purpose of collision avoidance, including safety provisions for launches; zoning (selection of orbits), priority of manoeuvres; specific provisions for geosynchronous orbits (harmonized with ITU rules); specific rules for low Earth orbit satellite constellations; debris mitigation mechanisms; safety provisions for re-entries; and environmental provisions (pollution of the atmosphere/troposphere and so forth).
- Clarifies “space objects”, including a legal distinction between valuable objects and valueless space debris.
- Provides a framework and main features for national licensing regimes, which implement the provisions of the agreement.
- Sets forth an enforcement mechanism (for example, the renouncement of access to information) and dispute settlement.
- Clarifies institutionalized links with the International Civil Aviation Organization, ITU and other relevant organizations.

Organization

- The provisions of the three agreements initially would be monitored by COPUOS and handled by the United Nations Office for Outer Space Affairs.

Subsequently, post-2020 the new agreement, together with the existing space treaties, could be superseded or replaced by a comprehensive Outer Space Convention. The operative oversight, that being the task of space traffic management, could be taken up by an already existing forum or organization (such as COPUOS or the International Civil Aviation Organization), which would evolve into a body designed for that purpose. Looking 20 years ahead, the job could also be handled by a non-governmental entity tasked by the states parties to an Outer Space Convention. In the end, space activities by private actors will come to have the same legal status as air traffic.

Notes

1 The study has been prepared by a group of 16 international experts and coordinated by Kai-Uwe Schrogl (regulatory part) and Petr Lála (scientific and technical part). The Rapporteur of the group is Corinne Contant. For more information, see *Cosmic Study on Space Traffic Management*, International Academy of Astronautics, 2006.

THE SECURITY DIMENSIONS OF SPACE TRAFFIC MANAGEMENT

Phillip J. Baines

Introduction[1]

Outer space is becoming a environment contested by many space-faring states as they pursue increasingly tactical military interests in this domain. In January of this year, China tested a direct-ascent hit-to-kill anti-satellite weapon system in low Earth orbit. The resulting collision of the land-based weapon with a weather satellite produced a 10% increase in trackable space debris. The estimated lifetime of much of this debris will be measured in tens, if not hundreds, of years. In the absence of a new international agreement for outer space dealing with the potential deployment of weapons into that domain, and the usage of yet other weapons based on the Earth that reach into outer space, armed conflict in this domain could seriously jeopardize humanity's sustainable use of outer space for the myriads of peaceful uses that benefit all of the inhabitants of the Earth.

Experience shows that negotiated arms control agreements have often been presaged by transparency, confidence- and security-building measures (TCSBMs) that have first built up the necessary critical will, often in times of crisis or increased tension, to address more permanently the national security interests of affected states. For example, it was the prelude of the failed Mutual and Balanced Force Reduction (MBFR) Treaty talks and the Conference on Confidence and Security Building Measures and Disarmament in Europe talks that ultimately resulted in the successful conclusion of the Treaty on Conventional Armed Forces in Europe (CFE). In this case the international community felt compelled to act and it did so very effectively. So in searching for TCSBMs that could possibly serve as a catalyst to address the Prevention of an Arms Race in Outer Space (PAROS) agenda item of the Conference on Disarmament, there is no better candidate than the rising international interest in the subject of space traffic management. In short, we should use the present challenges we all face as an opportunity to take much needed and overdue collective action.

What is space traffic management?

Space traffic management is an operational idea for the safe exploitation of outer space as new space actors arise and as existing space-faring states increasingly make use of outer space for a variety of civil, military and commercial purposes. In accordance with the International Academy of Astronautics *Cosmic Study on Space Traffic Management* (2006), space traffic management means: the set of technical and regulatory provisions for promoting safe access into outer space, operations in outer space and return from outer space to Earth free from physical or radio-frequency interference.

Space traffic management thus applies to three phases of spaceflight: launch, operations in-orbit and return to Earth. It envisages the use of technical and regulatory means to monitor space launches, the in-orbit manoeuvres of artificial satellites, as well as the planned and unplanned re-entry of vehicles and derelict spacecraft at the end of their useful lives. The concept deals primarily with freedom from both physical and radio-frequency interference to enhance the integrity of space operations. Not unlike the prior development of air traffic control for the safety of air travel, space traffic management will be needed to safely navigate artificial satellites through increasingly congested operations in outer space.

Recent space technology developments also call for the monitoring of space launch vehicles, artificial satellites and re-entry vehicles. The first of these developments is the continued production of space debris by the lack of sound de-orbit practices for the upper stages of space launch vehicles and for artificial satellites at the end of their useful lives. Resumed testing of anti-satellite weapon systems based on physical principles seeking to damage or destroy their targets, as opposed to electronic warfare principles tending to temporarily, locally and reversibly disrupt or deny communication signals, will exacerbate this critical environmental problem. The deliberate destruction of even a single large military satellite could nearly double the current space debris population around the Earth.[2] The world can ill afford numerous battles in outer space based on physical destruction methods as have been witnessed in the land, sea and air domains before it, because the space environment cannot quickly recover from such potentially catastrophic destruction, and there are no fast and ready remedies at this point to address the very serious problem of significantly increased space debris.

The recent development of artificial satellites capable of approaching, docking or manoeuvring close to another uncooperative artificial satellite will also raise the concerns of states whose satellites could be visited by such highly agile spacecraft. A satellite that is capable of an in-orbit repair mission for ordinary satellites could also be capable of inflicting damage or even destroying satellites during armed conflict. An analogy of an unannounced visit by one of these satellites will illustrate this newfound anxiety. Were a new passenger to sit down in the seat next to you out of all of the available empty seats late at night on a public bus, that act would likely elicit in you a primordial fight-or-flight response. The same dangers will arise in space operations as these new dual-use systems begin to gain wider use.

Laser communication payloads are also a new technology to be introduced on artificial satellites that will raise the need for improved space situational awareness. Unlike radio communication technologies that exhibit large spill-over radiation patterns, these new capabilities will be far more secure against eavesdropping and interference methods due to their more tightly focused beams of light. As these on-board laser capabilities grow in number, new techniques, possibly based on close-proximity-operations-capable satellites, could be developed to meet national security requirements to exploit, disrupt or deny satellite laser communication signals in the service of national security interests on the Earth.

Satellites harming other satellites

Today, it is not unusual for space objects from different launching states to pass within 5km of one another for no other reason than certain orbits are preferable for certain missions. These events are called conjunctions. What is worrisome about such close approaches is that dedicated explosive warhead designs could be fashioned to damage or destroy space objects from about that range.[3] Thus satellites, specially designed or modified to inflict harm, could be introduced into outer space to harm other satellites after making an approach. Alternately, a specialized satellite may harm another satellite at range if it possesses large apertures to focus electromagnetic radiation tightly, or alternately, can generate a substantial amount of power to account for radiation intensity decreasing as the square of increasing range.

In the field of architecture there is a tenet that “form follows function” and this same tenet is observed in spacecraft design, because there are so many constraints acting on a satellite's design to meet the functional requirements of the mission. The cost of launching satellites into outer space also dictates that every single gram of a satellite's mass must make a contribution to an essential function. In the arms-control language of an earlier era, discernable features unique to an object's purpose were called "functionally-related observable differences" and this technique was primarily used to differentiate nuclear weapon from non-nuclear weapon delivery platforms under the Strategic Arms Reduction Talks (START) treaties.

For an example applicable to outer space, consider that an ordinary spacecraft will have one of several well-known configurations of rocket thrusters for the satellite to maintain its position and orientation. These rocket configurations are not well suited to turn ordinary satellites into "suicide" satellites to inflict damage on others through intentional collisions. Ordinary satellites will also not possess the dedicated sensors necessary to track targets for intentional collisions. Close-proximity-operations-capable satellites will, on the other hand, likely employ a different number and configuration of rocket thrusters to ensure that they do not collide by accident with satellites they are designed to approach safely. This specialized configuration of rocket thrusters can thus help discern low-threat satellites from other more dangerous dual-use satellites deployed in orbit. Such agile satellites will also employ dedicated radar, lidar and optical-tracking sensors to direct their precise rendezvous manoeuvres. Even greater specializations would be evident for dedicated space-based weapons, which, in addition to being agile, would also likely possess rocket thrusters of the size and orientation needed to move from one orbit to another quickly. Dedicated space-based weapons would also not likely use multiple redundant technologies to perform the end-game tracking function necessary to safely approach another satellite in order to keep the amount of fuel mass they must carry to an absolute minimum.

A harm index for satellites

Given that form follows function for artificial satellites, is it possible to assign a "harm index" to satellites based on a limited amount of information declared or collected by national technical means of observation? The answer to this question is yes. The answer must be affirmative, if for no other reason than a nation that is reliant on outer space for its national power base can never be caught unawares as to the emergence of new threats that would risk their assured use of artificial satellites upon which they depend for their military prowess on Earth. As outer space moves increasingly towards becoming a contested environment, space situational awareness will increasingly become a strategic tool to first ascertain, and then manage, the risk presented by the space activities of rival powers. Three questions consequently loom for every space object:

- Does the artificial satellite have the capability to harm another artificial satellite in close proximity or at range?
- Is the artificial satellite specialized enough to be classified as a space-based weapon, where “weapon” could mean “any device, specially designed or modified, to injure or kill a person or damage or destroy an object by the projection or the occlusion of mass or energy”?
- Does the owner or operator of the artificial satellite have the intent to harm another satellite?

The second question of this series is the most important question in need of an answer because a threat of such magnitude for one’s own satellites cannot ever go unmet by the lowest-risk combination of defensive and offensive means available in outer space or on Earth to avoid, accept, mitigate or transfer the risk of such observed deployments. Fortunately, the answer to the first two of these questions lies in just three engineering equations. These equations are:

- The Rocket Equation, which indicates the cost in terms of propellant mass for an artificial satellite to move from one orbit to another and thus how easy or difficult it is for a satellite to quickly approach another satellite in a different orbit.
- The Link Equation, which indicates whether an artificial satellite has an ability to irradiate another object with sufficient power for benign radio communication services or with sufficient power to damage or destroy the objects it could illuminate at range.
- The Energy Balance Equation, which indicates how much electrical power is generated, radiated for useful purpose and otherwise emitted as wasted heat from an artificial satellite as a function of time to ascertain whether it is saving enough electrical charge to rapidly discharge later.

When this information is combined with the orbital position and change in orbital position information made available by a space traffic management system, a "harm index", or a capability-based threat assessment, can be established for all space objects.

To answer the last question posited above, an estimate of a space actor's intentions can be made by contrasting their prior declarations with recorded observations, for example with prior notification of space launches; rendezvous, docking or close "fly-by" manoeuvres; and atmospheric re-entries. This contrast will result in a measure of a space actor's behaviour predilections over time. Commercial satellite operators are less likely to intentionally damage other objects than civil government operators who are even less likely than certain military operators. Thus both capabilities and intentions can be estimated to create a coherent threat assessment for all space objects operated by all space actors.

Space traffic management plus additional information improves space security

A space traffic management system can provide the position, geometry and motion data for states to calculate harm indices in order to allay fears of intentional damage or destruction from dual-use satellites, such as close-proximity-operations-capable satellites. Additional information is required, however, to perform these analyses with any confidence. This information can come from additional state declarations, open source information collection and other national technical means of observation.

Consider for example the specific case of the Rocket Equation:

$m_f = m_i \cdot e^{-(\Delta v / Isp \cdot g_0)}$

where,

m_f is the final mass of the rocket,
m_i is the initial mass of the rocket,
e is the natural logarithm,
Δv is the change in velocity of the rocket,
g_0 is the acceleration due to gravity at mean sea level, and
I_{sp} is the specific impulse of the rocket fuel at mean sea level defined as the rocket thrust divided by the mass flow rate for the propellant type.

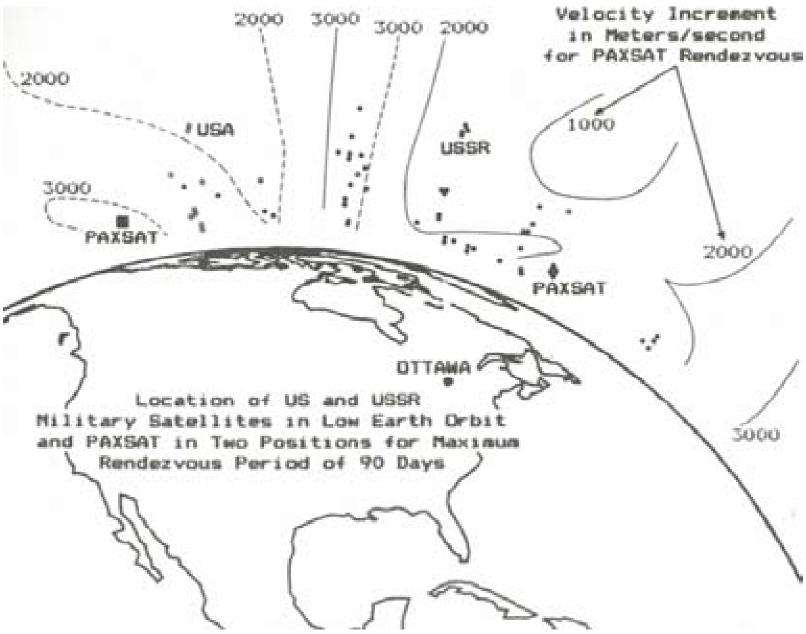
It is noted that the difference in the initial mass and the final mass of the rocket is the amount of rocket propellant used to perform an orbital manoeuvre. Thus, additional state declarations of an artificial satellite's total dry mass (here m_f), total wet mass (here m_i), and the specific impulse of its rocket thrusters (I_{sp}), is sufficient to calculate the change in velocity (Δv) available to a satellite to perform orbital manoeuvres. When this information is contrasted with the cost of orbital manoeuvres calculated from its orbital elements and those of another satellite, one can quickly determine whether a satellite is capable of a rendezvous or an intercept attempt. In other words, one can determine whether a satellite can reach another satellite using the position information collected by a space traffic management system and just three declared, estimated or measured properties of the satellite under consideration.

Orbital mechanics severely constrain an artificial satellite's ability to move to another orbit without substantial effort. It is as if each satellite is dropped into the bottom of a gravity well by its placement in one particular orbit and a great deal of effort (Δv) must be spent to climb out of that well to manoeuvre into a different orbit. Once the satellite locates itself in that new orbit, however, it will again find itself at the bottom of another gravity well. Thus any anti-satellite weapons stationed in outer space would likely be found in the same general volume of space as their potential targets. Similarly, orbital bombardment systems and orbital ballistic missile defence systems would likely be deployed into low Earth orbits that would provide regular coverage of regions of the Earth likely to be targeted.

Figure 1 illustrates the Δv cost functions for two of these gravity wells in low Earth orbit based on two initial orbital positions for the PAXSAT A spacecraft. This spacecraft was a concept for a close-proximity-operations-capable satellite to determine whether a space-based weapon ban could be verified by in-orbit remote sensing techniques. Also depicted in the figure are the locations of superpower military satellite deployments characteristic of the era, based on open source data collected during the study. The lines denoting the Δv costs of manoeuvring the satellite from its initial orbit to another location is also depicted.

The Δv cost functions displayed in Figure 1 are minimum-cost rendezvous manoeuvres because they make use of an assist from the Earth's non-spherical shape in order to precess the PAXSAT A orbit to match its target satellite's orbital plane in the right ascension direction within a period of 90 days. This is a strategy that trades time-of-flight for significant fuel savings. A more rapid rendezvous interval would require much more energy expenditure than that depicted here, since plane-change manoeuvres are the most expensive types of orbital manoeuvres to perform. The consequence of the Δv cost functions depicted in Figure 1 is that once a close-proximity-operations-capable satellite is placed into any given orbit, it is not necessarily going to be able to visit another satellite quickly enough to pose an immediate military threat, and it is not necessarily going to make multiple visits to numerous other satellites without first refuelling. Dedicated space-based weapons would look and act differently from such satellites, and such satellites would likewise look and act much differently from ordinary, more benign types of artificial satellites.

Figure 1. Cost of proximity operations in low Earth orbit



Source: Spar Aerospace Limited, *PAXSAT A Study of the Feasibility of a Space-Based System to Determine the Presence of Weapons in Space*, 1984.

Continuing with the harm index, the dimensions of radio-frequency apertures or electro-optical apertures on an artificial satellite, taken together with either measurements or declarations of a satellite's maximum radiated power and its frequencies of operation, can be used to assess the potential risk that such a satellite may disrupt or deny the radio frequency signals of another space object, or further damage or destroy another space object at range. The equation used in these assessments is the Link Equation typically employed by national radio frequency licensing bodies and by the International Telecommunication Union for satellites in the geostationary orbit. The relative position and motion data needed to calculate range between satellites could come from the information collected by a space traffic management system. Any space-based object that is specially designed or modified to damage or destroy another object at a significant range will possess specialized features for that intended mission. Recall, for example, some of the conceptual designs that had emerged from the Strategic Defense Initiative programme of the United States and its counterpart in the Soviet Union during the mid to late 1980s.

Finally, certain declarations associated with maximum power generation, heat rejection rates and maximum energy storage capabilities could help bound the extent of possible harm indices for satellites through the use of an Energy Balance Equation. In the absence of state declarations, open source information and national technical means of observation could be used to collect data to estimate such capabilities. For example, the measurement of the dimensions of a satellite's solar panels will enable an estimate of the power a space object would have available to project at another object in space or on Earth.

Obstacles and opportunities

Many of the necessary technologies needed to implement a space traffic management system are available to a diverse set of states. There is increasing evidence that the necessary technologies are not all that demanding. Infrasound detectors used to monitor nuclear weapon test explosions on the Earth appear also to be able to detect space launch events.[5] In parallel to the use of such arrays for detecting meteorite events, infrasound detectors should also be able to detect artificial re-entry vehicles and re-entering satellites. Space object tracking devices can be a simple as a set of stopwatches, binoculars and star charts. Several one-metre-diameter earth-based telescopes, when combined with a simple radio frequency fence,

ought to be sufficient to establish an initial space traffic management system. More developed states may wish to launch modest space-based telescopes to track space objects, as Canada plans to do with its Project Sapphire mission being developed by the Department of National Defence.
Some governments could oppose the formation of a space traffic management system on national security grounds, in order to maintain a veil of secrecy for their operations in a domain in which it is extremely difficult to hide space objects from persistent observation by a collection of dedicated ground-based and space-based observatories. Nevertheless, the challenges posed by these arguments can be addressed by managed-access architectures for the space traffic management system and through the natural proliferation of space situational awareness systems underway in China, India, Russia, the United States and European Union among others. Finally, the use of constellations of remote-sensing satellites to collect information will diminish the need to protect the orbital elements of a few reconnaissance satellites because the constellations will provide continuous surveillance of any desired region of the Earth.

Much infrastructure and many institutions and operational practices also already exist for the development of a space traffic management system. In terms of institutions, the International Civil Aviation Organization (ICAO) has several decades' worth of experience in handling more complicated national systems of systems for air traffic control. The International Telecommunication Union (ITU) also has a long service record of coordinating radio frequency signals for artificial satellites in geostationary orbit. Finally, the UN Office of Outer Space Affairs (UNOOSA) maintains the space object registry on behalf of the United Nations. In terms of new potential forums, the Committee on the Peaceful Use of Outer Space or the Conference on Disarmament could take up as part of their work programmes the safety and security dimensions of space traffic management simultaneously or even jointly.

Conclusion

The continued assured access to outer space by all nations must preclude violence or accidents that would result in long-lived space debris. Newly introduced "dual-use" satellites capable of close-proximity operations with other satellites, while not dedicated weapons in themselves, could perform a limited but still dangerous role during armed conflict. Were outer space to become a hotly contested environment in the future, dedicated space-based weapon placement might also then be witnessed. For these reasons, all nations that derive benefit from the use of outer space should support the development of a space traffic management system for its promised safety gains and thus enormous commercial benefits. Consideration of state declarations concerning the objects they launch into outer space could also result in additional security gains to help prevent armed conflict in outer space. Recognition that artificial satellites can be assessed for their potential harm, and aided by a simple definition of a weapon (as presented here), might also lead to international consideration of codes of conduct for outer space wherein nations would first pledge to prohibit the placement of weapons in outer space, prohibit the testing or use of weapons against artificial satellites, and prohibit the testing or use of any artificial satellite itself as a weapon. With that critical will first established, formal agreements might then become more feasible.

Notes

1 The views expressed in this paper are those of the author and do not necessarily represent the views of the Department of Foreign affairs and International Trade or the Government of Canada.

2 David Wright, "Orbital Debris Creation by Kinetic-Energy Anti-Satellite Weapons", draft paper for *Celebrating the Space Age: 50 Years of Space Technology, 40 Years of the Outer Space Treaty*, 2–3 April 2007, Palais des Nations, Geneva.

3 "The maximum weapon effects would extend to a few miles for pellets and to tens of miles for nuclear weapons", in Richard Fitts (ed.), *The Strategy of Electromagnetic Conflict*, Peninsula Publishing, 1980, p. 175.

5 Dr. Peter Brown, "The Potential of the International Monitoring System Infrasound Network for the Detection of Rocket Launches", Final Report, 5 September 2006, Department of Foreign Affairs and International Trade Canada, ISROP Study Contract Number IDC 0061.

A BAN ON DESTRUCTIVE ANTI-SATELLITE WEAPONS: USEFUL AND FEASIBLE

Laura Grego

Introduction

The human presence in outer space has been relatively short—it has only been 50 years since Sputnik I was launched—and just now are we approaching the era in which we move beyond "what can we do?" to "what should we do?" in outer space. How do we care for this resource so that it can be used for many generations beyond this one? To be sure, for the most part, outer space is used well and in an orderly manner, and supports the operation of over 800 satellites amidst the detritus of 50 years of launches. We are developing intelligent policies for dealing with the most likely sources of conflict—overcrowding, the allocation of orbits and the creation of incidental debris. These are the most likely sources of conflict, but also those that have the most direct solutions.

A much more complicated set of issues is how to manage the likely inevitable conflict over the military utility of space.

The two baskets of issues, the environmental issues that threaten the sustainable use of outer space and the strategic issues that can engender instability and exacerbate conflict on the ground, are distinct, and separate approaches can be very useful. But they are also deeply intertwined in important ways: a failure in managing security problems will likely result in an environmental crisis in outer space, and vice versa.

Space operations could become too dangerous or too expensive because of the threat and use of ASAT weapons. If the transition to a future regime is not managed well, and satellites are seen as legitimate targets and outer space is cluttered with debris, outer space will become less and less useful, rather than more and more useful.

And when the uses of outer space are contested, it is critical that the conflict is managed in the most graceful manner possible and that it does not lead to dangerous reactions on Earth. For example, in simulated war games, when US reconnaissance satellites are lost, conflict quickly and violently escalates. The loss of early warning satellites (even if due to natural causes) in a world where ASAT weapons exist and proliferate can be expected to result in the same. The testing of destructive ASAT weapons indicates not only that the weapons exist, but also generates debris that increases the risk of accidentally disabling a satellite–the risks reinforce each other.

Conflict may be inevitable, but from that it does not follow that weapons in outer space are inevitable. It is likely that a mixture of arms control measures, "rules of the road", and confidence-building measures will yield the greatest amount of collective security as well as preserve the many benefits of outer space for the long term.

Moving forward: a ban on destructive ASAT weapons

In this conference, we have heard a number of good ideas of ways to move forward, from the comprehensive treaty addressing space-based and ASAT weapons offered by the Russia, to the "rules of the road" discussed by Michael Krepon, to the ideas about more specific pieces of the puzzle that Kiran Nair, Jeffrey Lewis and David Wright alluded to. The speakers have elegantly set the context for me, and I am offering some ideas of where to start.

As my colleague David Wright mentioned, dangerous amounts of debris will be generated from the testing and use of destructive ASAT weapons and, depending on the altitude of the target, could persist for many generations. If the use and testing of such weapons were unrestrained, regions of outer space could become unusable for decades or centuries. Jeffrey Lewis argued that hit-to-kill weapons were the most pressing and central threat to satellites and a technology that many countries may want to acquire, and Kiran Nair suggested that destructive ASAT weapons are not particularly useful and might be ripe for a ban.

Benefits of the ban: safeguarding the space environment and improving security

I propose that this community consider a multilateral ban on the testing and use of destructive ASAT weapons, particularly those that generate debris. If this agreement could be negotiated and respected, the single biggest threat to a sustainable space environment could be mitigated—the destruction of a single large satellite could yield as much debris as would have been eliminated by 70–80 years of careful observance of the kind of debris mitigation guidelines that will soon be before the United Nations Fourth Committee and General Committee. This protection of the space environment would be the primary benefit, and a meaningful one.

Another benefit would be making illegal the simplest but also the most immediate and irreversible threats to satellites. Kinetic-energy ASAT (KE-ASAT) weapons, those which use the force of impact to destroy a satellite, are operationally attractive: their effects are predictable beforehand and are easily verifiable afterward. This is the type of weapon tested in January 2007 by China. And indeed, this was the main type of ASAT weapon the United States pursued decades ago in the Cold War. (At the same time, the Soviet Union developed its own co-orbital ASAT system. It was permanently destructive of its target satellite, but approached the target at a much lower speed and then used an explosive to propel shrapnel towards it. This weapon did produce debris but not to the extent that KE-ASAT weapons do.) The United States abandoned these weapons for a variety of reasons, but a primary one was the debris that they would create. Indeed, until a few years ago, the United States was still tracking pieces from the Soviet and US KE-ASAT weapon tests of the 1980s.

We propose a ban on both the testing and use of destructive weapons against satellites. The benefits are obvious, and I hope that all countries that wish to keep outer space usable in the long term will consider the idea carefully.

What the ban would include and how it may be verified

The specifics should be straightforward: the ban could be, for example, on hit-to-kill kinetic energy attacks on satellites, or it could set a limit on the pieces of large debris resulting from any satellite attack, or it could ban attacks which would result in the total destruction of a satellite (the total destruction of a satellite can be predicted by the expected velocities and masses of the satellite and weapon).

Such a ban should be verifiable from the ground, perhaps with already existing observational assets, perhaps with additional assets and coordination among observers. Countries that consider this idea could convene a panel of experts who could assess existing national technical means and their suitability for the purpose.

For example, early warning sensors could detect all launches—any test of a ground-launched hit-to-kill asset would be detected by these; China's ASAT test, as well as the tests leading up to it (that did not destroy a satellite), were detected in this way by the United States, and perhaps Russia as well. Ground-based assets such as radar could determine the trajectory once the launch was detected. Clearly, if a launch notification protocol were in place, it would simplify the step of detecting launches that need to be followed up.

Additionally, preferably with, but perhaps initially without, launch detection, all possible satellite targets for a destructive ASAT test can be monitored to verify that they have not been destroyed. The US Space Surveillance Network (SSN) regularly tracks thousands of objects larger than 10cm; its tracking of active satellites and inactive satellites and large pieces of debris is considered to be complete.

Such a system is overkill for verifying a ban on destructive ASAT weapons. Developing an independent capability to track all possible targets is a much simpler and focused task than trying to replicate the US SSN catalogue, as the number and type of targets is tightly circumscribed—and the most basic system would be charged just with tracking these objects, perhaps only objects bigger than half a metre or a metre and verifying that they are intact. For example, a study done in the European Union showed that a system that could replicate most of the SSN catalogue (not just big satellites) could be developed for quite a modest expense. And certainly the owners of those satellites themselves track their own satellites much more regularly than does the SSN. The absence of an object and the creation of debris are events that are noticed relatively quickly.

Of course, such a scheme does not prevent tests, it simply verifies that they are happening or not happening.

Indeed, I expect that an immediate criticism of this idea is that even if testing is stopped, such a ban does not prevent "heirloom" ASAT weapons being used in a crisis, and barrier to a breakout capability is only modest. That is correct, although I would like to point out that there is likely to be measurable value in such an agreement anyway. There is great value in the absence of the debris that would have been generated by testing programmes, as well as in the decreased likelihood of the use of such weapons in a conflict because of low confidence in an untested or incompletely tested system. Bans on tests can be useful, just as the Comprehensive Nuclear-Test-Ban Treaty.

This brings me to some issues that should be considered carefully. The first is our "Inconvenient Truth": missile defence testing. As we have discussed here, missile defence uses essentially the same technology as do hit-to-kill ASAT weapons. How do we ban destructive ASAT tests, when we assume the United States will elect to continue its ground-based missile defence tests?

Currently, the missile defence tests consist of intercepts of a missile, at suborbital altitudes. A ban on destructive ASAT weapon tests would prohibit the missile defence interceptors to be tested explicitly against satellites, and the ban could set an upper altitude limit for tests. This, of course, does not keep other countries from developing hit-to-kill technology and testing it as a missile defence in order to develop their own de facto ASAT capability. This situation stands in curious contrast to that in the 1980s, when ASAT tests were considered a roundabout way to develop missile defence capabilities, which were then banned by the Anti-Ballistic Missile treaty.

So it will be important to understand the possibilities of limiting high-altitude missile defence tests; it is also important to understand how much confidence a missile defence system tested at low altitudes could have as an ASAT system at high altitudes. A KE-ASAT ban may likely have its limits vis-à-vis missile defence testing; but it may yet be meaningful, as the Comprehensive Nuclear-Test-Ban Treaty is meaningful despite not banning hydrodynamic testing.

Additional, mutually reinforcing measures

Such an agreement would be particularly powerful if it comes in the context of other efforts to deter the use of destructive ASAT weapons in a conflict, and they should be pursued alongside a test ban. Some important examples of these efforts are:

- To have a clear and declared set of consequences for the destruction of a satellite. There are various pieces of international law which already address intentional interference with a satellite, including pieces of the Outer Space Treaty and the Liability Convention.
- To reduce the attractiveness of satellites as targets. Satellites are vulnerable and valuable—a difficult combination. They should be part of a redundant system; if they are an actors' Achilles' heel, it is due to poor planning. Countries with a lot of resources, such as the United States, can provide backup capabilities for the most critical satellite functions, and can distribute satellite function over a number of smaller satellites, making each less valuable. Countries with fewer space assets are likely not to have such high reliance on satellites, and so the satellite might not present as a critical target. As well the availability of high-quality commercial remote-sensing satellites makes the logic of targeting low-flying reconnaissance satellites less compelling. Such a provocative attack will be less likely if the loss does not cripple an adversary's capability.
- To employ simple ASAT countermeasures, such as decoys or flares to further reduce confidence in an attack.
- To complicate the decision to use destructive weapons against targets: the more international the set of owners and users of a satellite, the more complicated the decision would be to use a weapon against it.

Conclusions

I believe such an agreement can have value. It is not a new idea, but it is one that might be timely, as Russia and the United States have largely abandoned such programmes, and recent events have emphasized just what is at stake when destructive ASAT weapons that create debris are used.

A destructive ASAT weapon ban will derive greater relevance and usefulness as part of a comprehensive regime of arms control measures, "rules of the road" and confidence-building measures. It cannot guard against other types of ASAT threats. But particularly if it is coupled with other suggested work—such as unilateral statements of "no first deployment" of weapons in space akin to that made by Russia, “rules of the road” that promote orderly and transparent conduct in outer space suggested by a number of countries and non-governmental organizations, and space traffic management and other confidence-building measures as advocated by Canada and others—it can prove to be a useful and meaningful tool to increase the secure and sustainable use of outer space for all.

OVERCOMING INSTITUTIONAL INERTIA

Rebecca Johnson

The Conference on Disarmament (CD), some might say, is drinking at the last-chance saloon and there is many a slip between the cup and the lip. Even if the CD managed to adopt its programme of work for this year, it has to renew it next year, and the next, and the next. Whether anything can be done on space security in Geneva will be heavily dependent on whether constructive progress is made towards a fissile materials treaty.

Patricia Lewis introduced me, saying that I was going to do some creative thinking, but in the last 13 years I have been invited several times to give creative, constructive thinking on how the CD can work around its rules of procedure, how it could maybe use certain mechanisms; and not just the CD but the Nuclear Non-Proliferation Treaty too. I have come up with pragmatic procedural suggestions, and I have come up with creative ideas and strategies. But ultimately such improvements will not be adopted or implemented unless the countries themselves identify that they have sufficiently strong interests in seeing the CD get to work. If even one country perceives that it has stronger interests in preventing progress, then by the current institution of the CD with its consensus rule, that will be enough to prevent any moving forward in that context.

At the moment, rather than come up with more creative suggestions, let me just backtrack a little bit and look at some of the factors that need to be addressed to overcome the blocks. I am going to summarize some of the key factors that I identify, and then I would like to look more closely at a few additional elements that need to be addressed.

First, one can recognize that there are different political objectives and different perceptions of national security and interests. I might once have called this factor “political will”, but I know that UNIDIR avoids this term because it encourages fatalism and may also encourage sloppy thinking.

The second is the division of labour, or what Anton Vasiliev called the "political red line", between what current institutions traditionally regard as their remits—peaceful uses on the one hand, and on the other, arms control and disarmament. I will come back to look at what is positive and negative about this division.

The third factor is the perceived contradiction between incremental approaches and prohibition or comprehensive approaches. I am going to suggest that this is a false dichotomy.

Fourthly, there is the venue or the institution for negotiations on these issues. It is often represented that it is the CD or nothing at all. I am going to argue that this is a false choice.

Fifth, there is the question of timing. How urgent is the need? And, equally important in understanding this, how urgent is the perception of the need to get something done? And also, how big is the window of opportunity? This relates to Ambassador Palihakkara's presentation—if we do not establish the principles for control or norms for non-use or -deployment now, will we be facing a much harder and less effective task of building a non-proliferation regime in a few years down the track?

Different political perspectives and perceived interests

Many are concerned about what they see as political obstruction by the most dominant space-using country, as it pursues (at least for now) the neo-conservative doctrine of keeping a free hand for US freedom of action, as clearly stated in the 2006 Space Policy—in other words, to keep all options open. What needs to be remembered is that this in itself is an option that denies several other options. To try to keep your own options open inevitably prohibits the option of choosing a shared security path. We can relate it also to the US nuclear weapons approach; in 1945, the United States was the sole country with nuclear weapons. They underestimated the Soviet Union's capacity to catch up. With some of the reverberations following China's missile test in January 2007, perhaps we are seeing parallels with the shock felt in the United States due to the 1949 Soviet nuclear weapon test.

What happened as a result of the Soviet test in the context of the Cold War was that the competition turned into a mad, expensive nuclear arms race.

It was destructive and debilitating on all sides, not only because of the vast waste of resources and the appalling dangers to world security for many decades, but also the diversion of attention in both of those countries, and indeed others in their spheres of influence, so that they failed to deal with other kinds of domestic and international security challenges.

What may change the United States' perceived interests? I argue that they are actually in the process of changing. First, there was the failure to get the level of domestic funding and support for much of the missile defence programme, at least the further reaches—the "star wars" reaches. Second, there is a growing recognition that space test-beds are infeasible or at least that, in the medium term, there is not the money or technology to get the space component off the ground sufficiently to demonstrate how space-based weapons would work as part of the imagined multi-tiered architecture for a ballistic missile defence. Third, there is the Iraq factor, which I will not discuss more widely because we could get into an entire discussion about the lessons from that debacle, but the point is that there are very important consequences from the Iraq war of choice that wiser political heads in the United States are gradually absorbing. In particular, they are coming to see that consolidating the security of existing assets is more crucial now than pursuing the chimera of multi-tiered invulnerability. This relates to point five: the Chinese missile to satellite interception may act as a kind of shot across the bow, to provide a shock to wake up the United States to the consequences of pursuing its current mistaken policies. Or it may play into the hands of the scaremongers, providing them with a threat image of China as a space-capable, rising military power that will then be used to justify missile defences.

So a key question is: will the United States repeat Cold War mistakes or will it come to the table to negotiate and build collective space security rules and limits? If it comes to the table, will China and Russia or indeed others engage constructively with the United States on a shared mission of security or will they move the goal posts and go back to the kind of games that were played in the Cold War, where as soon as one was prepared to move forward, the other would move back, and then the dance would go into reverse the next time round?

Another aspect to consider is: can ballistic missile defence be unpacked, can it be disaggregated? What level of ballistic missile defence might be acceptable or perhaps even stabilizing given that some countries have already begun collaborating at certain levels, such as Japan, NATO and so on. This question may not be popular in some civil society circles, but it does need to be asked: would we be willing and able to make a trade-off in accepting some level of ballistic missile defence, perhaps limited to theatre defences, in return for bringing the United States on board collective negotiations to prevent the weaponization of space?

A further aspect of different perceptions is geostrategic relations. With regard to space security, these are often put in terms of China, Russia and the United States, but we need to remember that there are other important strategic relations that need to be taken into account. For example, there is the important, and woefully avoided, role of Europe—both the European Union and NATO—of growing importance are also the developing space-faring states such as Brazil, India, and also states such as Iran, which is determined to develop long-range ballistic missiles. The relationship of missile development to this whole issue is crucial to understand.

In addition, more and more developing states have growing needs and interests as users of satellite technologies, for example for communications, education, travel, emergency planning, banking and commerce, and so on. This leads us to the commercial interests. Again, though the United States still dominates the scene, space assets are less and less the purview of a single nation; on the contrary, they increasingly have shared plurinational investment and ownership, and are intended to have multinational consumers.

This overview of factors likely to change the United States' calculation of interests with regard to cooperative space security is relevant because, in arms control, the most enduring and sustainable controls and prohibitions generally come with an attractive incentive structure. In my view, the incentive structure for engaging in multilateral initiatives to build a space security regime is now beginning to fall into place. However, traditional diplomacy is missing this big picture. The argument that you cannot have negotiations without the central involvement of the United States from the very beginning is missing a crucial point. Whether it likes it or not, the United States cannot afford to be left out.

If one requires institutional consensus in order to begin, then of course the current US administration will block. But if others begin to go ahead and make progress in various ways, the United States' overriding commercial and security interests mean that they will need to be at the table.

The division of labour and remits

As noted, there are positive and negative aspects to this division of labour between the peaceful uses remit and the military uses remit, including arms control. The distinction between non-aggressive and aggressive made in Brachet's presentation is extremely helpful for this. We need to recognize that security is overarching, that we are dealing with dual-use—indeed multiple-use—technologies and capabilities. Therefore there have to be exchanges, better communication between the UN Committee on the Peaceful Uses of Outer Space (COPUOS) and the CD, since preventing an arms race in outer space is critical for both the peaceful uses and arms control security agendas. However, the fact that space security has both peaceful uses, "rules of the road" aspects, and arms control dimensions should not become an excuse for states to avoid negotiations by using the negative ping-pong tactic, in which the claim is made that you cannot deal with something here because it ought to be deal with there, but in fact it is not being dealt with there so it cannot be dealt with at all.

Incremental versus prohibition or comprehensive approaches

Two examples are "rules of the road", representative of an incremental approach, and treaty making, representing a comprehensive approach. The previous discussion addressed this, but I want to argue that this is really a false dichotomy. At the same time, it has to be acknowledged that some incremental measures facilitate further progress towards a more enduring, comprehensive solution, while others may impede further progress, principally by diverting attention and resources into measures or negotiations that either solve only a small part of the problem or become bogged down and fail to go anywhere useful. However, being aware of the risks, we can avoid the pitfalls.

Treaties generally get concluded to codify a restriction or renunciation that a dominant government or critical mass of states has already decided to implement. However, the process of imagining a treaty in which to imbed the norms and thus rid the world of a particular danger happens much earlier. It is usually driven and fed by civil society and less powerful nations. Similarly, long before they accept the need for legally binding agreements, governments will tend to seek more flexible, ad hoc or voluntary restrictions, such as “rules of the road”. History shows that the very process of these developments will build confidence, knowledge and practical expertise among participants and can therefore lay the groundwork and make it possible for treaties to be brought in if they need to be.

Venue

It is often represented that arms control or prevention of an arms race in outer space needs to be negotiated in the CD, and that the alternative to the CD getting a work programme or negotiating mandate is nothing. This is simply not the real situation. If for whatever institutional, structural or political reason the CD cannot negotiate the instruments we need for space security when we need to negotiate them, then a different institutional and political arrangement can be initiated to establish an alternative venue and an appropriate structural environment to make negotiations possible—as happened when the public pressure for a ban on landmines became so strong that states decided to bypass the impasses in the Convention on Certain Conventional Weapons and the CD and establish the Ottawa Process, which succeeded in negotiating and concluding the Mine Ban Treaty in record time.

Timing

There may be more time than we thought a few years ago, as the Bush administration has encountered delays and setbacks in pushing forward US weaponization plans; but on the other hand, missile proliferation and the Chinese test suggest that some of the negative consequences predicted five years ago of ballistic missile defence policies, including an increase in the number of states with destabilizing capabilities, may already be coming to pass. So we have time, but not a lot of time.

Let us close this stable door before the horses have all bolted. Once they bolt we may be able to chase them all down and get them back into the stable again but that will be dangerous, time consuming and energy consuming, and they could have done a lot of damage while they were out there. Better to be prudent and prevent such a disaster while we still can.

Conclusions

US interests are already being reframed by the facts on the ground that the neo-conservatives around Vice President Cheney and former Secretary of Defense Rumsfeld thought they could ignore. But more has to be done to change perceptions in the United States of their real security interests and also to change how other countries deal with the United States in relation to their security interests with regard to key political and military constituencies.

Shocks may create change, so the shock of the Chinese missile test may change US calculations. To get the major states to the negotiating table you do need sticks, but you also need to have some carrots. We need to think of how to build a more desirable incentives structure into the space security regime. That has not been sufficiently dealt with.

MOVING FROM DIALOGUE TO ACTION

Colleen M. Driscoll

I am a political scientist with a specialty in International Law. However, I am not going to speak on either of these topics. Instead, since I am the final speaker, I am going to do two things. First, I am going to put a human face on the issues about which we have been speaking. Second, I am going to suggest a broad range of possible actions which can lead to providing true long-term security in outer space.

Some of these actions have been discussed in this conference and in the Conference on Disarmament (CD), while others are my own additions to the discussion. Some could be undertaken more quickly than others. The best way to go about keeping the uses of outer space peaceful and positive is to begin taking action on many fronts, thus keeping the issue prominent. While the CD meets to consider the topic of the prevention of an arms race in outer space (PAROS), there are many other discussions and actions that could take place in other forums and in various countries.

Thus I am going to put forth a request to humanity and propose steps on a path toward sanity, sensibility and security that can create the world that I believe all of us want to help to create. What legacy do we want to leave the Earth and its people? Do we want to leave a new arms race or a more peaceful, cooperative world? We live on a small planet in a large universe. If we would stop thinking small and instead think large, we could create a security system that does not depend on newer and more sophisticated weapons, but rather on shared action and an understanding of and common dependence on what we need to do to protect and preserve this small planet and its resources. Since outer space surrounds us all, this plan must also depend on a joint system for using technology to assure the national security of every country.

A large part of the problem in protecting outer space is that there has never been a clear delineation of what constitutes a positive, beneficial use of outer space versus a negative use. Neither is there any clarity as to what constitutes national security, or the interwoven connection between it and global security.

We may begin with different mindsets and experiences—differing visions of why we have reached into outer space. In fact, this is where we need to begin. We need to redefine and identify our goals for the human use of outer space. To do this, we need to have a wider dialogue among people, governments, scientists and experts—military and civil—as to why we are there and where we want to go from this point forward. The dual use of outer space has, of course, been one of the hallmarks of space use. The military had the technology and training to take humanity into space. Military satellites are part of the security system for those countries capable of deploying them. In many positive ways, military and civil space activities have assisted and complemented each other. Thus, unless we commit to a dialogue that includes all interested parties, respectfully listening to each other's views, there will be weapons over our heads and, most importantly, over those of our children and grandchildren.

We may begin with different philosophical perspectives. Some make the assumption that the state is the most important actor in world affairs and in the choice of how to use outer space and the Earth. I assume that the people of Earth, no matter their country, are the most important actors and that they have a right to express their opinions and to create their visions of the future. Government officials rotate in and out of office, but the people continue from generation to generation.

The decisions being made today about outer space affect the future of every man, woman and child on earth. Thus they have a right to be involved in the decision. At various forums of governmental and non-governmental groups, dialogue has been ongoing concerning the peaceful use of space and the prevention of an arms race in that environment. One of the first people with whom I discussed this was Ambassador Dhanapala of Sri Lanka when he was at the CD.[1] The mid-1980s were a wakeup call as governments and their people became aware of the threat that weapons might be used in outer space. In the United States there was a public outcry against a government initiative that would have led in this direction. Yet, here we are in 2007, no further along in preserving outer space, yet much further along in technology.

My request is for governments, non-governmental entities and all of civil society to take immediate action to move forward in the process of preserving outer space for all humanity for all time. Along with this, I ask everyone to do so in a spirit of cooperation and commonality of interest, free of special interests and of the tendency of countries to stake out a position as if it could stand alone in an era of interdependence. The preservation of outer space is a collective good and requires collective action. The path to this has many possible steps, and that is what I am going to present here.

Back to the beginning

In a sense, what we need to do is to go back to the beginning of the space age. We all know that the space age began in the era of the so-called Cold War. Beyond that fact, however, lies another. Once humanity began to set its sights upward, and observation satellites looked down and sensed the Earth, something happened. We began to realize what humanity's entrance into outer space could mean for the well-being of Earth's people, countries, environment and future. As images of Earth from outer space appeared, in so many ways they began to help make life better.

As we consider all those ways in which space technology is making life better across the globe, we now need to reassess the present stage of the space age. We need to see where we are, to identify why we are at this point, and where we want to go from here. If we are to expend the enormous amounts of money that space activities require, then for what purpose? If it is not to enrich the lives of all of Earth's people and to create a global security system, then it has been wasted. If we creative, inventive, curious human beings are searching for knowledge, for our beginnings, and for worlds beyond our own, then we should identify that as one of our purposes. If, instead, outer space becomes an arena of weapons and war to take Earth's conflicts to a new and terrifying level, we have not proven our creativity—we have denied it.

Dialogue and first steps on the path

How many of Earth's people—not those of us at this conference, or governments, or informed non-governmentals, but rather the core populations of our countries—are aware of the decision that faces the world concerning outer space? I speak to many community groups and to students and, with only a few exceptions, I find them unaware of the issues involved in the use of outer space. These, then, are some of the immediate steps that can be taken:

- Education of the public in all countries about what space use has meant to their lives; about the decisions to be made at this time; of the potential benefits to them of positive uses and the dangers of negative ones. Education can take place at any level. The continuing work following the Group of Government Experts Study on Disarmament Education is a possible starting place. Although it had not been their original intention, they did add outer space to their study, connecting it to education efforts on weapons of mass destruction (WMD).[2]
- Discussion in communities, organizations, churches, schools and universities based on the information they have received. Through the use of discussion guides and action guides, people can be encouraged to think through the issues for themselves, then make an informed opinion known to their own governmental authorities. My institute, the Kurtz Institute of Peacemaking, is involved in a project to open dialogue in the United States in this manner.
- Expand the reach of World Space Week and broaden the population reached by these programmes and others such as the UN Programme on Space Applications.

Some first steps for governments are:

- Open an active, ongoing dialogue among the governments and their representatives who want to discuss the issues of PAROS even if other countries do not. This can take place in a variety of forums, from the CD to the First and Fourth Committees of the General Assembly, to seminars and private talks.
- Develop an atmosphere of transparency among countries so that each shares what kind of plans and activities for the use of outer space are held by their own governments. This includes better and complete registration of space activities as a major part of confidence building and cooperation. Beyond registration, more cooperation in informing the international community about their plans for future space use would add to building trust.
- Pass national legislation or resolutions renouncing development, testing or deployment of space weapons.

- Establish controls on budgetary expenditures so that the available monies are spent on economic growth and consumer needs rather than on budget-breaking research and development of weapons for space. Along with this, increased transparency in those budgets will give the public a role in the decisions to be made and will build trust among governments.

A necessary immediate action

The present administration in the United States is making broad offers to a large number of countries to participate in missile defence systems. Potential financial gain and sharing of advanced technology have been used as incentives to convince other countries to join. Before another country accepts this offer, there must be a full consideration by all countries of the implications of a missile defence system for the uses of outer space. This would involve:

- looking beyond the immediate monetary gain to the potential long-term expense that each country will face;
- a study of the weapons of the future and whether a missile defence has any application to those weapons, for example miniaturized nuclear weapons;
- a study of the conflicts of the present and those that might be predicted for the future and whether a missile defence has any application to those conflicts; and
- a study of the long-term implications of missile defence systems for the placement of weapons in outer space, as well as for the use of anti-satellite and other Earth-based, space-targeted weapons.

The placement of missile defence systems has repercussions for those countries that allow them on their territory as well as those that do not have them, thus all have a right to engage in a dialogue on the subject. I call on states to begin discussing this issue immediately in a variety of forums, including the Conference on Disarmament, the General Assembly and its committees, and in any other meetings, conferences and groupings of states.

Potential immediate actions

There are actions which countries can take immediately while treaties are being discussed or drafted:

- All countries can urge those who have not yet ratified the Outer Space Treaty (OST) to do so. Ninety-eight countries have ratified the Treaty and another 27 have signed but not ratified. This is another project in which my Institute has been engaged. It is much more important, however, that the signatory states encourage others to ratify the OST.
- Continuing to discuss PAROS in a variety of forums. My institute has begun talking with the Office of Disarmament Affairs (ODA) about a celebration of the fortieth anniversary of the OST at the United Nations in New York in the fall. We had worked with them in organizing a seminar in celebration of the thirty-fifth anniversary of the OST five years ago. The best way for states to celebrate the coming anniversary would be by declaring their reaffirmation of the principles declared in the OST.
- Increase the number of joint space projects, especially in the work of research and development. Cooperation is the foundation stone for maintaining peaceful uses of outer space.
- An immediate declaration by states individually, or in groups, of a moratorium on the development, testing and deployment of weapons in or aimed at outer space. Since outer space use is a decision in which all countries and all people have a right to participate, a valuable contribution can be made by any country, whatever its level of space use, in making this declaration. This has been proposed by a number of states at the CD.
- An immediate, separate declaration by states of “no first deployment” of space weapons. This does not have to wait for consensus decision making because it is a statement each state can make for itself.
- There need to be clear definitions of the terms that are used in PAROS discussions. Canada has called for such definitions many times.[3] Without a common understanding of the definitions of the terminology, discussions will just go around and around. These terms include, although this is far from an exclusive list, peaceful uses, spacecraft, space objects, military uses, space weapons and weaponization, weapons of mass destruction and security. This is a

complicated project that could take place within the CD committee on PAROS, in General Assembly committees, and working groups of interested states or a combination of government and non-governmental experts.

- A request by the General Assembly for an advisory opinion from the International Court of Justice on the legality of the use of weapons in outer space or from Earth to outer space and an interpretation of the terms and legal implications of the principles of the Outer Space Treaty. This could include an interpretation of the broader meaning of WMD.
- Strengthening the OST to add, in addition to the prohibition against weapons of mass destruction, the prohibition against the deployment of any weapons in outer space or aimed at space systems from within Earth's atmosphere.
- A declaration of *res communis*, identifying outer space as belonging to no country, although open for the use of all, and a reaffirmation, preferably in written form, that activities there take place in the interest of all countries and their peoples. As a Sri Lankan statement of August 2004 states, "Today there is a widespread recognition of the notion that outer space should be preserved as a 'sanctuary'—the common heritage of mankind."[4] Also, at a conference in 2005, Ambassador Hu Xiaodi of China said, "Outer Space is the common heritage of mankind and the peaceful use of outer space is the aspiration of all peoples."[5]
- The development of Rules of the Road or a Code of Conduct. These have been discussed at the CD and at this Conference but require much more development as to what might be included in them and in what form they would be written.
- Continuing discussions in the United Nations bodies in addition to the CD, such as in the General Assembly—as Switzerland has said will occur this year[6]—and its First and Fourth Committees, and in the Committee on the Peaceful Uses of Outer Space. Action on the part of any of these bodies will help to move ahead the work of the CD on PAROS.

Longer range activities

As action is taken on the steps that do not require consensus decision making, states can begin to take action on the more difficult steps. Treaties are, of course, necessary to establish international law, but there are many steps that can be taken as the treaties are being negotiated:

- Further development of the principle of non-use of force to include the use of force against space objects. Ambassador Skotnikov of Russia said that the non-use of force principle "obligation fully applies to activities conducted by states in outer space."[7]
- Include the outer space weapons issue in discussions of WMD, for although they may be targeted against specific space systems or targets on Earth, the debris from such activity, the damage it can cause to spacecraft—including manned spacecraft—and the potential fallout on Earth could effect everyone.
- The declaration of a Space Preserve (also referred to as a Space Sanctuary) with a treaty-based management plan to maintain outer space for the benefit of all humanity. If outer space were a preserve, all states could more fully share the costs and benefits of space activities as their right. What a step forward it would be if, in the future, people could travel and live in space as humans sharing an experience free of the constraints of national boundaries and the mistrust that has for so long separated us.
- A treaty or treaties banning weapons from outer space is a necessary part of protecting the peaceful nature of space.[8] These could define the positive civil and military activities, such as early warning, surveillance, and other such security-building activities. Freedom of access to outer space can be assured only if weapons are not placed there. If they are, the "keep-out zone" approach of the Strategic Defense Initiative in the 1980s would prevail and the area over the Earth would begin to close, bit by bit, to freedom of use by all countries.
- From this might follow the proposal that France took to the Special Session on Disarmament in 1978, that was reported on by a Group of Governmental Experts, for an international satellite monitoring agency (ISMA).[9] By whatever name, this concept would create a global system for monitoring all arms control treaties and could provide trust-building as well as instant, high-resolution data to states, the Security Council, and the Secretary-General.
- A long-term study begun now by governments and experts on the environmental effects from present space use and projected environmental effects from weapons, whether ground- or space-

based interceptors, or any other potential weapons for use in outer space.
- The calling of a Space Conference to look at all the issues in a comprehensive, in-depth meeting of all countries.

To conclude

The discussion we have been having the past two days is not a discussion that should end when we leave. Neither should the discussions of how outer space will be used in the future and of whether the issue of weapons being deployed there or used against space systems should go on and off the agenda. There are many steps that can be taken on the road to securing outer space—steps that will sustain and advance this goal.

We now have a limited window of opportunity where the positive aspects of outer space use can outweigh the negative. It is now that we can stop weapons from entering outer space before they are there and that the difficult job of trying to work out arms control agreements must begin. To quote Alfred, Lord Tennyson, "'Tis not too late, my friends, to seek a newer world."

Notes

1 See Colleen Driscoll, *Outer Space for the Benefit of All Humanity,* CURE, 2003, p. 64.

2 *Disarmament and Non-Proliferation Education: Launch of the UN Study,* 9 October 2002.

3 Conference statement by Paul Meyer, Ambassador and Permanent Representative to the Conference on Disarmament, *Space Security and the Prevention of an Arms Race in Outer Space,* Geneva, 26 August 2004. This is just one of many statements and papers submitted by Canada on the subject of definitional issues.

4 Intervention by Sri Lanka at the Plenary Meeting of the Conference on Disarmament, Geneva, 26 August 2004.

5 Opening Statement by Ambassador Hu Xiaodi, *Safeguarding Space Security: Prevention of an Arms Race in Outer Space,* Geneva, 21–22 March 2005.

6 Reaching Critical Will, *The CD Report*, 6 March 2007.

[7] Conference statement by Ambassador Leonid Skotnikov, Permanent Representative of the Russian Federation at the Plenary Meeting of the Conference on Disarmament, *Space Security and the Prevention of an Arms Race in Outer Space,* Geneva, 26 August 2004.

[8] See *The Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects*. Presented at this Conference by Anton Vasiliev, Deputy Permanent Representative, Permanent Mission of the Russian Federation.

[9] *Study on the Implications of Establishing an International Satellite Monitoring Agency*, UN document A/AC.206/14, 10 June 1981.

ACRONYMS

ABM	anti-ballistic missile
ASAT	anti-satellite
BMD	ballistic missile defence
CBM	confidence-building measure
CBO	US Congressional Budget Office
CD	Conference on Disarmament
CFE	US Commercial and Foreign Entities programme
COPUOS	UN Committee on the Peaceful Uses of Outer Space
DARPA	US Defense Advanced Research Projects Agency
DoD	US Department of Defense
FSP	Russian Federal Space Programme
GEO	geostationary orbit
GPS	Global Positioning System
IAEA	International Atomic Energy Agency
ISO	International Organization for Standardization
ISS	International Space Station
ITU	International Telecommunication Union
JSPOC	US Joint Space Operations Center
LEO	low Earth orbit
NASA	US National Aeronautics and Space Administration
NRO	US National Reconnaissance Office
NSS	national security space
OST	Outer Space Treaty
PAROS	prevention of an arms race in outer space
PPW	Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Space Objects
SSA	space situational awareness
SSI	Space Security Index
SSN	US Space Surveillance Network
STRATCOM	US Strategic Command
TCBM	transparency and confidence-building measure
TCSBM	transparency, confidence- and security-building measure
WMD	weapons of mass destruction