# CHAPTER 1

# CONFERENCE REPORT

## INTRODUCTION

In March 2006, the United Nations Institute for Disarmament Research (UNIDIR) continued its commitment to holding an annual discussion to explore the issue of security in space in order to further the understanding by, and the debate among, governments, academics, non-governmental experts and industry experts.

The meeting focused on:

- The preconditions for a space regime that would provide sustainable and secure access to outer space for peaceful purposes;
- The creation of an environment that convinces space actors that it is safe not to base weapons in space; and
- Increasing awareness among governments and the public of the benefits of sustainable and secure access to and use of outer space.

The meeting was organized by UNIDIR and supported by the Governments of Canada, the People's Republic of China, the Russian Federation and The Simons Foundation and held in the Council Chamber of the Palais des Nations, Geneva. Representatives from member states and observer states of the Conference on Disarmament (CD) and experts from Canada, China, France, Germany, India, the Russian Federation, the United Kingdom and the United States brought the total number of conference participants to over 100 people. Opening remarks were delivered by Patricia Lewis, Director, UNIDIR; Sergei Ordzhonikidze, Director-General, United Nations Office at Geneva; Ambassador Paul Meyer, Permanent Representative of Canada to the CD; Ambassador Cheng Jingye, Ambassador for Disarmament Affairs, People's Republic of

China; Ambassador Valery Loshchinin, Permanent Representative of the Russian Federation to the CD; and Jennifer Allen Simons, President, The Simons Foundation.

The following constitutes a summary report of the conference. The keynote speakers are identified along with summaries of their presentations. Participants in the ensuing discussions remain unidentified.

## Session I
## Future and current threats to the peaceful uses of outer space

### Threats to the security of outer space: emerging technologies
### *Laurence Nardon, Institut français des relations internationales*

Emerging technologies can be defined as those technologies most actively researched at present, as opposed to technologies currently coming online. Research conducted in the United States could be the best indicator of such emerging technologies given that in 2005 the United States had a space budget of approximately US$ 22.5 billion.

In terms of the possibilities for anti-satellite (ASATs) weapons, three considerations need to be taken into account: the target; the location of the weapon itself and the level of damage required. All three considerations combine to make many kinds of ASAT weapons imaginable and/or desirable, from electronic warfare equipment ("jamming" devices) and cyber warfare capabilities to weapons that attempt to directly target the satellite itself. However, in the past, attempts at developing the latter have run aground such as the "hit-to-kill" Kinetic Energy ASAT (KEASAT) programme during the Clinton Administration as well as the direct-ascent nuclear weapons tests that took place in the 1960s (known as the Starfish Series). Regarding directed energy weapons, ground-based lasers capable of attacking objects in low-Earth orbit (LEO) require a significant amount of power, making them difficult to mount on aircraft due to their size and difficult to place in space due to energy requirements. Although funding in the 2007 US budget for the Mid-Infrared Advanced Chemical Laser (MIRACL) programme has been cancelled, other ASAT programmes continue.

## Development and peaceful applications of outer space: the Indian experience

***Balakrishnan Vasudevan, Indian Space Research Organisation (ISRO)***

India currently spends US$ 650 million per year on its space endeavours, which employ a workforce of 16,500. During the past 40 years, India's remote sensing capabilities have gone from 1-kilometre resolution to 1-metre resolution and space launch vehicle capability has evolved so that India can now launch into geosynchronous orbits (GEOs).

For India, the most important peaceful applications of outer space include meteorological, surveillance, education, Earth observation and crisis management. The tsunami in December 2004 underlines the necessity of space for India's security—the value of remote imagery and space communication became clear to all. In addition to human security, space applications play an important role in the agricultural sector. Satellites identify potential fishing zones by measuring the temperature of the sea and then broadcast the information through radio transmissions to local fishermen. A number of other applications, such as remote education programmes, were also outlined. The speaker concluded by stating that enabling the peaceful application of outer space is as important for developing countries as for developed ones.

## The private sector and the security of outer space

***Stephen Stott, New Skies Satellites***

Since the early days of space exploration two basic principles have governed the use of space: right of access and freedom of navigation. As of 2006, there are many new and independent operators and space has become a truly open environment, comparable to the high seas when they were of prime importance to public, private and governmental agencies for civil, commercial and military operations. This surge in space-based activity has been met with a matching surge in irresponsible use, debris, radio frequency contamination and commercial piracy. There is a need now for the commercial sector to come to agreement on criteria that would ensure the security of space for commercial operations, that is, mission assurance—the ability to provide a product when needed. Increasingly, the line dividing the military and civil sectors in the field of space exploration is blurring, as is the distinction between strategic and commercial interests. Given the reliance of the military and the civil sector on each other, true space security requires collaboration in order to deter and protect against attacks on friendly space systems, be they military or commercial.

### Terrorism in outer space
### *Jeffrey Lewis, Belfer Center, Harvard University*

The utility of the concept of terrorism in the field of space security was questioned. First, the term "terrorism" contains a normative connotation and is difficult to define, which poses a number of problems in and of itself. Second, the space element may not be absolutely necessary to disrupting outer space activities given that an attack by a non-state actor could be made against a ground station or a launch vehicle at time of launch. Whether such an act would be considered any different to attacking an embassy, for example, is generally considered doubtful.

Four challenges posed by non-state actors were examined. The threat to satellites or space stations was ruled out and the threat of an attack at the time of launch was deemed highly improbable. The real challenge seems to lie in physically protecting satellite ground stations or protecting operational systems from outside interference such as computer hacking. But such protection would not entail measures unique to the realm of space. A second challenge relates to the issue of signal jamming or communications interference, however Lewis questioned whether this was a challenge particular to dealing with non-state actors given that governments are also involved in this activity. The proliferation in commercial satellite use and the diffusion of technology are two further challenges, but they are not understood to be associated with malevolent non-state actor behaviour (that is, terrorism), but more as challenges posed by commercial entities.

### Space weapons and proliferation
### *Michael Krepon, Henry L. Stimson Center*

The central dilemma is that satellites are both indispensable and highly vulnerable. This dilemma generates a number of potential responses such as improving space situational awareness (SSA) and intelligence, developing quick replacement parts/satellites, devising a code of conduct, drafting a new space treaty or developing space weapons. Space weapons are defined as those weapons designed to physically attack satellites; jamming devices are excluded as space weapons, as are weapons with residual ASAT capabilities. The vulnerability of satellites is tied to the problem of space debris, which is a problem that space weapons are unable to counter and would only serve to make worse.

On the question of an arms race in outer space, the language of "arms racing" can be unhelpful in constructing arguments against the weaponization of space because such a scenario is viewed as being highly unlikely in a time of asymmetric threats to the United States. The vulnerability of satellites to a "cheap kill" attack on a ground station or even direct attacks in outer space could well make such competition unnecessary. The real problem lies in the proliferation of space weapons and is driven by such factors as perceptions of insecurity and weakened norms. Space weapons could also make the problems of satellite vulnerability and space debris worse, which, in turn, would likely have a negative impact on proliferation. A code of conduct as discussed in previous meetings was offered as a near-term solution.

## Debate

Following the presentations, participants exchanged views on the following issues:

- Civil–military collaboration;
- The question of arms racing;
- ASAT technologies and Ballistic Missile Defense (BMD);
- The definition of space weapons; and
- Protection measures and commercial operations.

Referring to greater civil–military collaboration in defending space-based assets, the question was asked if members of the commercial sector advocate the placement of certain weapons in space. The response from representatives in this field was that, as is generally understood, offensive weapons are not advocated but that a line needs to be drawn between what is acceptable self-defence and what is unacceptable. This led to a debate on the distinction between offensive "weapons" and defensive "systems". Regarding the notion of acceptable self-defence, another question arose as to whether this includes active defences such as "shoot-back" systems, which many regard as weapons. The argument, common in the BMD debate, that a system is not regarded as a weapon because its primary role was seen to be defensive was felt to be illegitimate. One strong view from the commercial sector—although not shared by all—is that shooting back in any way is offensive, and the type of defences supported, and with which collaboration with the military is hoped for, are capabilities such as redundancy measures, radiation hardening and so forth.

The utility of the language of arms racing and the argument that space weapons deployment is unlikely to precipitate an arms race received considerable attention. On the relevance of symmetry in competition, a number of participants argued that symmetry of actors' capabilities in terms of resources and numbers was not necessary for an arms race as arms racing was not an end result, but a process. However, it was stated by one person that given the high vulnerability of satellites, any race to weaponize space was rendered unnecessary—significant capabilities are not necessary in order to compete in this area. As such, the kind of arms racing that was witnessed during the Cold War where the two superpowers developed thousands of weapons could not translate to the space arena; intelligent actors would not pursue such a course. But this was said to be a misunderstanding of what an arms race is: an arms race is not about numbers, but about perceptions of threat that lead another country to attempt similar capabilities, reinforcing perceptions, and so beginning a process of escalation. A view was expressed that arms racing is not solely a quantitative matter, but also a qualitative matter, meaning weapons development and research is just as important. However, one response to this point was that the language of arms racing is not useful from a political perspective as there are those who believe that an arms race in outer space could be won. Thus, the language could be unhelpful and many participants felt that it should be replaced with something more apt. The withdrawal from the Anti-Ballistic Missile (ABM) Treaty was cited as a case in point where, despite warnings to the contrary, an arms race has not yet ensued, thus supporting the argument that the terminology used in this debate should be made more accurate. However, as others pointed out, it could still be too early to tell what effects the ABM withdrawal might have. A closing comment on this issue was that it was unhelpful to focus on definitions of arms racing as this was not the only argument for prohibiting the weaponization of space—the existence of weapons in space is a danger in itself.

On the question of emerging ASAT technologies, questions were asked about research being conducted outside the United States in this area. The consensus among the experts was that very little research is being carried out in Western Europe or the Russian Federation, although it is difficult to be sure in some instances. For example, there tends to be suspicions that governments are willing to develop ASAT capabilities when they are funding research on, or the development of, micro-satellites, as such systems are susceptible to being converted into ASAT weapons. A number of countries whose intentions related to ASAT capabilities development are not made public are actively researching micro-satellites. The issue as to whether space-based missile systems such as BMD fall under the auspices of ASAT weapons was debated. One view expressed was that BMD is primarily a nuclear policy issue and not a space policy one, meaning that BMD operates according to a different logic. However, this view was contested by the analysis that a weapon in space is a weapon in space, regardless of what its purpose is.

Concerning the definition of space weapons, one point of debate was whether a nation's nuclear-tipped intercontinental ballistic missiles (ICBMs) and space-based BMD should be considered as space weapons. Regarding weapons capable of targeting objects in outer space, such as ICBMs, it was argued that these should not be included in the definition of space weapons as only those weapons specifically designed to physically attack objects in space and weapons with latent or residual ASAT capabilities ought to be considered space weapons. However, space-based BMD should be considered as a space weapon because, as had already been expressed, a weapon in space is a weapon in space, regardless of its purpose there. It was noted that there is a difference between "objects in space" (for example, warheads) and "space objects" (for example, satellites), and that certain states are working toward a suitable definition on this front. It was generally thought that the definition needed more input from a variety of interested actors.

There was interest regarding what measures the ISRO has taken to protect its space assets and what the organization considers the chief concerns regarding vulnerability in the long term were, including steps that have already been taken such as redundancies or backups, for example. As far as ground systems are concerned, redundancy measures are in place. Regarding the actual satellites, studies are being conducted but nothing has been implemented yet. And on the commercial aspect of India's space programme, this is considered to be in its infancy and the issue of commercial satellites and their vulnerability still needs to be addressed.

## SESSION II
## A RULES-BASED BEHAVIOUR APPROACH TO ENSURE SPACE SECURITY

### Creating rules-based behaviour to help space-faring nations avoid conflicts in space
***Douglas G. Aldworth, Foreign Affairs Canada***

The international community needs to adopt a broadened approach on the issue of space security to include all influencing factors of the space environment on space security, be they economic, technological, environmental or political. In this way, the development of rules-based behaviour could best be approached. Weapons-effects hardening, evasive manoeuvring, redundancy and electronic protection measures such as anti-jamming technologies are all alternative ways of protecting space-based assets. Concerning methods for advancing rules-based behaviour, proposed space debris mitigation guidelines of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) are welcome. This approach to the development of rules-based behaviour might also be considered in the context of other space traffic management issues and as a means of building confidence and preventing conflict in space. Cooperation between the CD and other international forums that deal with various dimensions of space was also suggested, including with the First and Fourth Committees of the UN General Assembly and the International Telecommunications Union, as a way of fostering greater awareness of their respective activities relating to the peaceful uses of, and sustainable access to, outer space. For the commercial sector, voluntary guidelines for the commercial industry might not be very effective, but voluntary guidelines for states to apply, as appropriate, at the national level through national mechanisms could be a feasible alternative.

### Ways to address the security of space assets
***Pan Jusheng, Defence Science and Technology Information Centre of China***

As an initial measure, states should strictly adhere to the current treaties and agreements governing the use of outer space such as the 1963 Partial Test-Ban Treaty, the 1967 Outer Space Treaty (OST), the 1968 Astronaut Rescue Agreement, the 1975 Registration Convention and the 1979 Moon Agreement. As a second measure, states should negotiate and conclude new treaties preventing the weaponization of space and an outer space arms race. The fourth article of the OST, which intends to keep space free of weapons of mass destruction (WMD), but neither defines WMD nor prohibits the deployment of other weapons, has significant shortcomings. This is a strong reason to negotiate new agreements, as is the fact that the threat or use of force in outer space is not yet prohibited. As an interim measure until such agreements are formulated, a number of transitional phases or intermediate steps, including a code of conduct, confidence-building measures (CBMs) and unilateral measures such as the Russian no-first-deployment pledge could be made. Such initiatives, while serving as temporary measures to further secure the space environment, would also engender greater trust and cooperation and thus serve as a good foundation for a future agreement on a treaty on the prevention of an arms race in outer space (PAROS).

### Activities or types of space assets to be monitored and verified
***Laura Grego, Union of Concerned Scientists***

The current threat is primarily from activities related to ASAT weapons, such as jamming devices, ground-based lasers and kinetic energy weapons. Regarding jamming devices, signal interference is easily monitored; the only real difficulty remains in finding the appropriate diplomatic and legal channels to resolve the problem. Laser technology, such as that for "dazzling" and "blinding" satellites, is prolific and difficult to monitor, although there is no great utility in using such weapons. Regarding ground-based lasers that physically damage satellite integrity, the technology is not widespread and such lasers are generally at fixed sites and very difficult to transport. However, as far as kinetic energy weapons are concerned, the only technology really needed for an effective capacity in this area is satellite manoeuvrability in orbit and the ability to conduct close-proximity operations with another object in orbit. In case of such an attack it would be unlikely that ground-based surveillance could detect the event happening in time to prevent it. Pre-launch inspections, though controversial, would have some value here. There are about 22 active launch sites at present, giving space launch a potential "bottleneck" advantage in terms of verifying and monitoring space-related activities. However, as satellites become smaller and technology improves, mobile space launch vehicles will become a greater possibility, thus making this task more difficult. There is also the possibility of using space launches in a fashion similar to the "atoms for peace" element of the Nuclear Non-Proliferation Treaty (NPT).

### Verification measures applicable to future outer space instruments
*Richard A. Bruneau and Scott G. Lofquist-Morgan, Canadian Centre for Treaty Compliance*

A verification framework or blueprint designed to apply to any potential treaty proposal on preventing the weaponization of space was outlined. Knowing which tools are technically available, financially feasible and credibly effective could force negotiators to be more specific about any proposed treaty's terms and scope, thereby helping to progress and shape negotiations. In designing the blueprint, four considerations need to be taken into account:

- Flexibility, in order to apply to multiple treaty designs;
- Details of intrusiveness levels and confidence issues to facilitate decision making;
- Reliable estimates of costs associated with each verification method; and
- Possible synergies between verification methods to increase cost-effectiveness.

With these considerations in mind, the optimal way to structure a verification system is a layered approach. Six layers were outlined: on-site verification; launch detection and post-launch confirmation; SSA; on-orbit inspection; detecting the use of laser and other directed energy weapons; and re-entry vehicle detection and characterization. The possibility of designing verification systems according to desired cost, whereby it is possible to demonstrate what a verification system might look like at US$ 100 million, US$ 150 million and so on, can provide a concrete tool for negotiators. In addition, outsourcing is always a possibility, for example, the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) has such potential.

## Debate

Following the presentations, participants exchanged views on the following issues:

- Verification;
- CD–COPUOS collaboration; and
- ASAT weapon use.

The central topic of discussion arising from the speakers' presentations in this session concerned verification issues following the presentation of the verification blueprint concept. Participants were quick to note the utility of the blueprint concept and felt that perhaps it would function better if it were designed as a "pick and mix" option, giving it even greater flexibility. However, the blueprint model was criticized for relying on more traditional verification measures when the current trend is moving away from such systems and their associated high management costs. An alternative is to think of verification as a system of collective sharing and information analysis.

How the commercial sector could be integrated into any proposed verification regime was raised as a potential obstacle that needed due consideration. The problem of commercial secrets being exposed to external bodies or personnel is a significant concern. This was tied to the issue of vulnerability—the more advanced a company, the more vulnerable it felt, making it less likely to concede vital areas of research and development to verification measures. This was compared to the age-old problem faced by governments concerned with questions of national security, which often has the effect of limiting a treaty's level of intrusiveness and thus effectiveness. This led to the question of who would carry out inspections for any proposed treaty. The general feeling among participants was that commercial actors needed to put more thought into the verification issue at both the research and policy levels.

An effective verification and compliance system would provide credibility to any chosen enforcement mechanisms. Disaggregating the issues of enforcement and compliance, as some states do, was said to constitute a misperception of how the two activities interact with each other.

With any proposed treaty, the capabilities under surveillance would all be dual use—this applies across the board, including space-based interceptors. The crux of the matter is in verifying acts of non-compliance, not capabilities that could be used to contravene a treaty. This points to the importance of SSA in monitoring activities and thus acting as a means of verifying events that had already occurred or were in the process of occurring. It was proposed that this should be the purpose of any proposed verification model given the problem of dual-use technologies. International space surveillance systems could be used to pool information.

How to promote more effective partnership between the CD and COPUOS on space-related issues was of considerable interest. The space environment is changing: the artificial barriers between civil and military activities in space are already dissolving and in turn will affect how the United Nations operates in this area. One idea is to see which activities of the CD and COPUOS are in concert and then cooperate on those. But simple factors, such as the fact that the Russian Federation will hold the presidency of the CD in June 2006, at the same time the CD is planning to discuss the PAROS agenda item, which also coincides with COPUOS's annual meeting, could act as a mechanism for examining common thinking and activities and deciding where to go from there.

Regarding ASAT technologies, debate centred on who would be in a position to use these devices. Signal jamming and communication disruption could be the key here, for example, the jamming of global positioning system (GPS) signals, which has a short-term impact. Such incidents are increasing and pose a significant threat. Incidents of television and Internet content signal jamming in certain countries in 2005 were noted.

## Session III
## Leveraging existing instruments to enhance space security

### Framing the debate: the Space Security Index (SSI)
***Sarah Estabrooks, Project Ploughshares Canada***

The annual SSI provides a comprehensive approach to the issue of space security in framing the debate for policy makers. The index incorporates eight indicators of space security that highlight current trends and developments: the space environment; laws, policies and doctrines; civil space and global utilities; commercial space; space support for terrestrial military operations; space systems protection; space systems negation; and space-based strike weapons. A brief summary of developments in 2005 was given using these eight indicators. The number of objects in the space environment increased by 195 in 2005, bringing the total number of identified trackable objects in space to 9,428; 24 civil spacecraft were launched and budgets increased everywhere except in Japan. The United States continued to be the single largest commercial space client, with 60% of the commercial satellite sector. There were significant cutbacks to a number of US military space programmes in addition to the cancellation of the US Near Field Infrared Experiment (NFIRE) Kill Vehicle test, although the United States successfully tested its GPS "pseudolite". A number of occurrences of jamming incidents have been reported. In the policy realm, 2005 also saw the first opposition to the PAROS resolution in the UN General Assembly.

## Leveraging the existing UN space machinery for sustainable and secure access to outer space

***Gérard Brachet, incoming COPUOS chair, Sic Itur SARL***

COPUOS is a body composed of 67 states and 30 observer organizations. It could contribute to developing the architecture for sustainable space security by:

- Raising awareness among its members and community of observers that space security is a major issue;
- Building on the experience gained from the discussions on space debris mitigation: more work is needed beyond the guidelines and a report on space traffic management will be officially presented in June 2006 at the COPUOS plenary meeting;
- Contributing to confidence building via its current work on the application of the 1975 Registration Convention: in 2004, COPUOS established a working group on registration, reporting to the Legal Sub-Committee, whose work plan should lead to a set of recommendations in 2007; and
- Promoting open communications on PAROS issues with the CD; the incoming chair of COPUOS is committed to facilitating and encouraging such communication.

In February 2005, the COPUOS Scientific and Technical Sub-Committee proposed a set of guidelines on space debris mitigation. These guidelines will be officially submitted to COPUOS member states before the sub-committee's next meeting in February 2007. If approved at the COPUOS plenary in June 2007, they will then be submitted to the UN General Assembly in the form of a resolution later that year.

### Outer Space Treaty review conference: progress and possibilities?
*Joanne Irene Gabrynowicz, University of Mississippi*

In terms of international law, the OST is relatively rare because it created an interrelated framework with other space treaties. The OST is "quasi-constitutional" in that it functions like a constitution. This means that if the OST were to be opened for amendment of one particular article or to clarify a certain issue, the entire treaty would then be open for discussion. A thorough risk analysis of what could be lost as well as gained if an OST review conference was convened (with the intention of amending the treaty) is needed. This means asking some difficult questions regarding whether the provisions the OST presently contains could be achieved under current conditions. For example, an agreement banning nuclear weapons and WMD might not be possible to achieve in the current climate, nor perhaps an agreement on limiting military activity to peaceful or scientific purposes. The status of the OST during such negotiations would also be uncertain. There is a fear that some states could potentially move into the legal vacuum and create new types of practices. On the question of the treaty's status in international law in the case of an outbreak in hostilities, the presumption is that the treaty would not be suspended. This presumption is based on the similarity of the OST principle of non-interference with the neutrality principle in the law of war that is maintained during conflict. Participants were warned to be careful about what they wished for in reviewing the treaty's operation as this could increase the lack of clarity on certain issues.

## Debate

Following the presentations, participants exchanged views on the following issues:

- Reframing the debate—the environmental aspect;
- The purpose of an OST review conference;
- Launch registration obligations; and
- The OST's principle of non-interference and the neutrality principle.

The use of terminology commonly associated with environmental issues to apply to space, for example, "pollution" and "debris", was postulated as a useful way of approaching the notion of outer space security since such language could serve as an alternative paradigm for promoting objectives. The quality of the space environment is directly connected to the ability to operate in a secure manner. As of 2006, the problem or threat is not yet space weapons but rather space debris, which is primarily an environmental issue. In addition to the discussion in COPUOS, there are people already looking at how the environmental approach could complement the arms control approach. The concern, however, is that although space weaponization has not taken place, serious pollution already is having a major effect. Yet, the focus of the international community is still on the former and not on the existing problem.

A review conference of the OST could be convened to review the treaty's status without the intention of amending the treaty, similar to the review conference processes of other arms control treaties. It was generally felt that there could be a lot of utility in assessing the OST's performance at this stage. It was asked whether there would be value in negotiating a protocol to the treaty that could further the international community's understanding vis-à-vis Article IV, with the intention of extending its prohibition to the placement of all weapons in space. A review conference was suggested as a possible means of establishing a working group to look at such a possibility. In that regard, the very first UN General Assembly resolution (of 24 January 1946) defines WMD as all weapons adaptable to WMD. Had this definition been included in the OST, the Article IV problem would not exist. It was suggested that instead of a review conference an anniversary meeting could be held in 2007 timed to coincide with the OST's fortieth anniversary (noting too that 2007 was also the fiftieth anniversary of the first Sputnik mission). It was asked who would call for such a meeting. As the UN Secretary-General is the treaty's depositary, it was suggested that a meeting could be established via a UN General Assembly resolution.

Regarding the 1975 Registration Convention, concerns were expressed as to whether this is a voluntary or political commitment, whether it is a requirement for all UN Member States and whether it applies to both military and commercial satellites. One participant gave the example of the European Space Agency's (ESA) Ariane launch programme that launches from French Guiana. In this case it was asked whether the host country is responsible for registering launches or if this is the responsibility of the owners of the satellite. One problem is that some commercial satellite bodies that were once intergovernmental organizations have since been privatized. At present, states in which a company's headquarters are located do not take responsibility for being the launching state. A COPUOS working group is currently reviewing this situation in relation to the Registration Convention and it was felt by a number of participants that both the owners of the satellite and the launch hosts should share responsibility in this matter.

In regard to the similarity between the OST's principle of non-interference and the neutrality principle in the laws of war, both are concerned with protecting peaceful activities in an area or region from non-belligerents. The OST codifies the right of all states to peacefully use and explore space. If two or more states were in conflict, it is presumed that this would not affect the rights of access of others. Thus, the treaty would be maintained during conflict, following the reasoning that the neutrality principle is not suspended in times of war.

## Session IV
## Developing confidence-building measures

### The potential for outer space CBMs
***Phillip J. Baines, Foreign Affairs Canada***

CBMs are not designed to address the capabilities of others, rather they address perceptions of intent; thus, they succeed best when they lead to a transformation in perceptions. Some previous CBMs in outer space have worked well such as the 1975 Apollo Soyuz Test Project concerning the use of compatible docking systems that led to the first international handshake in space. Pre-launch notification is an area of space utilization in which CBMs could be effective today. A cooperative monitoring process referred to as "3D" (Declare, Do, Demonstrate) could be a suitable practice to apply to pre-launch CBMs. A 3D process would consist of three steps: declare what you will do, do what you had declared, and demonstrate that you did what you had declared. Such cooperative monitoring, which places the onus on compliance demonstration, could be less adversarial than challenge inspections or invitations to observers. Infrasound technology could well be an applicable technology—it is possible to detect Space Shuttle launches at the Kennedy Space Center from a distance of 1,200km. Applying the 3D cooperative monitoring system initially to pre-launch notifications and then to in-orbit satellite manoeuvres as well as to guided vehicle re-entry could take the international community to the next level of CBMs: a space traffic management system. Taking a "system of systems" approach, akin to air traffic control, is one way of achieving this system.

### Confidence building in outer space

***Anton V. Vasiliev, Permanent Mission of the Russian Federation to the CD, and Alexander Klapovsky, Ministry of Foreign Affairs of the Russian Federation***

The Russian Federation's resolution on transparency and confidence building in the sixtieth session of the UN General Assembly was a significant event. A simple first step in securing outer space and engendering confidence could be for interested parties to develop recommendations on possible CBMs together. In this way, CBMs could contribute to favourable conditions for a new agreement or treaty. Disagreements over verification measures could pose a considerable obstacle to agreement. These, however, could be prepared at a later stage and CBMs could compensate for a lack of verification measures in a new treaty for the time being. Transparency is the key for any specific CBM. A number of ways in which CBMs could be implemented were outlined including: information sharing; demonstration; notifications (of launches, satellite manoeuvres, re-entry of guided spacecraft, re-entry of nuclear powered craft); consultations; and thematic workshops. Such a proposal is not new, but builds on what has already been done to build confidence among space-faring nations. The Russian Federation's no-first-space-weapon-deployment pledge is a good example of how states could take unilateral measures to build confidence. Such CBMs initially could be of a voluntary nature with the possibility that they might form part of a future treaty.

### The ESA Space Situational Awareness

***Gerhard Brauer, ESA***

Space surveillance or Space Situational Awareness (SSA) systems need to be able to provide characteristics of satellites, in particular, orbit parameters and activity status of satellites; characteristics of potentially threatening debris, in particular trajectory data and physical parameters; and information related to space weather and near-Earth objects. Other data could be included to provide up-to-date SSA needed for threat assessments as well as alert cues to avoid collisions. From the European view, the cost-effectiveness of any system would depend on its use.

### CBMs: help or hindrance in achieving a space-based weapons ban?
***Theresa Hitchens, Center for Defense Information***

CBMs are a stepping stone to an eventual legal mechanism and as such they should not be skipped. As discussions on a PAROS treaty are currently at a standstill, states have a number of other options before them. One option is for dedicated nations to pursue a weapons ban treaty outside formal processes and structures, as was successfully done through the Ottawa Process used to achieve the Mine Ban Convention. Another alternative could be for interested nations and parties to continue to work to define a possible treaty approach, creating draft legal instruments, verification protocols, etc., until the time was ripe for negotiations to occur in the traditional setting of the CD. The crux of the situation is that some states remain unconvinced that a weapons-free space environment is either achievable or necessarily in their interests. In this regard, CBMs are of value. They are a way of dampening national threat perceptions and establishing consensus on mutual interests. Space debris is the most immediate area relevant to CBMs. COPUOS's proposed guidelines need development such as better data sharing across the gamut of space stakeholders, international practices and protocols for collision avoidance and joint research to combat problems such as ways to remove space debris. While CBMs are no substitute for a treaty, a combination of transparency regimes, CBMs, codes of conduct and strictures against debris-creating weapons, could, taken together, go almost as far as a total weapons ban.

## DEBATE

Following the presentations, participants exchanged views on the following issues:

- Transparency issues;
- CBMs and BMD;
- The "dual-use" problem;
- The objective behind CBMs;
- Existing reporting requirements; and
- The view from the United States.

The need for greater transparency within existing transparency measures was expressed. None of the pre-launch notifications or reports of ballistic missile tests required in the existing arrangements and agreements or submitted to the Hague Code of Conduct (HCOC) are made available to the public. This information is important and its lack of transparency could undermine the ability of the HCOC to further build confidence. The 3D concept could contribute to increasing transparency of those CBMs already in place.

On the question of BMD, it was suggested that states should think ahead as to what possible CBMs could be applied for the deployment of such systems. Some felt that when states begin testing in space, regardless of whether the system worked, it would erode the norm against weaponizing space and, therefore, needed to be addressed. The issue is not whether the system is effective, but rather what perceptions such deployment or potential employment engenders in others—which is precisely the point of CBMs: to build confidence in one state's perceptions of another state's intentions and activities. Another participant added that while BMD systems might not function as a whole, elements of BMD have latent ASAT capabilities that have been tested by directing missiles at particular targets in space; hence the relevance of the CBM question.

The dual-use problem related to SSA was raised in the sense of the same asset being used by both civilian and military enterprises. So far, there has not been sufficient discussion on how a system could be developed to serve both the civilian and military communities. It was thought that if the military contributed to any such system it could demand to own it at certain times, for example, in times of crisis. The space-faring community's discussion on this issue is still in its early stages and there is currently only one agreement in existence, the Turin Agreement between France and Italy. Legal research is being conducted on what a satellite-sharing agreement that satisfied both communities would look like.

Undue fixation on a treaty or on the necessity of agreeing to negotiate a treaty before other measures are discussed could be a mistake. It is important to remember the primary principles: the central issue is outer space security and how to establish it. Negotiating a treaty is a lengthy process—one the international community has yet to agree to. Interested actors now need to think about their goals and not become confined to the process. Some participants felt that a treaty might not be the best solution in any case. Often, people regard treaties as the optimum way to shape state behaviour, but the custom and practice that arises out of CBMs was proposed as another way. However, as one participant mentioned, it is important to remember that CBMs would not prevent the weaponization of space, but should be understood as a transitional measure or part of a more realistic way to achieve this goal. Although CBMs are not a panacea, they would be worthwhile if they could command consensus and strengthen or create trust.

The prospects for consolidating the present reporting requirements under the various arrangements and agreements—for example, the HCOC and the 1975 Registration Convention—with a view to using these reports to monitor compliance with current obligations were discussed. Consolidation could develop transparency and build confidence on the basis of existing arrangements and agreements. A space traffic management system could serve this function. An important question is how the existing reporting requirements could best be interfaced and who should be responsible for coordinating this as well as which department at the national level should handle the information.

There was uncertainty expressed as to the United States' view of CBMs. The United States voted against a Russian-sponsored resolution in 2005 that concerned preliminary discussions on CBMs. The internal debate was said to be on transparency/CBMs versus what might be risked. The United States Air Force is interested in transparency, but apparently the intelligence agencies are not as keen. However, there are two areas where internal bureaucracies in the United States could move toward positions that could be expanded into CBMs. The first is regarding the protection of commercial satellites. There is increasing recognition that private companies are not national entities and so discussions concerning the protection of commercial satellites would need to include actors from outside government. A level of transparency would be needed to have these discussions. The second area concerns space debris, a problem that possesses no national allegiance. There is increasing recognition that mutual interests are apparent on these two issues. A way to start a dialogue that recognizes these mutual interests is now needed.

## Session V
## Interactive debate on public awareness and advocacy in policy making

### Strategies for raising public awareness and influencing political decision making
***Rebecca Johnson, Acronym Institute for Disarmament Diplomacy***

Much has changed since the first Geneva seminar on space security was held in November 2002, with a main focus on educating, informing and raising awareness. A range of proposals and initiatives that have come to the fore since then, including the SSI, codes of conduct, guidelines for mitigating space debris, initiatives for reviewing and strengthening the OST in its fortieth year (2007) and treaty approaches such as the Russian–Chinese draft treaty tabled in the CD.

But, however good the ideas might be, without public awareness and effective strategies they remain in the realm of thought, not action. There are various drivers for raising public awareness, including fear of weapons or war in space, self-interest not to lose vital space applications on which we are now so dependent, commercial investments and interests, opposition to BMD and the romantic or moral appeals associated with space exploration and notions of keeping the heavens safe and peaceful.

Resolutions in both the UN First and Fourth Committees in 2007 could be tabled, calling for support for and universal adherence to the OST, and for a review conference to be held to commemorate and review its 40 years of operations and consider ways to strengthen implementation and progress toward universality. It could also be possible to bring the 1967 OST up to date (without opening it for amendment, which would not be desirable) by adopting a more space-relevant interpretation of the term “weapon of mass destruction” in the treaty: that in view of the particular circumstances of outer space, any weapon used in or from outer space would result in unpredictable and potentially mass destructive effects.

The discussion on this presentation returned to the proposed review conference of the OST, specifically linking it to the fiftieth anniversary of the launch of Sputnik (4 October 2007) and holding it at the United Nations in October 2007. It was proposed to invite commercially interested parties to the discussion table: Boeing, as a part owner of the pioneering Sea Launch

Company, was singled out as one such entity that could be worthwhile to include. The idea of convening a specific forum whereby those in the business and academic communities could come together to share their views was also suggested.

The possibility of creating an Internet network for exchanging ideas as a useful way of facilitating and developing ongoing discussions was raised. It was noted, however, that such a network already exists although it remains underutilized due to lack of awareness. Participants were informed of the Pugwash Internet Discussion and Information Sharing Forum, an initiative borne on the sidelines of the Pugwash conference "60 years after Hiroshima and Nagasaki" held in Hiroshima, Japan, in 2005. The forum was created to stimulate ideas and overcome the various existing boundaries to such interaction.

Rebecca Johnson concluded that:

- There is still a need to forge alliances and communicate better with commercial and military players, including in the United States, to ensure sustainable space security;
- We now need to engage parliamentarians much more effectively to raise the level of debate in different countries and regional institutions such as the European Union, and to provide legislators with the information and questions to ask governments, defence ministries and regional alliances such as North Atlantic Treaty Organisation;
- We need to do more to break down the institutional and political barriers so as to address both the civilian and military aspects of space security more coherently; and
- In order to adapt a principle of political strategy (think globally, but act locally), we need to think comprehensively, but build the space security architecture incrementally.

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Any errors or omissions in this report are the responsibility of UNIDIR.

CHAPTER 2

# THREATS TO THE SECURITY OF OUTER SPACE: EMERGING TECHNOLOGIES

Laurence Nardon

## INTRODUCTORY REMARKS

The most advanced space weapon systems are technically very difficult to develop. Some technologies have, indeed, been trying to "emerge" for the past 40 years and are still not operational today. Only the most conventional ground-to-ground anti-satellite weapon (ASAT) systems are operational at this point. So, by "emerging technologies" we really mean the technologies that are the most likely to emerge, that is, those that receive distinct attention from defence planners and get the most research and development efforts in 2006–2007.

This presentation is of the descriptive kind and focuses mostly on US systems. With a requested military space budget of US$ 22.5 billion in 2006, the United States is where the bulk of the military space research is being done currently. Although a large part of US military space programmes remains classified, the United States is also where the open press has the most access to information.[1]

The definition of space weaponry is a difficult issue that the conference participants had to tackle. In this presentation, we chose to define as "threats to the security of outer space" all ASAT weapons, including systems meant for missile defence when they can have a secondary use as an ASAT.[2] This is a broad definition. A more limited one may prove politically more adequate when it comes to writing an arms control proposal.

A definition of ASATs is based on three sets of parameters:

1. The target of the ASAT can be the satellite itself, but also the control station on the ground or even the electronic communication link

between the ground station and the satellite. If the satellite is the element being targeted, a technically important distinction appears between target satellites in low-Earth orbit (LEO), which is relatively easy to reach, and target satellites in geosynchronous orbit (GEO). Orbiting 36,000km from the Earth, the latter are much harder to get to.

2. The ASAT weapon itself can be launched from the ground or from a plane to either of these targets. It can also be stationed in space, waiting to attack elements of a satellite system in space or elsewhere.[3]
3. The issue of what type of damage one aims to produce, which is more of a policy decision than a technical one. In 2002, the US Joint Space Command came up with a list of possible tactical actions.[4] Although not offering very clear definitions, it distinguishes between different degrees of damage:

   - Disruption: a temporary impairment of the satellite system, for example, delaying transmission of data by jamming a telecommunication satellite or dazzling an observation satellite;
   - Denial: a temporary elimination of the satellite system, for example, the interruption of electrical power to the ground station so it cannot process the data it receives;
   - Degradation: a permanent partial or total impairment of utility, for example, an attack on the ground segment, or the blinding of an observation satellite; and
   - Destruction: a permanent elimination of the utility of the space system.

These three sets of possibilities combine to make many types of weapon systems possible.

## EXISTING TECHNOLOGIES

The easiest and most inexpensive ASATs to deploy at the time of writing are the following:

- Electronic warfare such as jamming or spoofing telecommunication systems. One of the rare ASATs currently deployed, the Counter Communication System, is an electronic warfare device that was deployed in 2004 in the US 76$^{th}$ Space Control Squadron. It consists of three ground-based portable jamming packages, bought off-the-shelf from commercial companies, and produces reversible damage to the communication links of satellites, even in GEO if they are unprotected types such as commercial satellites;

- Cyberwarfare, which means hacking the space system's computer system; and
- Conventional attacks on ground stations are another easy military action. It would be surprising not to find a target list of foreign countries' satellite control facilities ready in many countries' military command, but attacks on a ground station are not always an efficient option since satellites operate in a network so that they can relay data to other ground stations.

## EMERGING TECHNOLOGIES?

Weapon projects that target the satellites themselves are those that render technological innovation necessary. The development of these technologies encounters many technical difficulties. Indeed, the first systems developed to reach and harm satellites did not give satisfactory results at all.

### NUCLEAR DIRECT-ASCENT WEAPONS

The US military services launched no less than four different nuclear ASAT programmes in the early 1960s. The US Air Force launched the "Bold Orion" air-launched missile programme in 1959 as well as another project based on the Thor rocket. The Navy had its own air-launched programme called Hi-Ho. The US Army developed Project Mudflap, which was responsible for the first successful satellite intercept test in May 1963 and based on the Nike and Zeus rockets.

But different problems made these systems unsustainable. In the early 1960s, the guidance systems remained too poor (probably in the order of a few miles) to allow conventional warheads to be considered for an efficient ASAT: only a nuclear warhead could destroy the target satellite. But the explosion of a nuclear device in LEO generates electrons that get trapped in the Earth's magnetic field and destroy all non-hardened satellites. After a test in 1962, seven US satellites were impaired during the following months.

It also became more difficult to conduct such tests after the Partial Test-Ban Treaty was signed in 1963. Work on nuclear ASAT systems was, therefore, eventually stopped and all US programmes were dismantled.

In the former Soviet Union, work focused on improving guidance systems so that an ASAT that would detonate a conventional bomb close to the targeted satellite became feasible. The "co-orbital ASAT" system was developed and tested between the 1960s and the 1980s.

### Kinetic Energy ASATs (KEASATs)

After the nuclear ASATs disappointment, the attention in the United States turned to kinetic energy ASATs. Kinetic weapons rely on their speed to smash into and destroy the target. They are often also called "hit-to-kill" programmes.

Again, there have been numerous attempts at developing a successful programme. Among many projects, two have received particular attention in the past. The Air Launched Miniature Vehicle was a US Air Force project consisting of a rocket launched from an F-15 plane and equipped with a heat-seeking "Miniature Homing Vehicle". It was cancelled in 1988. The KEASAT programme was an Army-operated ground-based system targeting LEO satellites. It was apparently cancelled by the Clinton Administration in 1997. For a few years, Congress reinstated the budget line for KEASAT in spite of the Pentagon's disinterest.

The problem with kinetic energy weapons, apart from their questionable feasibility (and particularly the infrared homing technology), is the creation of debris that, just like nuclear weapons, can harm friendly satellites as well as the intended target. Indeed, the KEASAT project included the development of a sheet of Mylar plastic to hinder the scattering of the debris. This apparently proved too difficult to make.

For these reasons, the hit-to-kill method has now lost favour. A new solution appears to be the ejection of the target satellite out of orbit by a micro- or nano-satellite,[5] rather than smashing it. Kinetic ASAT programmes are, therefore, looking into "ejection" or "de-orbiting" capacities. Several such systems are currently researched, as shown by the US military budget request for 2007:

- The Space-Based Interceptor Test Bed is a Missile Defense Agency (MDA) programme, which aims to build and test a satellite that could manoeuvre in orbit and intercept a target. The programme probably has links to the MDA Micro-sats programme and it may really be a continuation of the old KEASAT programme under a new name and new management;
- The Near Field Infrared Experiment (NFIRE) is an MDA programme for a manoeuvring satellite. It was intended to have a kill-vehicle on-board, but it was cancelled;
- The XSS is an Air Force micro-satellite programme that does proximity operations in LEO and takes pictures. The XSS-11 is currently deployed as a test; and
- Angels is an Air Force defensive nano-sat programme.

The Spacecraft for the Unmanned Modification of Orbits (SUMO) was a Defense Advanced Research Projects Agency (DARPA) programme that attempted to build satellites that would approach, seize and push satellites away from their orbit. SUMO was mentioned in the press in 2004 and 2005. There is no trace of a budget request for SUMO in 2007.

Kinetic or "de-orbiting" ASAT technologies that are being actively researched include:

- Developing nano-sat and micro-sat buses, which may also offer applications in the field of space mines;
- Acquiring precise LEO and GEO manoeuvring capacities, including research and development on propulsion and power issues; and
- Improving high-resolution hardware and lightweight optics to equip these satellites.

## Directed energy weapons

Directed energy weapons are based on the use of laser or microwave beams. Laser ASATs can temporarily or permanently affect the sensors of an observation satellite (respectively dazzling or blinding them); microwave ASATs can jam a telecommunication satellite. If using high levels of energy, both types of ASATs can permanently destroy most satellites electronic systems.

There is evidence of Soviet research on chemical source laser and other types of directed energy weapons in the 1970s: research facilities were located in Dushanbe (Tajikistan) and Sary Shagan (Kazakhstan). Both territories are now outside Russian control and it is likely that all laser-related work has been stopped. On the other hand, a US Department of Defense report of July 2005 claims that China is conducting research to develop a ground-based laser ASAT weapon.[6]

Although the technology meets many challenges, continuing research seems to indicate that the Pentagon thinks such ASATs remain a credible option today. The budget request for 2007 shows that a number of research programmes on laser (including the excimer and free-electron types) and microwave weapons is under way in the United States.

The Mid-Infrared Advanced Chemical Laser (MIRACL) programme has been mentioned since the 1980s. It is a ground-based laser system fuelled by a chemical reaction and is managed by the US Army. The 2007 budget request for the Army shows US$ 16.6 million for the laser programme that includes MIRACL. The US Air Force has a global request of US$ 162.3 million for programmes related to high energy and directed energy.

A space-based laser programme that was launched by the MDA seems to have disappeared from the 2007 budget request. Here too, technical difficulties are present. In the case of a ground-based laser, the beam has to be very powerful and focused to get through the atmosphere. If the laser system is airborne, the issue becomes the size and weight of the instruments. Positioning a space-based laser in orbit so that it can harm its target is equally very challenging.

Another issue is the type and level of damage that such weapons could cause to their target. The “defensive” MIRACL test of October 1997 produced initial information on laser damages to satellites, but further tests are deemed necessary.

Currently researched technologies include:

- More powerful and better focused laser beam technologies to go through the atmosphere and on to LEO, where most observation satellites are deployed;
- Miniaturization and lightening of the instruments;
- Assessment and analysis of damages made to the target, which makes the conduct of tests necessary; dazzling and blinding tests could be commissioned by the US Air Force in 2006 or 2007; and
- Microwave technology is less mature than laser technology, and microwave-related programmes deal more with basic or advanced research than with weapon systems development per se.

ASAT technology developments are meeting technical challenges every day, so “emerging” should be understood as a process, not a result. Also, given that half the US military space budget is classified, we must admit that there may be some technological developments that we do not know about.

## Notes

1 Most of the sources used for this paper come from Laura Grego, Union of Concerned Scientists; Jeffrey Lewis at <armscontrolwonk.com>; and a recent paper by Michael Katz-Hyman, Henry L. Stimson Center, and Theresa Hitchens, Center for Defense Information.

2 However, arms control debates on missile defence per se such as the debate held at the beginning of the 1980s in relation with the Reagan Administration “star wars” programme is a controversy steeped in the nuclear mindset of the Cold War and is irrelevant to today’s ASAT issue.

3 According to this definition, a weapon deployed in space and targeted at ground targets that are part of the satellite architecture such as a control station, would be an ASAT. On the other hand, a system such as the very exotic “Rods from the Gods” project, where tungsten rods would be deployed in LEO to strike deep-buried ground targets, would certainly be a space weapon but not an ASAT, because the target would not be part of a space system. Mentioned in 2005, “Rods from the Gods” does not seem to be researched anymore.

4 United States Joint Space Command, 2002, *JSCUS DoD Joint Doctrine for Space Operations*, 9 August, Washington, DC, pp. IV-7–IV-8.

5 Micro-sats weigh between 10kg and 100kg, nano-sats weigh between 1kg and 10kg.

6 United States Office of the Secretary of Defense, 2005, *The Military Power of the People's Republic of China*, Annual Report to Congress, July, Washington, DC.

# CHAPTER 3

# THE ROLE OF NON-STATE ACTORS IN OUTER SPACE SECURITY

Jeffrey Lewis

## NON-STATE ACTORS IN OUTER SPACE

The "terrorist" threat to space assets has largely been a minor concern in the dialogue about sustaining the common interest in the peaceful uses of outer space. An exception to this rule was the Congressionally-empanelled Commission to Assess US National Security Space Management and Organization (Space Commission), which warned that threats to US space systems "might arise under a variety of conditions" including during "peacetime, as a terrorist act".[1]

The topic raises a number of interesting questions—questions that are easier to raise than answer. For example,

- It is always difficult to define terrorism. Is an act of terrorism one that kills people? What about an act that only destroys property? Must an act of terrorism kill a person or destroy property, or is it merely enough to generate fear or chaos? Terrorism also carries a certain normative connotation, that is, one's enemies may be terrorists, but one's friends may be freedom fighters or liberationists.
- What is special about "space" terrorism, as distinct from more mundane, if that is the right word, forms of terrorism? Is a terrorist who hacks into a computer network to attack the financial system doing something manifestly different if the network manages satellites instead of bank transfers? What if a terrorist attacks a ground station or a spacecraft about to launch? Are those acts different from attacks on embassies or aircraft?

Yet, the relationship between terrorism and outer space is part of a larger, overlooked dialogue about the increasing role of non-state actors in outer space.

Since the dawn of the space age, the exploration and peaceful uses of outer space have been the province of governments. The primacy of states as actors in space is captured by the Convention on International Liability for Damage Caused by Space Objects, which assigns the responsibility for damage caused by an object in space to the state that launched the object.

That decision reflected the reality of the 1960s. Today non-state actors play an increasing role in the uses of outer space. Universities build small, capable satellites. Dissident groups broadcast their complaints on commercial communications satellites. A small number of very wealthy individuals have purchased "vacations" on the International Space Station. More may soon have the opportunity to enjoy a suborbital flight and experience a few seconds of weightlessness. Only launch services appear to remain a fundamentally national endeavour, although here too some firms are looking toward the future in the private sector.

The growing presence of non-state actors in outer space, combined with our growing dependence on space assets, raises a series of interesting questions about the security of our space assets—a point the Space Commission makes rather plainly:

> The relative dependence of the U.S. on space makes its space systems potentially attractive targets. Many foreign nations and non-state entities are pursuing space-related activities. Those hostile to the U.S. possess, or can acquire on the global market, the means to deny, disrupt or destroy U.S. space systems by attacking satellites in space, communications links to and from the ground or ground stations that command the satellites and process their data.[2]

I focus on the implication of *all* non-state actors for sustainable uses of outer space; that is to say, a number of real examples involving non-state actors that are not necessarily terrorists by addressing two questions:

- What challenges do non-state actors pose for the peaceful uses of outer space? and

- How should governments and international institutions respond to the increasing presence of non-state actors in outer space?

In general, I do not think non-state actors pose much of a threat to space assets, largely because even states have not developed advanced anti-satellite technologies. This conclusion is based, in part, on unclassified intelligence estimates and official US statements. That said, I believe non-state actors pose a number of challenges to the peaceful uses of outer space that might usefully be part of a larger dialogue on the effect that greater access to space has on building a sustainable space security architecture.

## CHALLENGES POSED BY NON-STATE ACTORS

### Physical attack against the International Space Station, Space Shuttle or private spacecraft

Perhaps the only traditional "terrorist" scenario is that a group of individuals somehow hijack the Space Shuttle or International Space Station. This is the subject of countless science fiction novels and at least one mean-spirited conspiracy theory.

In the wake of the terrorist attacks of 11 September 2001, the National Aeronautics and Space Administration (NASA) did impose additional security surrounding the launch of STS-108 in December 2001.[3] A NASA administrator at the time, Sean O'Keefe, told reporters:

> There is no question (the Space Shuttle) is a high-value target. It has been identified as such by all the intelligence information that we had received post-Sept. 11, that this is considered to be a very high-value target opportunity that terrorists view as a great way to make a statement.[4]

Overall, however, the risk of such a scenario, according to a group of non-governmental experts from The George Washington University, "seems remote to most people involved in the US space programme since the Space Shuttle facilities are reasonably well protected and that once in space the vehicles are physically remote from any would-be attackers".[5] A more likely threat is that terrorists might attack the ground stations that are used to control space assets, either physically or through some form of hacking.

An interesting case arises with regard to private firms offering suborbital flights as "space tourist" expeditions: perhaps some passenger might attempt to seize control of one of these craft. The US Federal Aviation Authority, which would regulate space tourist flights, has proposed security restrictions similar to those imposed on passengers on commercial airlines, including a recommendation that the operator consult the Transportation Security Agency's "no fly list".[6]

## JAMMING SATELLITE COMMUNICATIONS OR ATTACKING GROUND STATIONS

"Jamming" is the transmission of signals that interfere with the operation of a satellite or its payload.[7] Generally, it has been states that have jammed broadcasts by non-state groups and other states. As recent examples, the Rumsfeld Space Commission cited "Indonesia jamming a transponder on a Chinese-owned satellite and Iran and Turkey jamming satellite TV broadcasts of dissidents".[8]

In the case of the dispute between China and Indonesia, APT Satellite of China reported "limited interference" with its Apstar-1A satellite from another satellite in a nearby orbital slot that was operating on the same frequency. Although the commission calls the interference "jamming", the interference resulted from satellites operating too close together because the countries disputed the ownership of the orbital slot. The dispute was eventually resolved peacefully.[9]

The Islamic Republic of Iran and Turkey are reported to have jammed satellite broadcasts by dissident groups. A Kurdish television station claimed that the Turkish government jammed its broadcasts; the Islamic Republic of Iran, operating from the Iranian Embassy in Havana, jammed a dissident radio station.[10] In the case of the Islamic Republic of Iran, the United States reportedly pressured Havana to stop the jamming originating from the Iranian Embassy.[11]

Two cases of non-state entities briefly interrupting satellite transmissions bear mention. In 1986, an American using the name "Captain Midnight" briefly interrupted a cable programme to protest the cable channel's fee structure. John R. MacDougall, a 25-year-old satellite dish dealer and electronics engineer, later pleaded guilty to violating a Federal Communications Commission (FCC) statute against "broadcasting without a license".[12] More recently, in 2002, the Chinese government accused a Taiwan-based Falun Gong group of interfering with Chinese satellite television signals. Taiwanese authorities claim to have investigated and found no evidence of these activities.[13]

A special case of jamming might involve a non-state actor who could attempt to use a commercially available global positioning system (GPS) jammer to interfere with a plane while it is attempting to land. Commercial aircraft do not, however, rely exclusively on GPS signals for navigation. US Air Force Lt. Col. Ken McClellan, a Pentagon spokesman, told *Computer World* that although jammers "could disrupt commercial operations", the Pentagon viewed homemade jammers as "a nuisance" rather than a hazard to commercial aircraft and ships.[14]

## Other challenges posed by non-state actors

There are two other ways in which non-state actors raise interesting questions about the uses and misuses of access to outer space.

One challenge is posed by non-state actors using commercial satellites for communications or imaging. Following the 11 September 2001 terrorist attacks against the United States, some observers worried that terrorists might use commercially available satellite images to aid in planning attacks, although terrorists arguable require more timely and detailed information than is available from commercial imagery.[15] Commercial availability of images and communications is widely accepted as a beneficial development; nevertheless, a sensible dialogue about the peaceful uses of outer space should reflect the potential for misuse of such services. In the months before Operation Enduring Freedom in Afghanistan, the United States purchased exclusive access to commercial images taken by Space Imaging's Ikonos satellite, at least in part to deny those images to the Taliban.

A second challenge emerges from the greater access to space experienced by non-state actors, including private launch services and the development of very small, but capable, satellites. The world's leading builder of "micro-satellites" is the university-based firm Surrey Satellite

Technology Ltd (SSTL), which is developing a constellation of remote sensing micro-satellites for natural disaster monitoring and mitigation.[16] Some American observers have expressed concern about SSTL's role in helping Chinese scientists at Tsinghua University build and launch TsinghuaSat-1, a micro-satellite containing a multispectral camera with 40-metre resolution. One area worth considering is the development of satellites that are capable of on-orbit manoeuvres around other satellites, so called autonomous proximity operations. During the launch of TsinghuaSat-1, SSTL also launched SNAP-1, built by SSTL alone, which was designed to conduct proximity operations near TsinghuaSat-1. SNAP-1 successfully manoeuvred to within 9 metres of the Chinese satellite, transmitting a digital image.[17]

## CONCLUSION

The ongoing dialogue among all countries that rely on the peaceful uses of outer space remains important. This dialogue should be expanded in a number of areas to include interference, traffic control, mitigating debris and future proximity operations. Including actors such as Intelsat will be necessary in order to create practices that meet the needs of all space users.

States should not, however, disrupt existing efforts to protect space assets on behalf of terrorism. Physical threats to space systems can, and should, be dealt with at the national level. States might share best practices to discourage jamming from originating within their territories. In the United States, all satellite uplink transmissions carrying broadband video information contain an "automatic transmitter identification system" that provides the station's FCC-assigned Earth station call sign, a telephone number and serial number. This practice, adopted after the Captain Midnight episode, largely prevents individuals from jamming satellites anonymously.

### Notes

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# CHAPTER 4

# SPACE WEAPONS AND PROLIFERATION

Michael Krepon with Michael Katz-Hyman[1]

Will flight testing or deploying space weapons prompt arms races?[2] This assertion figures prominently in the writings of both critics and boosters of space warfare initiatives.[3] We contend that the arms race argument is weak and beside the point, since arms racing is not needed to negate the space weapons of a potential adversary. Advanced space-faring nations such as China and the Russian Federation could compete in making low-Earth orbit inhospitable to satellites with modest investments and unsophisticated techniques. Any nation that possesses medium-range ballistic missiles, space tracking capabilities and the means to precisely insert a satellite into orbit also has the ability to destroy a satellite. Rather than engaging in an expensive arms race, states threatened by US space warfare initiatives are likely to respond in cost-effective ways to counter US weapons. The fundamental problem associated with space weapons is not their expense or their propensity to generate arms races. Instead, the fundamental problem associated with space weapons is how easily they can pollute space, and how much long-term and costly damage could result from relatively inexpensive investments.

We argue that additional proliferation of nuclear weapons, rather than new arms races, is the most likely outcome in the event of renewed interest in space warfare. Proliferation will be a natural consequence of more nations feeling less secure as a result of space weapons. Furthermore, in the absence of united fronts against proliferation by major powers and by US friends and allies, international efforts to strengthen non-proliferation and disarmament norms are likely to fail, and hedging strategies against a more worrisome future are likely to multiply.

The US Air Force's Counterspace Operations doctrine, released in August 2004, embraces power projection in and through space by means of what the Pentagon calls "offensive counter-space" capabilities.[4] The implications of US initiatives to pursue offensive counterspace capabilities for the non-proliferation regime—constructed during an era of bi-polar, Cold War competition—have not been carefully analysed. Military dominance confers many advantages. Paradoxically, success in preventing proliferation is not one of them. Instead, the dominance of one state could prompt others to seek insurance or deterrence in the form of proliferation. Successful non-proliferation policies are usually based on collective, not unilateral action, since collective action is usually more dissuasive and effective than unilateral enforcement. A dominant state may have difficulty in generating collective action if other states view the dominant power with concern, or if they view proliferation as less of a threat to them than to the dominant state. The problems of shaping a collective response are exacerbated if the dominant state pursues initiatives that are widely perceived as unwise.

Our analysis suggests that the negative impacts of US military dominance on proliferation will be accentuated in the event that Washington also seeks dominant military capabilities in space. This pursuit will be widely viewed as unwise and dangerous, not only by potential adversaries, but also by most of Washington's allies and friends. Consequently, US initiatives to flight-test and deploy space weapons are likely to hasten efforts to seek insurance or deterrence against US might. We view the advocacy of US space dominance as a useful prism to analyse why proliferation concerns are growing, and why efforts to strengthen non-proliferation and disarmament norms have encountered such great difficulty in recent years.

## DEFINING SPACE WEAPONS

We define space weapons and offensive space warfare initiatives as terrestrially-based devices specifically designed and flight tested to physically attack, impair or destroy objects in space, or space-based devices designed and flight tested to attack, impair or destroy objects in space or on Earth. In other words, weapons that are designed to be "mass-to-mass" or that create physical effects on a satellite. This definition respects the distinction between capability and actuality. It excludes residual or latent space warfare capabilities such as ballistic missiles that temporarily travel through space en route to their destination. Also excluded in this working definition are satellites that provide essential military functions, but which do not serve as weapon platforms. In other words, the definition used here clarifies the essential distinction between the current military uses of space and the flight testing and deployment of space weapons that some wish to pursue in the future.[5] This definition also excludes activities that are specifically designed to interfere with the uplinks or downlinks of satellites. Jamming is treated separately from direct, physical attacks against satellites because jamming has long been considered a part of warfare, whereas direct attacks in or from space would be consequential firsts in the history of warfare.

## THE PERILS OF ANTI-SATELLITE TESTING

It is even harder to control or limit the effects of weapons in space than on Earth. When sea battles occur, debris sinks to the bottom of the ocean, but when space warfare occurs, debris can linger for years or for millennia, depending on the orbit where combat takes place. The problematic dimensions of weapon effects have previously helped to dampen interest in space weapons. The first profoundly disturbing glimpse of the dangers of space warfare occurred prior to the signing of the Limited Test Ban Treaty in 1963. Before this, the former Soviet Union and the United States tested nuclear weapons repeatedly in the atmosphere. One US test series, code named STARFISH in 1962, unwittingly and indiscriminately killed or damaged four US satellites, one British satellite and a Soviet satellite.[6] Realizing the dangerous and catastrophic nature of atmospheric and space-based nuclear weapon tests, and respecting the provisions of the Limited Test Ban Treaty to not test in space, the former Soviet Union and the United States (and later 121 other countries) agreed under the Outer Space Treaty of 1967 not to place weapons of mass destruction in outer space.

The preferred way of testing satellite-killing weapons in the 1970s and 1980s was by means of a direct collision. These Cold War-era anti-satellite weapons (ASATs) tests were an infrequent occurrence: the number of ASAT tests carried out by both nuclear superpowers averaged less than two per year during the 34 years between the launch of Sputnik and the demise of the Soviet Union.[7] In contrast, Moscow and Washington together averaged one nuclear test nearly every week during this time frame.[8]

The last Cold War-era ASAT test was in 1985, when a US F-15 fired a direct homing device against an ageing US satellite engaged in meteorological research. The resulting impact created over 250 pieces of space debris that were visible to US space surveillance systems.[9] The last piece of debris de-orbited 17 years later.[10] One piece of space junk from this ASAT test came within one mile of the International Space Station.[11] As with the earlier atmospheric nuclear tests during the 1970s and 1980s, few appreciated how debris created by ASAT tests could cause harm to one's own or friendly satellites.[12]

Currently, there is far greater recognition that space debris is an indiscriminate killer and the biggest threat to satellites, the Space Shuttle and the International Space Station. The National Aeronautics and Space Administration (NASA) has preliminarily reported that if another catastrophic accident occurs to the space shuttle, there is a 50% chance that it would be the result of space debris.[13] Even in the absence of ASAT tests over the past two decades, the amount of orbital debris has doubled. In a typical year, 150 metric tons of debris, including paint flecks, pieces of rocket boosters and stray nuts and bolts are placed into orbit.[14] Over 13,000 objects greater than 10 centimetres in diameter are now tracked by the US Air Force Space Command.[15]

With new appreciation for the dangers created by space debris, the international community has begun working on mitigation strategies. NASA and the European Space Agency, among 11 space agencies, have formed the Inter-Agency Debris Coordination Committee and have published a set of guidelines to mitigate space debris. These worthwhile steps would be overwhelmed if space warfare occurred and produced debris fields.

Because of the potential dangers posed by debris to US and friendly satellites, the Pentagon now proposes to focus on offensive space warfare capabilities featuring temporary and reversible effects. There are, however, no guarantees that adversaries would engage in space warfare using similarly polite rules. Dictating the rules of warfare has not been easy for the United States on the ground, and may be no easier in space.

## ASATS AND VERTICAL PROLIFERATION

For space warfare initiatives to generate an arms race, both contestants need to be able to compete, and see value or necessity in the competition. Moscow's ability to engage in an arms race with the United States is now very much in doubt. The Stockholm International Peace Research Institute estimates Russian military expenditures to be approximately US$ 20 billion a year, or less than 5% of the US defence budget.[16] Russian-deployed nuclear forces continue to decline in numbers, the result of block obsolescence of Cold War-era investments, funding constraints, defence production impediments and national decisions to apply limited resources to other priorities. From a high point in 1986 of over 40,000 stockpiled warheads, the Russian nuclear arsenal is estimated to consist of 16,000 warheads, no more than half of which may now be operational.[17] By contrast, during certain phases of the Cold War, the former Soviet Union increased its stockpile size by 1,000 warheads per year.[18] It will be difficult for Moscow to reverse the decline of its strategic nuclear arsenal, let alone engage in an arms race at present. While the Russian Federation's economic prospects have improved since 2002, these constraining factors still apply, suggesting that new predictions of an arms race in the event of a resumption of US space warfare tests are overdrawn.

Space-based weapons directed at terrestrial targets have long been a concern to Moscow, but the Pentagon's track record in this regard has been poor. These concepts remain technically challenging, extremely expensive, susceptible to countermeasures and politically unpopular. Unlike space- and ground-based missile defences, ASATs are relatively cheap to build and easy to deploy. Moscow is, therefore, likely to view the resumption of US ASAT testing as a very real potential threat. However, as was the case with the US withdrawal from the Anti-Ballistic Missile (ABM) Treaty and the initiation of limited national missile defence deployments, the resumption of ASAT testing by the United States is unlikely to prompt Moscow to engage in an arms race. Adjustments in the Russian Federation's strategic force posture, such as an increased commitment to deploying survivable, launch-ready strategic forces with improved penetration capabilities, as well as continued heavy reliance on tactical nuclear weapons, might be expected within the context of financial and structural constraints.

Compared to Moscow, Beijing is better positioned economically to increase its strategic forces if the Pentagon implements its new doctrine for space control. Beijing's views regarding space-to-ground weapons, national missile defence and ASATs are likely to parallel those of Moscow. A united diplomatic front on space weapons between Beijing and Moscow is now very much in evidence, with military and technical interactions also possible. Beijing will need to be more sensitive than Moscow about US national missile defence deployments, given the far smaller size and more relaxed readiness rates of its strategic nuclear forces, but Beijing possesses an insurance policy in the form of a burgeoning supply of shorter-range missiles that can target nearby US bases, allies and friends.

China's strategic nuclear posture was markedly relaxed during the Cold War, when Beijing faced not one, but two hostile nuclear superpowers. Even during the height of the border dispute with Moscow in 1969, Beijing kept its nuclear powder dry.[19] Now, as then, Beijing's leadership appears confident that national security interests can be met with numbers of strategic nuclear delivery vehicles that Moscow or Washington would consider to be unacceptably low. Since the early 1980s, public estimates of the total inventory of Chinese warheads have remained flat, with recent unclassified estimates suggesting a total stockpile of perhaps 200 weapons, of which approximately 130 may be operationally deployed.[20] The Pentagon currently estimates that China has deployed approximately 20 intercontinental ballistic missiles (ICBMs). This number is expected to grow to perhaps 60 ICBMs by 2010, an increase of eight per year.[21] By way of comparison, during peak periods of the Cold War arms race, the former Soviet Union and the United States each produced an average of 300 ocean-spanning missiles annually.[22]

China's strategic nuclear forces, unlike those of the Russian Federation and the United States, have remained at low states of readiness to respond in the event of an attack. China's liquid-fuelled ICBMs may not be mated with warheads. The deployed Chinese ballistic missile nuclear submarine "fleet" presently consists of one boat, which has difficulty operating at sea.[23] Furthermore, China rarely tests its ICBMs, having carried out no more than 20 such tests over the last 34 years.[24] In contrast, during the Cold War arms race, it was not unusual for the former Soviet Union and the United States to each flight test over 35 ocean-spanning missiles per year.[25]

The relaxed biorhythms of China's strategic modernization programmes suggest a strong inclination to spend as little as is required to deter nuclear threats, while applying resources to higher priorities such as the maintenance of domestic tranquillity, economic growth and contingencies related to Taiwan. While more attention is being paid to China's longest-range nuclear forces, these efforts do not begin to rise to the level of an arms race.[26]

Beijing, like Moscow, is likely to retain and improve various means to counter US space warfare initiatives,[27] while pursuing diplomatic initiatives against the resumption by Washington of flight-testing techniques for space weapons.[28] If, however, Washington initiates flight tests of an actual ASAT, Beijing and Moscow are unlikely to remain passive. Whether their responses are subtle or overt would depend on how they perceive they can best influence US choices, while meeting national security requirements.

## ASATS AND HORIZONTAL PROLIFERATION

The states of greatest proliferation concern at present—the Democratic People's Republic of Korea and the Islamic Republic of Iran—are a very poor match for US power projection capabilities. This relative weakness is not, however, the only reason for Pyongyang's and Tehran's interest in nuclear capabilities. Iranian security concerns extend to Israel and to states in the region that permit the basing of US forces. Iranian leaders may also view nuclear weapons as modern symbols befitting a proud, ancient civilization.[29] Speculation regarding the Democratic People's Republic of Korea's nuclear programme usually centres on Pyongyang's security concerns regarding Japan and the United States. The Democratic People's Republic of Korea's nuclear and missile programmes also provide an equalizer to the Republic of Korea's stronger and more modern armed forces as well as rationales for forcing engagement with Pyongyang.[30]

The flight testing and deployment of space weapons by the United States would certainly be noticed by Pyongyang and Tehran, but such US steps would not greatly affect the existing imbalance of power. Pyongyang and Tehran are unlikely to respond in kind in the event that the United States initiates the flight testing and deployment of space weapons. Granted, the Democratic People's Republic of Korea's Tapeodong and Nodong missiles could be used for space launches and space warfare. Pyongyang launched a missile over Japanese territory in 1998 that failed to place a satellite in orbit, but very much succeeded in gaining the attention of Tokyo and Washington.[31] If the Democratic People's Republic of Korea has produced a small number of nuclear weapons and is able to fit them atop missiles, Pyongyang could destroy or damage many satellites in low-Earth orbit with a nuclear detonation. In doing so, however, Pyongyang would not only be striking at the United States, but also other space-faring nations whose diplomatic support it seeks, especially China. Pyongyang could also use non-nuclear means, but would need to possess improved space tracking and accurate orbital insertion capabilities.

The Islamic Republic of Iran possesses a variant of the Democratic People's Republic of Korea's Nodong missile, which it calls the Shahab-3. Over time, it, too, could possess rudimentary space warfare capabilities.[32] But the Democratic People's Republic of Korea and the Islamic Republic of Iran do not need to launch ASATs in order to respond negatively to US space warfare initiatives. They might also try to interfere with US satellites by jamming techniques using Russian-built equipment, as did units of the Iraqi Republican Guard during the 2003 invasion of Iraq. Iraqi efforts, however, were foiled by the very satellite-guided munitions they were trying to neutralize.[33]

The dictates of asymmetric warfare suggest that while rudimentary forms of space-related initiatives by Pyongyang and Tehran cannot be ruled out in the future, it is more likely that they would seek to produce casualties on the ground rather than try to damage inanimate objects in space. The proximity of forward-deployed US forces as well as US allies and friends provide a "target rich" environment for asymmetric attacks. Covert attacks against the US homeland by various means would also seem to be more likely than more easily attributable attacks against US satellites. The flight testing and deployment of space warfare capabilities by the United States are not likely to alter the outcome of a war between the United States and either the Democratic People's Republic of Korea or the Islamic Republic of Iran. Nor would US offensive space warfare initiatives be likely to stop either of these two countries from harming the United States and its allies and friends in the event of a conflict.

Given these pre-existing conditions it is unlikely that new US offensive space warfare capabilities would prompt a large increase in Pyongyang's and Tehran's nuclear stockpile requirements. Increases in or threats to increase nuclear stockpiles could, however, occur for non-military reasons such as seeking to influence US, allied or major power diplomacy. Any increase in the Democratic People's Republic of Korea's or the Islamic Republic of Iran's nuclear capabilities for any reason would be unwelcome and could well have adverse proliferation consequences. In addition, the absence of an overt arms race would provide little comfort if small amounts of weapons-usable material or a single warhead change hands as a result of newly enlarged stockpiles. Put simply, the absence of arms racing, whether along the vertical or horizontal axis, is a poor indicator of the net proliferation effects of US space weapon programmes.

## DOMINANCE VERSUS PROLIFERATION

The United States already enjoys military superiority with respect to ground, naval, air and nuclear forces. In addition, the United States utilizes space for military purposes far more than any other nation. The military use of space conveys many advantages to US forces, helping to deter war and, if conflict arises, facilitating quick and successful military campaigns with a minimum of casualties and collateral damage. Adding offensive space warfare capabilities to existing US military dominance does not automatically equate to more success on the battlefield. Space weapons could greatly compound the difficulties faced by expeditionary forces in harm's way if the net result of space weapons endangers rather than protects US satellites.[34]

The protection of vital US satellites by means of space weapons requires the ability to dictate how a war in space would be waged. Space control, therefore, requires doctrine and capabilities not only to seize the initiative, but also to prevent weaker foes from successfully retaliating.[35] The clear US preference is to engage, if needed, in offensive operations using non-destructive means. The Pentagon does not, however, rule out the use of destructive methods in space.

It is most unlikely that weaker adversaries would play by Marquis of Queensbury rules in space in the event of US space warfare initiatives. Moreover, the implementation of a proactive and pre-emptive strategy of space control requires timely, accurate intelligence so that the initiative can be taken before US satellites are placed at risk. If the United States cares about lining up domestic and international support in the event of the first direct attack against a satellite in the history of warfare, then the intelligence supporting this action must be publicly persuasive. These are all very daunting requirements.

Effective preventive diplomacy in hard proliferation cases is clearly preferable to preventive war. Successful preventive diplomacy in such cases depends, in significant measure, on whether Washington is able to forge a united front among the Permanent Members of the UN Security Council and among friends and allies in regions that are threatened by proliferation. The flight testing and deployment of space weapons by the United States are likely to make it harder for Washington to round up help against hard proliferation cases. They are also likely to lead more states to seek insurance and deterrence policies against US power projection capabilities.

It is very difficult for the use of force to compensate for missing elements of a comprehensive non-proliferation and disarmament strategy. The risk of failure can be reduced, however, if the dominant state that threatens or uses force does so on behalf of norms that have broad international support. Conversely, when the dominant state disapproves of or rejects key elements of non-proliferation and disarmament regimes, garnering support for the use of force can be quite difficult. Under these circumstances, the use of force is not intended to bolster universal norms; instead, it is directed against a particular object. We should not be surprised, in such cases, when the use of force does more harm than good for non-proliferation.

The proliferation consequences of military dominance, combined with disinterest in key elements of a comprehensive approach to non-proliferation and disarmament, are now evident. The Bush Administration's ability to strengthen non-proliferation norms is limited by its "*a la carte*" approach to treaties and norms. The administration does not want others to resume testing nuclear weapons, while opposing ratification of the Comprehensive Test Ban Treaty. It seeks to prevent Russian nuclear commerce with the Islamic Republic of Iran, while desiring to engage in nuclear commerce with India. It seeks the adoption of intrusive monitoring in states suspected of proliferation, while sloughing off intrusive monitoring on US soil.

The results of this highly selective approach to non-proliferation and disarmament are internally consistent, but externally corrosive to global efforts to strengthen non-proliferation and disarmament agreements. The dominant power sets trends that others follow. If the United States deems it essential to adopt an *a la carte* approach to treaties and norms, others will order from this menu. When more customers order *a la carte*, treaties become hollow, and norms are sacrificed to hedging strategies. When the most powerful nation in the world undercuts treaty regimes and norms, weaker states cannot provide compensatory support. Major powers that are concerned by US military dominance become "free riders", standing on the sidelines in hard proliferation cases. They might also view US travails in dealing with proliferation as not being inimical to their interests. US dominance is proving to be a poor substitute for treaty norms, and an insufficient lever for collective security or unilateral enforcement.

Successful efforts to stop and reverse proliferation face long odds when the dominant state demands to play by its own rules. These odds become even longer when the dominant state cannot enlist the active support of Beijing and Moscow on hard proliferation cases that bother Washington more than them. Official Chinese and Russian threat perceptions of the United States are not articulated in public, but they may reasonably be inferred. Both capitals might well question why Washington seeks to extend its military dominance into space by pursuing capabilities that would not be particularly helpful in scenarios involving the Democratic People's Republic of Korea, the Islamic Republic of Iran or other developing countries. Instead, the pursuit of US dominance into space may well be viewed by Beijing and Moscow as part of a broader effort to negate their nuclear deterrents. If so, prospects for non-proliferation and disarmament would further decline.

## CONCLUSION

The Nuclear Non-Proliferation Treaty (NPT) regime was devised during the Cold War, when non-proliferation was one of the few large enterprises that Moscow, Washington and their allies could agree upon. Another important common interest during the Cold War was the inadvisability of initiating space warfare. It remains to be seen whether a unipolar system will be equally as effective in controlling proliferation or refraining from space warfare, but the early returns are not encouraging.

Space has been blessedly free of weapons, and for the last two decades it has been free of anti-satellite tests as well. Political sensitivities against crossing these thresholds are heightened, and efforts to do so will be quite divisive in the United States, in allied countries and elsewhere. China and the Russian Federation, the two nations whose assistance the United States needs most to stop and reverse hard proliferation cases, are likely to be most sensitive to the Pentagon's interest in space dominance.

Space warfare initiatives are, therefore, not merely emblematic of the difficulties facing existing norms, agreements and institutions designed to prevent proliferation and disarmament. A direct, physical attack against a satellite would be an historic first in the annals of warfare. The implementation of new doctrine and new capabilities for space warfare would come at a time when non-proliferation and disarmament compacts are under severe strain, when hedging strategies are growing and united fronts to stop and reverse these trends are scarce. The pursuit of offensive space warfare initiatives would surely accelerate these negative trends.

## Notes

1 An expanded version of this essay appears in *Non-proliferation Review*, 2005 (summer), vol. 12, no. 2.

2 The authors would like to thank Ellen Laipson, Clay Moltz and an anonymous reviewer for their comments.

3 For example, critics Helen Caldicott and Craig Eisendrath argue that “placing weapons in space inevitably would provoke an arms race there. Such a race eventually would consume hundreds of billions of dollars.” Supporters of space warfare initiatives also base their advocacy, at least in part, on pre-empting an arms race. Everett Dolman argues that “the time to weaponize and administer space for the good of global commerce is now, when the United States could do so without fear of an arms race there”. See No Weapons in Space, *Baltimore Sun*, 16 May 2005; Leonard David, Weapons in Space: Dawn of a New Era, Space.com, 17 June 2005, at <www.space.com/news/050617_space_warfare.html>.

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## CHAPTER 5

# CREATING RULES-BASED BEHAVIOUR TO HELP SPACE-FARING NATIONS AVOID CONFLICT IN SPACE

Douglas G. Aldworth

For almost 50 years, the cooperative and peaceful uses of space have yielded immense benefits to humankind. The degree to which the world relies on space for an increasing number of everyday activities has shown a truly amazing trend line. Space has been integrated seamlessly into our everyday lives. Satellites have become fundamental to modern society, especially so in the developed world but also increasingly in developing nations.

Television programming, the Internet, automatic bank machines, banking transfers, telephone service, credit card validation, weather prediction, terrestrial and oceanic mapping, atmospheric and natural disaster monitoring, urban planning, navigation, search and rescue, and arms control verification all rely on the use of satellites.

There is also a greater dependence of military and government on the commercial space industry. The revolution in military affairs is reliant on the use of space to enhance communications, command, control, surveillance, reconnaissance and intelligence, and these services are increasingly provided by commercial entities.

At least 19 nations have launch capabilities. Some 40 nations operate satellites for various purposes. There are some 600 to 800 operational satellites in orbit. Nations must be confident that their critical space assets will be secure from threats, both artificial and natural. This makes it a question of security. I believe we are now at the intersection of security in space and sustainable access to space. In fact, Canada uses a definition that connects the two. Our working definition of space security is “secure and sustainable access to and use of space; and freedom from space-based threats".

Therefore, it is timely that we speak of the architecture of sustainable access to space and how it should be designed. My remarks here focus on rules-based behaviour as an essential part of that architecture. I start with a couple of observations on what I believe are key elements of any approach to rules-based behaviour to help space-faring nations avoid conflict in space.

## BROADENING OUR CONCEPT OF SPACE AND SPACE SECURITY

Space security should be considered in the context of the overall space environment. These include political, economic, environmental, technological and military influences, all of which support the creation of an empirically based case for a broader view of space security.

It is for this reason that Foreign Affairs Canada has contributed funding for the past three years to a research programme on all elements of the space security continuum. The research quantifies the current economic benefits of the peaceful uses of space and underscores the long-term global benefits derived from maintaining secure access to space for all.

Spacesecurity.org, a consortium of non-governmental organizations (NGOs), is currently undertaking research with input from space experts from around the world on space security developments since 2005. The resulting *Space Security Index 2005*, the third in the annual series, is scheduled for issue in June 2006. I look forward to Sarah Estabrooks' presentation on the preliminary results of the 2005 survey at this conference.

## FOCUSING ON ENSURING THE PROTECTION OF OUR SPACE ASSETS

Ensuring the safety of satellites is vital to our security and prosperity, but we fear that the presence of weapons in space could actually make it harder to achieve security for these assets. This also means pursuing steps to build confidence and thus reduce the temptation to place weapons in space as a means to protect space assets.

It is sometimes said that the international community should not bother with the prevention of an arms race in outer space (PAROS), as there are currently no weapons in space and, therefore, there is no arms race. However, one can look at PAROS in a different light: as an exercise in preventative diplomacy to take advantage of the present non-weaponized status of outer space to ensure that this situation will be preserved.

All measures that build confidence that nations will not station weapons in space are important. We, therefore, need to consider alternative means to defend our space-based assets. Alternatives in this regard include weapons-effects hardening, evasive manoeuvring, redundancy and electronic protection measures such as anti-jamming technologies.

The use of some types of anti-satellite weapons could create significant debris, and thus significant damage to operational space assets. The resulting large increase in debris could render the space environment unusable. Moreover, basing weapons in space could force industry to assume burdensome liability and protective hardware costs that would eat into the profits of satellite operators. By contrast, increasing international cooperation between space-faring nations bodes well for space security. We foresee the increasing numbers of actors with access to space creating even more broadly based support to sustain and manage that access.

## ADVANCING RULES-BASED BEHAVIOUR

The rest of my remarks focus on building confidence through ways and means of managing access and use of space, of increasing transparency about space launches and of protecting our space assets from damage—that is, advancing the work on rules-based behaviour.

Work has begun in the Committee on the Peaceful Uses of Outer Space (COPUOS) to address this, for example, by tackling debris mitigation. The drafters (I had the opportunity to sit on this working group as a Canadian delegate) have naturally limited their work toward mitigating debris caused by the peaceful uses of space. In their present form, the new proposed guidelines only obliquely address the issue of debris that could be caused by anti-satellite activities by including a paragraph against the intentional creation of long-lived debris. The guidelines also note that debris due to collisions of space objects will be without question the primary source of debris in the future. In fact, it may already be the primary source of debris creation.

Nevertheless, an important milestone was reached in March 2006 when the COPUOS Scientific and Technical Subcommittee accepted its working group's recommended space debris mitigation guidelines. The guidelines, which are based on the technical contents of the Inter-Agency Space Debris Coordination Committee (IADC) Guidelines, will be submitted to the United Nations General Assembly in 2007 if there are no objections from any countries. We expect that they will be passed, given the wide cross-section of countries that have contributed expert delegates to work on them.

But the importance of the space debris mitigation guidelines extends beyond their immediate applicability. The guidelines are the first set of recommended practices to flow from COPUOS in a long time, given the increasing importance of space and the difficulty in obtaining consensus on difficult issues. They demonstrate that COPUOS continues to be effective.

I believe that this success can be built upon by using the process employed for the debris mitigation guidelines as a template to address the outstanding need for other rules-based behaviour in space. For example, a multinational working group from the COPUOS Scientific and Technical Subcommittee is well into the process of developing guidelines on the use of nuclear power sources in space with their final recommendations expected in 2007.

Another example of an outstanding need that immediately comes to mind would be the creation of "rules of the road" based on technical space traffic management guidelines, which is discussed later. As we are all aware, success often breeds success, and one should not be hesitant to try out similar approaches. COPUOS negotiated all of the major space treaties now in existence, and there is no reason that they cannot re-assume this pre-eminent role in space. And if successful in instituting this rules-based behaviour in space, it might eventually influence the political will of the Conference on Disarmament (CD) to get back to the table on the PAROS.

We might, therefore, re-examine existing UN structures with a view toward encouraging closer cooperation between the CD and multilateral forums working on other dimensions of space such as the First Committee, the Fourth Committee, COPUOS and the International Telecommunications Union. There is a need to establish rules of the road that all can understand and follow. Order and expectations of acceptable behaviour must be instituted. We would all benefit from such standards. And we believe that the CD can also become particularly effective in acting as a conduit for many of these changes.

As one example, in 2005, Michael Krepon of the Henry L. Stimson Center released a model code of conduct to suggest one way to prevent incidents and dangerous military practices in outer space. Key provisions included avoiding collisions and dangerous manoeuvres; safer traffic management practices; prohibiting simulated attacks and anti-satellite tests; information exchanges, transparency and notification measures; and more stringent space debris mitigation measures.

Perhaps consideration should be given to an expanded international code of conduct, devised jointly by the CD and COPUOS, which would provide guidance for civil and commercial space activities as well as military activities. We could also consider whether a code of conduct would be best targeted toward the military uses of space, with the agreement to honour its provisions being struck between nations. I pose this question because commercial entities are not always strictly observant of voluntary guidelines, particularly if doing so will serve to decrease profits or negatively affect business expansion plans. While prescriptive rules would be difficult to negotiate in the UN setting, voluntary rules based on voluntary UN principles might work best, with implementation left up to national mechanisms.

As I mentioned previously, it might be pragmatic to suggest that rules of the road be negotiated for civil and commercial uses of space, which can then be made non-discretionary at the national level with passage of national mechanisms. These mechanisms, enacted by each country according to their needs, would proscribe and regulate the activities of their own industries' space-related ventures. This is but one suggestion.

The negotiation of guidelines that would provide examples of acceptable behaviour to all space actors would go a long way to create and maintain space security. Both the CD and COPUOS have the potential, but need the political will of member states to accomplish the necessary preconditions for the continued security of space. In the case of the CD, we need a political breakthrough. We, therefore, need to develop at the outset a long-range strategic plan in COPUOS. A wide range of actions is possible, but each poses certain questions. For example, would the successful negotiation of rules of the road by COPUOS then engender the creation of a permanent UN space coordinating body to implement them? Are there better ways to monitor compliance with agreed procedures? Where conflicts develop, should the details be referred to COPUOS, the CD or to some other body for remedial action? Should COPUOS or the CD be assigned responsibility for the overall coordination/regulation of the world's civil and commercial space activities? Is there a potential role for the International Civil Aviation Organization in this mix? These are just some of the questions that arise, but I will leave that for future discussion.

In conclusion, Canada believes that the evolution in space activities and benefits provides a strong rationale for the global community to work together to foster a stable politico-diplomatic environment. No one wants to lose the benefits that space provides. There is scope for much activity in the area of rules-based behaviour as part of sustainable access to space. Some of this may be more pertinent to discussion in the CD; some is really the preserve of COPUOS, building wherever possible on existing agreements. In the latter regard, Canada is preparing a paper for the UN Office of Outer Space Affairs as a follow-up to the 2005 informal organizational initiative of the COPUOS chair. We hope to confirm that the range of activities that can be carried out under the existing mandate is sufficient to reflect today's space requirements. If so, we would propose that COPUOS begin the process of establishing a forward-looking programme of activities to create new standards for behaviour in space.

To return to the two elements I mentioned earlier, we believe that development of rules-based behaviour to avoid conflict between space-faring nations would benefit if we adopt a broadened approach to space security and a perspective focusing on how we protect space assets.

## CHAPTER 6

# ADDRESSING THE OUTER SPACE SECURITY ISSUE

Pan Jusheng

## OUTER SPACE SECURITY IS SHARED SECURITY

Outer space is the common wealth of humankind, which should serve people around the world. It is hard to imagine a modern society without the support of outer space assets. The development and progress made in the fields of economy, culture, science and military of every country is related to the use of outer space. Outer space is an important resource for human beings at present and in the future. The exploration of outer space is related not only to the immediate interests of humankind, but also to the future of human society. Once the outer space peaceful environment is damaged, our descendants would suffer for a long time. Thus, countries all over the world must deal with outer space issues with caution, and must avoid any irreversible losses due to irresponsible activities.

Regarding the outer space security issue, the interests of all countries of the world, whether developing or developed ones, are intertwined with each other. One country cannot enjoy outer space security alone or avoid the negative impact of consequences from the disruption of the outer space peaceful environment. Therefore, outer space security can only be a shared security.

## CHALLENGES TO OUTER SPACE SECURITY

There are two categories of challenges to outer space security. One category consists of crowded orbits, the shortage of channels for frequency distribution and the increase of space debris that stems from increased outer space objects and the countries involved in space activities, and the expansion of human outer space activities. All of these have undermined the outer space security environment. Up to now, 19 countries have obtained space launching capability, over 40 countries have their own satellites[1] and about 130 countries have space-related programmes. The crowded geosynchronous orbit can be observed from the location charts of satellites. And there are now more than 13,000 large- or medium-size space objects in orbit, of which 6–7% are operating satellites. In low-Earth orbit, the size of most debris is less than 10 centimetres. Even tiny debris is capable of causing terrible damage to various operating spacecraft. However, these kinds of problems are being addressed by frequent international cooperation and coordination.

The second category of challenge is the threat of outer space weaponization and an arms race. It is reported that some countries are working on the research and development of space weapon systems such as air-launched anti-satellite missiles, space-based radio frequency weapons, relay mirrors (to bounce killer laser onto satellites in both low-Earth orbit and geosynchronous orbit) and the mysterious hypervelocity rod bundles (“Rods from God”).[2] Prompted by outer space strategy and military benefits, theories, doctrines and operational programmes concerning outer space war have appeared one after another. Some people have wishfully believed that by deploying various weapons in outer space, they are able to maintain their strategic and military superiority and provide effective protection of their outer space assets and, therefore, enjoy outer space security alone. This idea is short-sighted and dangerous. Because one country cannot maintain the monopoly of the advancement of technology, outer space weaponization would inevitably induce a new arms race, and outer space might eventually become a new battlefield. Outer space’s assets comprising millions of people’s wisdom and hard work could be destroyed overnight. At the same time, outer space weaponization and an arms race would damage cooperation and trust among countries all over the world. The fruits of all the efforts that the international community has made to tackle the problems of the first category of challenges would totally vanish. Therefore, outer space weaponization and an arms race is the most serious and immediate threat to outer space security.

## WAYS TO MAINTAIN OUTER SPACE SECURITY

Under current circumstances, the most effective ways to maintain outer space security are as follows.

## Strictly abide by the treaties and agreements concerning outer space

Since human beings have had access to outer space, with the joint effort of international society, many international treaties and agreements concerning or relating to outer space have been reached such as the Outer Space Treaty, Partial Test Ban Treaty, Moon Agreement, Registration Convention, Liability Convention, Agreement on Rescue, and the International Telecommunication Constitution and Convention. To a certain extent, these treaties and agreements have guaranteed peaceful outer space activities and positively defended outer space security at present and in the future. They should be strictly observed.

## Negotiate and conclude new international treaties preventing outer space weaponization and an arms race

The existing outer space treaties and agreements also contain some regulations of outer space military actions. For example, the fourth article of the Outer Space Treaty stipulates "not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner". This article intends to keep outer space free from nuclear weapons or weapons of mass destruction. However, these treaties and agreements also have defects in preventing outer space weaponization and an arms race. For example, the weapons that some countries plan to deploy in outer space or to use in space war are not categorized as weapons of mass destruction and not yet forbidden by the current treaties or agreements. In addition, neither the use of force nor the threat of the use of force is forbidden by them. So, under the current situation it is difficult to deal with the actual danger of outer space weaponization and an arms race. The most urgent task for the international community is to negotiate and conclude a new international treaty that will fundamentally maintain outer space security.

People should learn a lesson from the course of the development and the spread of nuclear weapons. We cannot afford the burden of extinguishing the evil fire of outer space weaponization and an arms race when it goes rampant. The international community should take precautions against outer space weaponization and an arms race from now on, and make great efforts in reaching a new outer space treaty.

## FORMULATE AND CARRY OUT TRANSITIONAL MEASURES AND INTERMEDIATE STEPS

Some countries, non-governmental organizations (NGOs) and scholars have put forward suggestions and proposals such as formulating a code of conduct for outer space activities; setting a standard for dangerous actions that are likely to cause misunderstanding such as collision, manoeuvring, following, and surpassing outer space objects; and improving the transparency of space activities and engaging in confidence-building measures. The Russian Federation, as a great power in outer space, has pledged "not to be the first to deploy weapons in outer space" and calls upon other countries to make a similar promise. If the international community is able to reach a common understanding on the norms and a code of conduct put forward by the above-mentioned suggestions and proposals, it will not only create a sound and safer environment for the joint, orderly and peaceful uses of outer space by all countries, but will also promote mutual trust between those countries and lay a foundation for reaching an international treaty on preventing outer space weaponization and an arms race through further negotiations. Therefore, I believe that much significance should be attached to regarding these measures as intermediate steps and transitional measures before a new treaty can be finalized. Of course, by these measures there is still a long way to go before thoroughly eliminating the threat of outer space weaponization and an arms race. The most urgent task is to negotiate and formulate a new international legal document that is fully capable of preventing outer space weaponization and an arms race.

Thus, I would like to stress our common understanding on the issue of outer space security, that is, outer space is the shared wealth of humankind and every country should enjoy equal rights to the peaceful uses of outer space; and outer space security is related to the interests of all human beings and maintaining outer space security is a common responsibility of every nation. I believe that once outer space's peaceful environment is damaged, the people of the world would suffer from it. If outer space is weaponized, the trend is next to impossible to reverse and the damage would be terrible and last for a long time. At present, the key to the protection of the security of outer space is that countries, especially those possessing advanced space capability, fully demonstrate their political will and vision. On this basis and through consultation on an equal footing, promoting consensus and creating a favourable atmosphere of mutual trust, the goal of negotiating and reaching a treaty preventing the weaponization of outer space can be achieved.

## Notes

1 *Space Security or Space Weapons: a Guide to the Issues*, 2005, Washington, DC, The Henry L. Stimson Space Security Project, p. 4.

2 Teresa Hitchens, *U.S. Military Space Policy and Strategy*, presented at the e-parliament Conference on Space Security, Washington, DC, 14 September.

CHAPTER 7

# TECHNOLOGIES AND BEHAVIOURS OF CONCERN: WHAT THREATENS LONG-TERM SPACE SECURITY AND HOW CAN THESE THREATS BE MONITORED?

Laura Grego

As we look forward toward addressing security concerns in space by using laws and agreements, we must work on the practical counterparts to these laws. To do so, one would like to answer a number of questions, for example: What are the technologies of concern and how could they be limited? What are the roles of verification and inspection? When does it make sense to monitor behaviour rather than limit technology? What is the value of monitoring behaviour if it cannot guarantee that no attacks are made? Does assigning responsibility for rule breaking increase security? Are there technical bottlenecks that are suited for arms control, in analogy to the control of fissile materials for nuclear weapons arms control?

I will not attempt to answer these questions in depth or with finality but, rather, I will support the discussion by giving an overview of the most important threats to space security and what some possible methods for monitoring and mitigating them might be, with an emphasis on technical solutions.

There are four basic categories of things that threaten the sustainable, secure use of space. The first, space-based weapons, comprises ground attack weapons, missile defences and anti-satellite (ASAT) weapons based in space. The second, ASAT weapons, includes those weapons that interfere with or harm satellites, whether the weapons are ground-based or space-based. These two categories are the most provocative and deservedly receive the most attention. However, there are other issues that also need to be addressed in order to keep space secure. This includes the third category: dual-use technologies and latent capabilities. These are systems designed to perform a peaceful or defensive task, but which can also function as space-based or ASAT weapons. Inspector satellites and defender satellites are examples of this category. And last, there are other things that are not weapons at all, but which can increase tensions and make space difficult or more expensive to use. These include unintentional or naturally occurring interference with satellites and lacunae in the legal framework that covers space. Examples include spill over onto neighbouring satellites of communications signals intended for a specific satellite, debris generation and leaving decommissioned satellites in orbit instead of de-orbiting them or moving them to “graveyard orbits”.

We intend to focus our energies on the most pressing concerns. We are unlikely to see in the near or mid-future space-based ground attack weapons systems, as they are enormously expensive when compared to ground-based alternatives. Nor will there be a large-scale space-based missile defence in that time frame, as such a system is also very expensive, and serious flaws render such a defence ineffective. There is little serious interest in the United States for fielding full-fledged systems of these types, and so we do not spend time on them here (although “test” assets for these systems may be the leading edge of space weaponization and can have a dual use as ASAT weapons).

Rather, it is likely that interference with satellite systems, rather than attacks on ground targets or missiles from space, will be the central security problem. The presence of a huge military space capability (some estimate that the US outlay on military space represents about 90% of military space spending) supporting conventional war-making presents a complex problem and arguably the central challenge to our work here. In a sense, these systems, by virtue of their great military value, have already drawn space onto the battlefield.

We are speaking of those systems that are not active weapons systems themselves, but that support military missions with targeting, intelligence and navigation information. Satellites providing these capabilities have had tacit approval, having no strongly voiced objection by other states, perhaps because other states may want this capability for themselves in the future. However, in a crisis, states in conflict may want to be able to deny such capabilities to their adversaries. Additionally, in the future, some of this “support” capability may be dual use and able to perform in a weapons capacity as well. The international community must decide what bounds, if any, to put on these capabilities and how to deal with the ensuing tensions. This has led to interest both in developing ASAT weapons and to banning them. In any case, the use and denial of the use of satellite systems are likely to be the central space security issues in the near future.

We will look at the most likely types of ASAT interference and how they might be controlled or monitored and try to identify the areas that deserve the most attention. Interfering with the broadcast and reception of satellite signals is a simple way to frustrate the use of communications satellites. "Downlink" jamming interferes with signals sent from a satellite to the ground. The interference is local in scope, as the jammer is ground-based and is jamming ground-based receivers. Downlink jamming is generally quite simple, especially jamming unprotected systems, and such actions by state and non-state actors have been reported frequently.

There are means to mitigate such an attack. In many cases, the location of interference can be identified using radiolocators and the interference stopped through diplomatic channels or by military action—that is, destroying the jammer. The law covering downlink jamming is unclear, but it is unlikely that a high compelling case can be made that a state must not interfere with the reception of satellite signals it finds dangerous. This, and the fact that this jamming is so simple to do, and that it does not interfere with the satellite itself but only with localized ground based receivers, makes it a low priority for security law.

Uplink jamming is a bit of a different case. Uplink jamming interferes with signals sent from the ground up to the satellite and can affect the performance of the satellite on a global basis, rather than just locally. There have been numerous instances of this, particularly with commercial satellites, which do not make a high priority of including anti-jamming equipment on their satellites.

Again, there are means to mitigate this interference. Commercial businesses have been developed that specialize in locating the source of such interference. Presumably, states are developing this capability for themselves as well. Identifying the source of jamming is not the difficult part; the trick is in identifying the legal and diplomatic channels for resolution of the interference. This can be more complicated than for downlink jamming, as the uplink jammer could be located in a state that is neither the primary sender nor receiver of satellite's real signals.

Another simple way to interfere with satellites is "dazzling", that is, using a bright light source such as a laser to make it difficult for a satellite to take an image of the ground. The power needed to mask a small area are small; to dazzle an area of 10 metres, a laser no brighter than a laser pointer is needed. However, to mask an area of significance, such as 1km in diameter, then more powerful lasers are needed on the order of 10 watts, which can start to damage the satellite's sensor. At this point, when permanent damage is done, the term used is "blinding". In both cases, the light source likely will be ground based and the interference will be eminently attributable, but difficult to prevent because the technology is readily available commercially.

For uplink and downlink jamming, as well as for dazzling and blinding, limiting technology is not a solution. The technology to mount such attacks is simple and widely available. All such attacks, however, can be attributed to their sponsor during and after the fact. The effects of the attacks, with the exception of blinding, are temporary and reversible. So, while these technologies are quite difficult to control, they also may be of the least concern for security. Qualitatively different from these are attacks that leave a satellite permanently disabled or destroyed. These ASAT techniques are considerably more destabilizing, but also provide more opportunities for monitoring.

At very high powers, lasers can be used to damage the physical structure of a satellite. These lasers could be ground or space based. Low-Earth orbiting satellites would be the targets from the ground or from low-Earth orbits. The distance to geosynchronous orbit (GEO) protects GEO satellites from such attacks. To generate the powers needed, they will be large and complex systems, and not simply bought off the shelf and generally not transportable on the ground. Hence, they may be identifiable with reconnaissance and technology limits may be useful. Additionally, verification sensors can be situated nearby to detect backscatter from the atmosphere if such highly powered lasers are used. These are not systems of the future, but are within today's capabilities. In 1997, the United States tested a high-power laser and tracking system on a satellite, and a test of a laser using adaptive optics to illuminate a satellite is slated for 2007.

Kinetic Energy ASAT (KEASAT) weapons use the force of impact on a satellite to damage or destroy it. Ground-based direct ascent KEASAT weapons could be based on short-range ballistic missiles or air-launched missiles with the ability to home in on satellites. It is not necessary to be a space-faring nation to develop these types of ASAT weapons, but advanced technical capability is necessary. These basic missile capabilities are dual use, but a distinction can be made between those used for ground targets and those that possess the ability to target satellites. This ability can be signalled by the inclusion of sensors that can home on satellites, for example, and the testing of such missiles in an ASAT mode will be evident and readily observed.

Space-based KEASAT weapons will need similar capabilities. Additionally, dual-use systems may also have KEASAT capability. Satellite "defender" bodyguard satellites and space-based missile defence interceptors would look and operate very much like a dedicated space-based KEASAT weapon. "Test" assets for a missile defence system, while not providing missile defence capability, would likely have significant ASAT utility. The pertinent technology is the ability to manoeuvre on orbit and accelerate rapidly and to be able to home in on a space object. So, restricting technology only for space-based KEASAT weapons, while making exceptions for missile defence or satellite defence weapons, is unlikely to be satisfactory for this reason.

Monitoring can be of some use in addressing the dual-use question. Once in orbit, it may be difficult to discern the abilities of a satellite, especially if some care were taken to disguise them, although imaging may be useful. Pre-launch inspections can provide some insight into the system's capabilities, although this is, of course, invasive and not the likeliest of possibilities. Surveillance of the behaviour of the systems will allow ASAT-like behaviour to be identified and responsibility assigned. Excellent surveillance may also help satellites to evade an attack once it has begun. However, for space-based KEASAT weapons as well as ground-based ones, routine ground-based satellite surveillance is unlikely to detect an attack in time to prevent it and may not be sufficient to assign responsibility for it either; sensors specifically configured for the problem would be necessary.

Another space-based concern is micro-satellite-based ASAT weapons. These small satellites would closely approach another satellite, perhaps at a leisurely pace, and then use a simple measure to interfere with it at close range. The micro-satellite could also be in an orbit different from the target but which crosses the target's orbit, and could make a last-minute diversion to approach. Micro-satellite and close approach technology is certainly dual use, and technology limits are unlikely to be useful in this case. To monitor the behaviour of micro-satellites, one needs the ability to track all objects of a given size; the size of a functional micro-satellite will get smaller as technology improves. One would have to monitor it closely, perhaps in real time, to prevent an attack by last-minute diversion, but for a slow approach, the requirements are much more lax. However, real-time tracking of even the most important orbiting objects is out of reach currently and it is still a technical challenge to find small objects that manoeuvre. There are not sufficient surveillance assets currently in use to monitor a "keep out" zone around even the most important satellites. The establishment and verification of keep out zones do not themselves protect satellites from attack, but it does set norms and assigns responsibility for violations.

Long-term security will require the ability to monitor all space launches. Currently there are some two dozen fixed launch sites, from which launches are announced in advance. An unannounced launch from one of these sites would not escape notice for very long. As technology advances, however, it will become more complicated to monitor all space launches. The ability to launch satellites into orbit from mobile platforms exists: the Russian Federation has launched satellites from a submarine and is currently developing airplane-based satellite launch (as is the United States, reportedly), and there is no great technical barrier to using ground-based mobile launchers for satellite launch. To be assured of detecting all launches in a timely manner, one would need early warning-type capability.

In a regime where ASAT weapons have been developed and tested, it will be important to be able to distinguish between an ASAT attack and unintentional interference and naturally occurring satellite failure. Space is a hostile environment in which to operate and satellites partially and wholly fail at the rate of several per year; often the cause is never identified satisfactorily, and there are thousands of instances of unintentional signals interference to contend with. Additionally, in an environment where a large amount of debris is present, a collision with debris could be interpreted as a KEASAT attack. It can be difficult to distinguish intentional interference with unintentional interference; it is necessary to have on-board sensors and diagnostics, good space surveillance and a comprehensive debris catalogue.

In conclusion, there are verification options—technological limits and behaviour monitoring—that can help support important decisions regarding the security of space.

# CHAPTER 8

# VERIFICATION MODELS FOR SPACE WEAPONS TREATIES: A FLEXIBLE, LAYERED APPROACH AS A NEGOTIATING TOOL

Richard A. Bruneau and Scott G. Lofquist-Morgan

## INTRODUCTION

The purpose of verification is to increase confidence in the implementation of a treaty. An effective verification system reliably detects non-compliance and allows abiding states to credibly demonstrate their compliance. It can also deter non-compliance, depending on the strength of enforcement measures within the treaty. Verification is necessary for an effective treaty in that it provides an objective trigger for enforcement measures and legitimizes those measures when they are implemented.

In the context of space security, official multilateral treaty verification is necessary for three further reasons. The first is the hazardous nature of the space environment. There are natural and man-made threats to satellites and spacecraft that can cause temporary or permanent damage, including solar radiation and orbital debris. Without a verification system it is difficult to credibly distinguish between natural causes of satellite failure and the effects of weapons use. The second reason emerges from dual-use problems of space verification technology: unilateral monitoring activities by individual states may be interpreted as offensive in nature and potentially provoke a protection-negation arms race. For example, a close-proximity fly-by to inspect a satellite could easily be interpreted as an interception attempt or surveillance for military advantage. The only way to engage in such sensitive activities in a non-provocative manner is to do so multilaterally. And third, there are many dozens of state and commercial actors with space assets, yet current capabilities for knowing what is happening in space are limited to only a handful of states. This means that verification of any allegations of illicit space weapon deployment or use is at the moment dependent upon the national technical means (NTM) of a select few.

Verification of a space weapons ban is technically possible. It may also not be as expensive as some analysts have suggested if it can leverage existing and emerging technologies and exploit synergies between verification methods. The primary determining factors for the design of a verification system are the scope of the treaty being negotiated, the level of confidence deemed necessary to assure compliance (for example, guaranteed 100% detection versus 60% certainty) and the level of intrusiveness politically palatable to negotiators (for example, limited versus anytime, anywhere on-site inspections). The last two factors are subjective and dependent on the larger international political environment and, therefore, each country must determine for itself what level of confidence and intrusiveness it desires and how such levels will influence the effectiveness of its desired treaty design. Answers to these questions will then help determine the acceptable level of cost.

Verification has been left out of some proposals for space weapons treaties due to its perceived complexity and divergent views about its effectiveness. To assist in negotiation and decision making, however, verification measures related to proposed treaty elements can and should be described ahead of time. This paper attempts to outline an encompassing framework, to be strengthened with further research, which can be flexibly applied to varying treaty requirements (see Table 1). For each potential treaty design there can be multiple layers of verification, allowing negotiators to balance cost, intrusiveness and effectiveness to provide the optimum level of confidence possible within the current context. The framework also highlights potential synergies between verification methods to increase confidence and cost-effectiveness.

## WEAPON CATEGORIES: EARTH-TO-SPACE, SPACE-TO-SPACE AND SPACE-TO-EARTH

There are three categories of weapons that can be addressed in a space weapons treaty: weapons on Earth that target space assets (Earth-to-space); weapons deployed in space that target other space assets (space-to-space); and weapons deployed in space that target assets on Earth (space-to-Earth). Each category offers unique challenges and opportunities for verification.

An Earth-to-space weapon is fired from the ground, sea or air. For example, a ground-based laser can be used to damage satellites, or an anti-satellite (ASAT) interceptor can be launched from an aircraft. One challenge for verification is the dual-use nature of many Earth-based weapons. Licit weapons designed to attack ground or air targets, such as ballistic missiles and high-powered lasers, could potentially target space assets. They can, thus, be difficult to detect as ASAT weapons until they are used or tested against space targets. On the positive side, if Earth-based facilities are declared, continuous on-site monitoring on the ground is much easier than monitoring in space.

Space-to-space weapons are placed into orbit to target other space objects. Examples include space mines, lasers and interceptors. Space-to-Earth weapons are still mostly theoretical, but could include things such as orbital bombardment systems, space-based ballistic missile interceptors or space-based lasers. Deployment of weapons into space (both space-to-space and space-to-Earth) faces the choke point of launch into orbit. This offers a valuable opportunity for verification that is not available for Earth-to-space weapons. Objects in orbit are also difficult to hide, a fundamental advantage in detection over Earth-based weapons. Dual-use technologies also exist related to objects deployed into space, such as on-orbit servicing spacecraft, and pose a challenge similar to Earth-to-space dual-use technologies.

## PROCESS STEPS: RESEARCH, TESTING, DEPLOYMENT AND USE

The process of creating a space weapon can be divided into four steps: research and development, testing, deployment, and use.[1]

### RESEARCH AND DEVELOPMENT

A ban on research and development of space weapons or weapons to target space would prove difficult to verify, and likely be unpalatable to states. It would require intrusive inspections of laboratories and development facilities, and a very high degree of cooperation. Hidden or clandestine laboratories would prove difficult to detect and identify, and the line demarcating the parameters of acceptable research would be hard to define.

## Testing

Laboratory testing of space weapons is limited in its reliability. Complete confidence in a space weapon's capability will invariably require testing of the complete prototype in the field (that is, space) and, therefore, field testing acts as a verification choke point between development and deployment. The methods for verifying field testing against space targets are the same as for verifying use, though greater sensitivity is needed in order to detect tests done at lower power or without explosives or other weapons functions. Verifying the testing of individual components of space weapons is more difficult, as they can often have non-weapon uses or can be tested in laboratory conditions. Some technologies are almost completely dual use as the final product can be used for weapon and non-weapon purposes (for example, micro-satellite rendezvous and space tugs). Verifying testing, thus, faces many of the same dual-use confidence problems as verification of deployment, and would require use verification to fill the confidence gap.

## Deployment

Verifying deployment of weapons into space is potentially one of the easiest verification activities, but has significant limits. The number of launches each year and the number of launch sites around the world are limited, presenting a significant verification choke point. Pre-launch payload inspections would, thus, be a valuable tool, and launch detection could flag any undeclared launches. The gap is in the dual-use nature of many satellite technologies. When a satellite can be changed into a weapon simply by ramming it into another satellite, deployment verification clearly is not adequate to cover all possibilities. Verifying deployment of Earth-to-space weapons faces different challenges due to the ability to hide weapons from detection. It would be extremely difficult, for example, to verify that there are no ASAT interceptors under the wings of any aircraft in all the hangers around the world. Larger facilities such as high-powered lasers, on the other hand, could be more easily detected and monitored.

## Use

Verifying a ban on weapon use is an essential stopgap measure of last resort. It does not provide any early warning and would leave the door open to significant "break-out",[2] yet, as discussed above, the dual-use nature of many space and weapon technologies sometimes rules out any other type of verification. It is also essential for assigning responsibility for satellite failures and distinguishing between weapon use and natural causes. Verifying use is limited only by the ability to detect an attack, which is significant given the necessary technical capabilities and costs involved in maintaining a detailed awareness of space activities.

## METHODS OF VERIFICATION

Verification methods for future space weapons treaties can be structured in six layers: on-site verification; launch detection and post-launch confirmation; space situational awareness; on-orbit inspection; detecting the use of laser and other directed energy weapons (against space targets or from space against Earth targets); and re-entry detection and characterization.

### ON-SITE VERIFICATION

Two variations of on-site verification could be employed: continuous on-site monitoring and on-site inspections. Both involve significant degrees of intrusiveness, and as such require sufficient political acceptance. Continuous on-site monitoring involves the permanent stationing of equipment and/or personnel at launch sites or other designated facilities. On-site inspections would entail the presence of inspectors at designated sites for limited periods. The level of intrusiveness for pre-launch inspection could amount to no more than a cursory inspection of spacecraft exteriors prior to final encapsulation. Inspections of payloads and facilities, the gathering of information on vehicle fuel capacity, flight and orbital paths and other data required to confirm a satellite's function would be far more effective, but would also necessitate greater openness by the host state. Concerns about the protection of sensitive commercial or security-related information can be mitigated with confidential data management policies and managed access techniques similar to those practised by inspection teams of the Organisation for the Prohibition of Chemical Weapons and the International Atomic Energy Agency (IAEA). If such concerns can be addressed to the satisfaction of states parties, on-site verification would be a useful and low-cost component of a space weapon verification system.

## LAUNCH DETECTION AND POST-LAUNCH CONFIRMATION

Verifying launches, particularly those that are undeclared, would be a key component in any verification system for a space weapons treaty. This verification method can be achieved in a number of ways with current technologies. Allegations of an undeclared launch could be confirmed or discounted by a post-launch on-site environmental sampling. Undeclared launches could be detected by use of infrasound and hydroacoustic sensors similar to those currently employed by the International Monitoring System (IMS) of the Preparatory Commission of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO).[3] These sensors detect sound waves travelling through the oceans and atmosphere, and would be a cost-effective way to verify sea and airborne launches in areas that may be difficult to reach with radar.[4]

An array of ground-based radars would provide very reliable launch detection, capable of surveillance, acquisition, tracking and discrimination. It could detect ballistic missiles, space vehicle launches and ground and air-launched kinetic-kill ASATs.[5] Over-the-horizon and sea-based radars could extend coverage into areas difficult to reach with standard ground radars. The most expensive option, but one providing the greatest global coverage, is the use of infrared monitoring satellites to detect rocket plumes in launch and boost phases.[6] Few states currently possess such capabilities, as the costs involved in acquiring and deploying infrared monitoring satellites are considerable. One satellite alone, however, could cover a third of the Earth and fill any gaps that exist in the coverage of other launch detection methods.

## SPACE SITUATIONAL AWARENESS

Space situational awareness (SSA) is the general term referring to all monitoring of activity in space. This is the only verification method capable of detecting the use of many space weapons. SSA solves the dual-use dilemma by verifying the use itself. It tends to be prohibitively expensive, however, with the cost of many systems running into the hundreds of millions of dollars. Ground-based SSA is carried out using two types of technology: radars and optical telescopes.[7] Ground-based radars and telescopes are currently the most reliable method for tracking known objects, searching for new objects and characterizing objects.[8] An emerging solution is to put radars and telescopes into orbit. This overcomes several limitations of ground-based SSA, but is usually more expensive.[9] A further option is to place limited SSA capabilities on new satellites as a protective feature, focused on proximity awareness around the satellite.[10] Mandatory placement of standardized locator beacons on satellites (especially those with dual-use functions) could also improve monitoring efforts.[11]

## On-orbit inspection

The concept of on-orbit inspection is quite simple: it involves sending a satellite with cameras and other sensing devices to inspect another satellite in space. Such an inspection would be a last resort, useful only if other verification measures such as payload inspection or launch detection were circumvented or not sufficient to determine compliance or non-compliance. An inspection could involve a quick fly-by or a more lengthy rendezvous and fly-around. Proposals for inspection satellites were first advanced in the 1980s, and feasibility studies at the time specified requirements involving satellites of over four metric tons and costing in the hundreds of millions of dollars.[12] Technology has progressed rapidly since then, especially in the area of micro-satellites and nano-satellites. The precise size, weight and cost of the satellite will depend on the number of sensors on-board[13] as well as the number and type of missions it will be designed to carry out, though it is now possible to outfit a small satellite weighing less than 10kg with an array of optical cameras to fly by and photograph other satellites, and do so for less than US$ 2 million.[14] Launching satellites into orbit is also getting cheaper, with some commercial services offering launches of 600kg payloads into low-Earth orbit (LEO) for as low as US$ 7 million.[15] Launch capabilities are also becoming more responsive, with launches requiring less time to plan and execute.[16] On-orbit inspection is, thus, far more feasible today than when first proposed.

## Detecting use of laser or directed energy ASATs

Detecting the use of lasers and other directed energy weapons is one of the most technically difficult verification activities. The only completely reliable way to detect laser attacks against satellites is through sensors on-board the target satellites themselves. Many military satellites already have such sensors and, though they add weight, they could be included on all new satellites to provide confirmation of the power and incident direction of a laser or directed energy beam. Other methods for verifying laser use include detecting radiation scattering as a laser passes through the atmosphere, detecting the laser's heat signature when in use, detecting light reflected off the target satellite and monitoring targets for unique types of damage.[17] Knowing a ground-based laser's location allows placement of sensors nearby to better detect atmospheric effects. Airborne lasers are far more difficult to monitor as they limit detection of atmospheric effects and increase the potential number of satellite targets. Airborne or space-based mirrors further complicate verification, as these would allow targeting of satellites beyond line of site and permit greater beam travel outside the atmosphere.[18]

### RE-ENTRY DETECTION AND CHARACTERIZATION

The detection of objects re-entering the atmosphere has not yet been extensively explored for verification purposes, but it has important applications in detecting space-based weapons targeting Earth with physical objects. Research related to meteoroid collisions with the Earth's atmosphere has demonstrated cheap methods for accurately detecting and characterizing trajectories of high-speed re-entry objects. Radio frequencies are reflected by the plumes of ionized air behind an object's path, detectable with simple antennae.[19] Explosions, such as those created by bolides[20] when they strike the atmosphere, can be detected with infrasound techniques similar to those used by the CTBTO's IMS.[21] A network of such detectors could verify the occurrence and location of a re-entry event and potentially determine characteristics such as energy and velocity. Infrared monitoring by satellite, though more expensive, could also track re-entry events.

## COSTS

### SYNERGIES

One benefit of the layered approach to verification is that it allows verification methods to supplement each other to increase both cost-effectiveness and confidence levels. Even limited pre-launch payload inspections, for example, can limit the number of satellites that need to be monitored once in orbit. A mix of verification methods can be chosen to exploit these synergies, narrow confidence gaps and minimize costs.

### Piggybacking

Establishing agreements to employ existing systems and assets may also mitigate costs. A treaty verification system could, for instance, utilize the NTM of individual states to reduce capital outlay and increase effectiveness. Concerns regarding the reliability of NTM-derived data employed within a multilateral agreement would, of course, have to be addressed, but given that some systems such as high-powered radars have cost into the hundreds of millions of dollars, such cooperation may be necessary. Multilateral technical means that are already operational may also be an option. The CTBTO already operates global infrasound and hydroacoustic networks, and it has already considered data provision for purposes outside the CTBT mandate such as tsunami warning systems and monitoring volcanic activity.[22] If a space weapons treaty could be developed, perhaps states parties to the CTBTO would allow it to sell data to a space weapons treaty verification body.

### Cost-first determination

When assessing costs, a useful exercise would be to start with a set budget and see what verification system could be built. The exact mix of verification methods could be manipulated to demonstrate the maximum level of confidence achievable for US$ 50 million, US$ 100 million, US$ 150 million and so on, providing an even more concrete tool for negotiators. Further research is needed to describe the precise costs and options within each verification method.

## CONFIDENTIALITY AND DATA MANAGEMENT

Securing proprietary commercial information and information pertaining to national security will be critical to establishing an effective verification system. Commercial and state actors would call for guarantees that all sensitive information gathered by a verification system will not be revealed to outside parties. A strategy to protect information need not reinvent the wheel, but can be modelled on similar existing arrangements. The United Nations Monitoring, Verification and Inspection Commission, in partnership with the IAEA, has already demonstrated that information and data can be collected, including NTM, while successfully protecting confidentiality.[23] On-site inspectors and staff supporting a verification system would be required to respect strict rules of confidentiality, and be legally bound to do so.

The management of raw space surveillance data is related to confidentiality, and will determine the ability of the verification system to contribute to extra-treaty benefits such as space traffic control or orbital debris tracking. The CTBTO model, which allows state signatories access to raw monitoring data almost in real time, may not be workable for a space weapons treaty, given national security concerns and legitimate military uses of outer space. Moreover, providing space surveillance data to commercial and other non-state actors with significant space assets will prove problematic as they will not be parties to the agreement. Questions arise as to whether data streams would filter military space traffic in ways different than civilian space traffic. These concerns must be addressed in treaty negotiations, which would set any such parameters for a verification data management body.

## CONCLUSION

A clear understanding of verification possibilities and costs will greatly facilitate the negotiation of a space weapons ban. Countries proposing draft treaties should, therefore, try to consider the precise verification methods applicable to the treaty design envisaged. Effective multilateral verification can legitimize enforcement mechanisms and increase the effectiveness of the treaty as a whole.

Clear ideas on the verification measures required may force negotiators to be more specific about the treaty's terms and scope. While many contend that treaty objectives must be established in advance of any detailed discussion on verification, one can credibly counter that knowing which tools are technically available, financially feasible and credibly effective could help to initiate or shape treaty negotiations.

The verification system applicable to an agreed upon space weapons treaty could also provide a number of extra-treaty benefits. Such a system could play an effective role in helping avoid collisions in space by coupling SSA with a space traffic management system. It could also track space debris, a threat to all space assets that continues to grow.[24] An effective verification system could also reinforce compliance with the current registration and liability conventions.

The flexible, layered framework proposed in this paper will hopefully serve to catalyse a deeper formulation of verification plans for a space weapons treaty. Yet, depth must not create unnecessary complexity. Simple, policy-relevant considerations related to cost, intrusiveness and confidence levels are essential. Developing a comprehensive and flexible verification blueprint could serve well the needs of treaty negotiators in advance of agreement on treaty objectives, and provide impetus to future discussions.

**Table 1.** Treaty requirements and corresponding verification mechanisms

| Treaty scope | Verification mechanisms |
|---|---|
| Banning use of weapons against space assets or from space against Earth targets | **Declarations and pre-launch payload inspections** would increase confidence and decrease costs of verification, but inspections would only verify deployment/non-deployment, not use |
| | **Detection of undeclared launches**<br>Increased need due to ground- and air-launched kinetic ASATs<br>Confirmation of launch by post-launch on-site inspection<br>Infrasound and hydroacoustics<br>Ground-based detection radars<br>Infrared monitoring satellites |
| | **SSA**<br>LEO orbit tracking and un-cued searching with a ground-based radar fence<br>Ground-based optical telescopes for characterizing assets in LEO and tracking and characterization in GEO<br>High-power ground-based radar and highly sensitive receivers for tracking, un-cued searching and characterizing in GEO<br>Space-based SSA through radar satellites and space-based telescopes<br>Locator beacons on satellites to facilitate tracking<br>On-board SSA on each satellite (radar/lidar) |
| | **Laser ASAT detection**<br>*Ground-based lasers*<br>Sensors near declared laser sites to detect use, verify target and power<br>*Airborne lasers*<br>Radar systems to track location of airborne lasers<br>*Both*<br>Ground-based monitoring of potential target satellites for reflection of laser light<br>Detectors on board satellites<br>Satellites monitoring the atmosphere for laser effects |
| | **Re-entry detection and characterization**<br>Radio reflection monitoring similar to meteorite detection<br>Infrasound<br>Radar tracking<br>Infrared-monitoring satellites |

* Cost levels are defined as follows: Very low = less than US$ 10 million; Low = US$ 10–50 million; Medium = $US 50–100 million;

| Setup/ infrastructure costs* | Operational costs* (per year) | Confidence gaps |
|---|---|---|
| | | |
| Low | Low | Air launches |
| Low[25]/Med[26] | Low/Med | Assuring global coverage |
| Med/High | Low | Detecting trajectory |
| Very high[27] | Low/Med | Assuring global coverage |
| High[28] | Low | No coverage of GEO |
| High[29] | Low/Med | Limited un-cued searching in GEO |
| Very high[30] | Low/Med | Resolution still limited |
| Very high[31] | Med | Very high confidence |
| Low/Med | Low | Not present on all satellites |
| Med | Low/Med | Little warning time |
| Low | Low | Undeclared sites |
| Med/High[32] | Low | Global coverage |
| Med | Low | Complete coverage of all targets |
| Med | Low | Not present on all satellites |
| Very high | Low/Med[33] | Difficult to detect from a distance, depending on laser energy |
| Low | Low | |
| Low | Low | |
| Med/High | Med | |
| Very high | Low/Med | |

High = US$ 100–500 million; Very high = greater than US$ 500 million.

**Table 1** (continued)

| Treaty scope | Verification mechanisms |
| --- | --- |
| Banning *deployment* of weapons in space | **State and commercial declarations of upcoming launches and detailed mission plan**<br>Central depository and tracking database |
| | **Pre-launch on-site verification of satellite payloads** (continuous on-site monitoring and on-site inspections )<br>Cursory inspection of spacecraft and payload exteriors prior to final encapsulation; general description of mission goals<br>Visual interior and exterior inspection at selected stages; presence at selected tests and real-time review<br>Complete access to technical data; visual inspection at any time; presence at all tests<br>Disclosure of all technical data submitted in advance; unlimited visual inspection, including unit/panel removal; radiographic examination where possible; 24-hour surveillance |
| | **Detection of undeclared launches** (see above) |
| | **SSA** (see above) |
| | **On-orbit inspection and surveillance**<br>Fly-by with inspection satellite<br>On-orbit rendezvous for intensive inspection |
| Banning *testing* of weapons for placement in or for targeting space | **Verifying field testing of full prototypes**<br>Generally requires the same technology as detecting use (see above)<br><br>**Verifying testing of component parts**<br>Laboratory inspections |
| Banning applied *R&D* of weapons to be used in space or to target space assets | **Verifying in-laboratory testing**<br>Laboratory inspections |

| Setup/ infrastructure costs* | Operational costs* (per year) | Confidence gaps |
|---|---|---|
| Very low | Very low | No verification;<br>very low confidence |
| Low | Low | Undeclared launches;<br>dual-use technologies;<br>hidden or opaque payloads;<br>false data provision;<br>limited intrusiveness |
| | | |
| | | |
| Med[34]<br>Med/High[35] | Low/Med[36]<br>Low/Med[37] | Small or hidden weapons |
| Low | Low | Easily hidden;<br>dual-use problems |
| Low | Low | Laboratories are easily concealed;<br>dual-use problems are enormous |

## Notes

1 Production is often included as a potential step. Regulating production can involve setting limits on weapon capabilities or on the number of weapons to be produced. Tracking production of dual-use technologies could also be a potential flag, but requires very high levels of intrusiveness.

2 "Breakout" here refers to a state building up its capabilities and arsenals to a high level without breaking the treaty, providing a military advantage that can then be quickly exploited when it does break the treaty.

3 *Monitoring Technologies: Infrasound*, Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization, 2006, at <www.ctbto.org/verification/infrasound.html>.

4 *Monitoring technologies: Hydroacoustics*, Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization, 2006, at<www.ctbto.org/verification/hydroacoustics.html>.

5 *Ground-Based Radar and X-band Radar*, Federation of American Scientists Space Policy Project, July 1999, at <www.fas.org/spp/starwars/program/gbr.htm>.

6 Simon Collard-Wexler et al., 2005, *Space Systems Protection*, Waterloo, ON, Space Security 2004, Spacesecurity.org, pp.103–104, at <www.spacesecurity.org/SSI2004.pdf>.

7 SSA can also include ground-based infrared monitoring of satellites. For example, see Major Michael J. Muolo, 1993, Space Support to the War Fighters: Space Missions and Military Space Systems, Chapter 3, in *Space Handbook: A War Fighter's Guide to Space,* Maxwell Air Force Base, AL, Air University Press, December, at <www.au.af.mil/au/awc/awcgate/au-18/au180001.htm>.

8 See Tim Grayson, *Space Situational Awareness: What was that? Where is it going? What is it doing?*, presentation at the DARPA Tech 2002 Symposium, Anaheim, CA, 30 July–2 August 2002, at <www.darpa.mil/DARPATech2002/presentations/tto_pdf/speeches/GRAYSON.pdf>.

9 The United States is exploring this option with its Space-Based Surveillance System currently under development. See Simon Collard-Wexler et al., op. cit., pp. 125–126. For a complete list of past, current and planned space-based telescopes, see <www.seds.org/~spider/oaos/oaos.html>.

10 Such on-board situational awareness is planned for the upcoming Orbital Express mission, see Lt. Col. James Shoemaker, *Orbital Express Space Operations Architecture*, US Defense Advanced Research Projects Agency, at <www.darpa.mil/tto/programs/oe.html>. It is also being explored by the United States Air Force in the form of Autonomous Nanosatellite Guardians for Evaluating Local Space (ANGELS), at <fs2.fbo.gov/EPSData/USAF/Synopses/2682/BAA-VS-06-03/BAASolicitationforANGELS%28Final2Dec05%29%2Edoc>.

11 Tracking of satellite beacon signals using radio receivers is a common method for amateur astronomers, see S. Solomon, 1984, Eavesdropping on Soviet Satellites, *Science Digest*, vol. 92, no. 1 (January), pp. 26, 32, 81. The method is also used by the United States Deep Space Tracking System, see *5th Space Surveillance Squadron: Factsheet*, United States Air Force, 2005, at <www.peterson.af.mil/21sw/library/fact_sheets/5spss.htm>; and was proposed in a 2004 US study on guidelines for re-usable launch vehicles, see J. Timothy Middendorf and Janice Mendonca, 2004, *Reusable Launch Vehicle Operations and Maintenance Guideline Inputs and Technical Evaluation Report: Subsystems, Volume 1*, 12 January, Research Triangle Park, NC, RTI International, prepared for the United States Federal Aviation Administration, pp. 87–90, at <64.29.75.106/Members/Government_Library/FAA_eDocuments_Collection/SubsystemVolume1-Final.pdf>.

12 For example, see SPAR Aerospace Limited, 1985, *PAXSAT "A": Space Based Remote Sensing: Space-to-Space, Volume 1*, January, SPAR, Ste-Anne-de-Bellevue, Quebec.

13 Designs for inspection satellites commonly include optical and infrared cameras, radar or lidar systems and signal detection functions, though they could also be outfitted with chemical or radiation detectors, or with X-ray systems to image the inside of the target satellite.

14 Surrey Satellite Technologies, Ltd (SSTL) developed and launched the SNAP-1 satellite in 2000 for less than US$ 1.5 million. Such small payloads can catch rides on launches of larger satellites, drastically reducing launch costs. For example, SNAP-1 caught a ride on a Cosmos rocket along with the Chinese Tsinghua 1 and a larger US–Russian search and rescue satellite. See Lee Siegel, *Butane Fuel Propels Nanosatellites*, Space.com, 22 August 2000, at <www.space.com/news/bic_fuel_000822.html>; *SNAP-1 Summary*, Andrews Space & Technology database, at <www.spaceandtech.com/spacedata/logs/2000/2000-033b_snap-1_sumpub.shtml>, *A Practical, Proven*

*Nanosatellite*, Surrey Satellite Systems, Ltd., at <zenit.sstl.co.uk/index.php?loc=47>.

15 *Falcon Overview*, Space Exploration Technologies Corporation, at <www.spacex.com/falcon_overview.php>; *Fact Sheet: Minotaur Space Launch Vehicle*, Orbital Sciences, 2003, at <www.orbital.com/NewsInfo/Publications/Minotaur_fact.pdf>; *Orbital Successfully Launches Minotaur Rocket Carrying U.S. Air Force's XSS-11 Satellite*, Orbital Sciences, press release 12 April 2005, at <www.orbital.com/Template.php?Section=News&NavMenuID=32&template=PressReleaseDisplay.php&PressReleaseID=498>.

16 See Simon Collard-Wexler et al., op. cit., pp.103–104.

17 Several in-depth studies of verification issues with lasers were completed in the early 1990s, including: Richard Garwin et al., 1991, *Laser ASAT Test Verification*, study group report, 20 February, Washington, DC, Federation of American Scientists; T. Broid et al., 1990, Laser Beam Verification, *Science & Global Security*, vol. 2, no. 1, p. 51; M. Fomenkova and O. Prilitsky, 1990, Atmospheric Scattering of Laser Radiation, *Science & Global Security*, vol. 2, no. 1, p. 79. See also Stanislav Rodionov, 1993, *Technical Problems in the Verification of a Ban on Space Weapons*, Research Paper No. 17, Geneva, UNIDIR; Regina Hagen and Jürgen Scheffran, Is a Space Weapons Ban Feasible? Thoughts on Technology and Verification of Arms Control in Space, 2003, *Disarmament Forum*, vol. 1, pp. 41–51.

18 Geoff Fein, 2005, AFRL Moves Aerospace Relay Mirror System Demonstration to 2006, *Defense Daily*, 20 October, p. 5A; Aerospace Relay Mirror System (ARMS), GlobalSecurity.org, last updated 7 September 2005, at <www.globalsecurity.org/military/systems/aircraft/systems/arms.htm>.

19 For example, see Tony Phillips, 1999, *Tuning in to April Meteor Showers*, NASA, April, at <science.nasa.gov/newhome/headlines/ast27apr99_1.htm>.

20 A bolide is an asteroid, meteor or comet that explodes when it strikes the Earth's atmosphere.

21 For example, see D.O. ReVelle, P.G. Brown and P. Spurny, Entry Dynamics and Acoustics/Infrasonic/Seismic Analysis for the Neuschwanstein Meteorite Fall, 2004, *Meteoritics and Planetary Science*, vol. 39, pp. 1605–1625; W.N. Edwards, P.G. Brown and D.O. ReVelle, 2005, *Bolide Energy Estimates from Infrasonic Measurements*, *Earth, Moon and Planets*, DOI: 10.1007/s11038-005-2244-4, at <aquarid.physics.uwo.ca/infrasound.htm>.

22 *Decision on Possible Contribution of the CTBTO Preparatory Commission to a Tsunami Warning System*, 2005, CTBTO Preparatory Commission, Twenty-Fourth Session, Part I, Vienna, 4 March, at <www.ctbto.org/press_centre/press_release.dhtml?item=246>; Oliver Meier, 2005, CTBTO Releases Test Ban Monitoring Data for Tsunami Warning, *Arms Control Today*, April, at <www.armscontrol.org/act/2005_04/CTBTO.asp>.

23 See Trevor Findlay, A Standing United Nations Verification Body: Necessary and Feasible, 2005, Canadian Centre for Treaty Compliance, *Compliance Chronicles*, no. 1, December, pp. 12–13.

24 The Space Environment, *Space Security 2005: Briefing Notes*, Spacesecurity.org, at <www.spacesecurity.org/BN-TheSpaceEnvironment.pdf>.

25 The 2001 cost for an infrasound station was US$ 350,000. *World Meteorological Organization*, at <www.wmo.ch/web/www/DPS/DPFS-ERA-US/ERA-COG-Doc8(2).F.doc>.

26 Hydrophone stations are expensive to instal and costly to maintain, see *Monitoring Technologies: Hydroacoustics*, Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization, 2006, at <www.ctbto.org/verification/hydroacoustics.html>.

27 As of October 2005, Defense Support Program Satellites are listed as having a unit cost of US$ 400 million, see Air Force Space Command: Air Force Link, at <www.af.mil/factsheets/factsheet.asp?fsID=96>.

28 As explained by globalsescurity.org, “a modest satellite tracking radar or telescope typically costs several tens of millions of dollars, while the more elaborate radars can cost well in excess of US$ 100 million”, at <www.globalsecurity.org/space/systems/track-overview.htm>.

29 The US Ground-based Electro-Optical Deep Space Surveillance (GEODSS) includes a total of five telescopes, constructed at a total cost of approximately US$ 250 million. The DARPA Space Surveillance Telescope development project has a projected budget of approximately US$ 15 million/year for six years. See United States Department of Defense, 2005, *Fiscal Year (FY) 2006/FY 2007 Budget Estimates, Research, Development, Test, and Evaluation, Defense-Wide, Volume 1: Defense Advanced Research Projects Agency (DARPA)*, February, p. 247, at <www.dod.mil/comptroller/defbudget/fy2006/budget_justification/pdfs/rdtande/DARPA.pdf>.

30 The DARPA Deep View program is developing a high-resolution, high-powered radar for SSA and has a projected budget of approximately

US$ 11 million/year for six years; see United States Department of Defense, op.cit., p. 249.

31 The US Space-Based Surveillance System (SBSS) is projected to involve a constellation of four satellites at US$ 189 million each, at <www.cdi.org/PDFs/FY05Appropriations.pdf> and <www.boeing.com/defense-space/space/space_systems/news/2004/q1/nr_040330n.html>. DARPA's Innovative Space-Based Radar Antenna Technology (ISAT) project developing an array of space-based radars has a projected budget of US$ 44 million/year for seven years, see United States Department of Defense, op. cit., pp. 248–249. On the other hand, Canada's Near Earth Space Surveillance (NESS) satellite, with fewer capabilities, has a planned cost of US$ 3–4 million, at <www.space.com/scienceastronomy/astronomy/ness_asteroid_000824.html>.

32 Depends on overlap and cooperation with global air traffic control system.

33 Replacement costs are considered infrastructure; operational costs are ground control and analysis.

34 Costs depend on sensor choice, number of missions to be carried out and size of orbit changes required.

35 Costs depend on sensor choice, number of missions to be carried out and size of orbit changes required.

36 Replacement costs are considered infrastructure; operational costs are ground control and analysis.

37 Replacement costs are considered infrastructure; operational costs are ground control and analysis.

## CHAPTER 9

# SPACE SECURITY 2006[1]

Sarah Estabrooks

## INTRODUCTION

The strategic environment of outer space is rapidly evolving. A growing number and diversity of actors are accessing and using space, revenues from its commercial exploitation are growing, satellite services affect daily life all over the world and military space applications are continually expanding. While demonstrating the vital importance of this environment, intensifying space use creates governance challenges including management of space traffic, orbital debris and the distribution of scarce resources such as orbital slots and radio frequencies. It has become clear that technological and political developments are outstripping the existing governance framework for outer space. These governance challenges affecting space security will become increasingly salient as states' dependence on space for national security grows.

For the purposes of this paper, space security is defined as *the secure and sustainable access to and use of space, and freedom from space-based threats*. This definition accepts that space is a global commons, as enshrined in the 1967 Outer Space Treaty (OST), bordering every community on Earth. The concept of space security also embraces a comprehensive understanding of security, encompassing environmental, legal, civil and commercial factors in addition to military ones. Indeed, there cannot be security in space in any meaningful sense if critical space assets are being pelted by orbital debris, if commercial space interests lack the protection of a robust legal regime or if satellites are threatened by space weapons. For space to remain a path to prosperity and a path to peace, these dimensions must be addressed. This paper aims to provide a snapshot of the current state of space security, a vital tool for the space security debate.

## THE SPACE ENVIRONMENT

The danger posed by orbital debris and the distribution of scarce resources such as orbital slots and radio frequencies are key environmental aspects of space security. The number of objects in Earth orbit has increased steadily and there are an estimated 35 million pieces of space debris in orbit as of 2006. Approximately 13,000 orbiting objects large enough to seriously damage or destroy a spacecraft—over 90% of which is space debris—are being tracked. However, the annual growth rate of tracked orbital debris has been decreasing since the early 1990s, due in large part to national space agency debris mitigation efforts. In 2005, the space debris population grew by 2.1%, a modest rate of increase compared with those of recent years.

Recognizing that space debris is a growing threat, many space-faring states, including China, Japan, the Russian Federation and the United States, as well as the European Space Agency (ESA) have developed national debris mitigation standards. In 2005, the Space Debris Working Group of the Scientific and Technical Subcommittee of Committee on the Peaceful Uses of Outer Space (COPUOS) reached agreement that the intentional destruction of *any* orbiting object that could generate "long-lived" orbital debris should be avoided.

In order to mitigate the threat of space debris, space surveillance has been slowly improving. The US Space Surveillance Network and the Russian Space Surveillance System currently provide the most important capabilities. Canada, China, the European Union, France, Germany and Japan are also developing new space surveillance capabilities. In 2005, the United States announced plans for a space situational awareness nano-satellite in geostationary orbit. China established its first Target and Debris Observation and Research Center, while actors in Europe explored the possibility of setting up a space surveillance network by pooling existing ground-based radars and optical telescopes with new assets.

Another environmental concern of expanding satellite applications has been the growing demand for radio frequencies. The number of satellites operating in the 7–8 gigahertz band commonly used by geostationary orbit satellites has been increasing. The growth in military consumption of bandwidth has also been dramatic. Demand for radio spectrum continued to increase in 2005. Radio frequency interference and piracy are also becoming a concern to commercial space actors. In 2005, 1,374 incidents of satellite radio frequency interference were reported, although only 1% of these incidents was intentional.

Furthermore, the space environment is affected by orbital crowding. There are more than 620 operational satellites in orbit at the time of writing: about 46% in low-Earth orbit (LEO), 6% in medium-Earth orbit and slightly more than 47% in geostationary orbit. Increased competition for orbital slot assignments, with greatest demand for geostationary orbit slots where most communications satellites operate, has caused occasional disputes between satellite operators. The International Telecommunications Union has been pursuing internal reforms designed to address slot allocation backlogs and related financial challenges. Demand on orbital slots continued to increase in 2005, with ongoing competition between communication satellite operators and with Iran becoming the forty-fifth state to acquire indirect access to space.

## LAWS, POLICIES AND DOCTRINES

Since the signing of the OST in 1967, the international legal framework related to space has grown to include the Astronaut Rescue Agreement (1968), the Liability Convention (1972), the Registration Convention (1979) and the Moon Agreement (1979) as well as a range of other international and bilateral agreements and relevant customary international laws. This legal framework establishes the principle that space should be used for "peaceful purposes" and is not subject to claims of national sovereignty. While there currently exists no ban on the deployment of conventional weapons in space, the OST prohibits the stationing of weapons of mass destruction anywhere in space.

Since 1981, the United Nations General Assembly has adopted a resolution on the prevention of an arms race in outer space (PAROS) with near-unanimous support. In 2005, there was a noteworthy shift in the PAROS debate when Israel and the United States voted against the resolution—the first opposition votes in the resolution's history. In 2005, the Russian Federation also tabled a new resolution, inviting states to provide input on measures to promote transparency and confidence building in outer space.

A range of international institutions such as the General Assembly, the COPUOS, the International Telecommunications Union and the Conference on Disarmament (CD) have been mandated to address space security issues. However, the CD has been deadlocked since 1998 and unable to undertake the PAROS mandate to develop an instrument relating to space security and the weaponization of space. An aborted effort was made in 2005 to create four open-ended ad hoc committees under the auspices of the General Assembly First Committee to address the PAROS and other priority issues.

All space-faring states emphasize the importance of cooperation and the peaceful uses of space, including the promotion of national commercial, scientific and technological progress. The United States has recently announced plans for peaceful space exploration of the Moon and Mars, while there is growing interest in manned space programmes. Brazil and India tend to focus on the utility of space cooperation for social and economic development. New space policies were adopted in Europe, China, Japan, Kazakhstan, the Russian Federation and the United States in 2005. The European Commission, for example, unveiled a plan to spend more than US$ 5 billion on "security and space" programmes for 2006–2013 and to double its budget for space-related research programmes.

A growing number of states led by China, the Russian Federation, the United States and key European states are increasingly emphasizing the use of space systems to support national security. This has led several states to view space assets as critical national security infrastructure. US military space doctrine has also begun to focus on the need for "counterspace operations" to prevent adversaries from accessing space. In 2005, actors such as the European Union, India, Israel and Japan continued emphasizing the national security applications of space. The United States is expected to release a new military space directive that, according to certain media reports, would depart from current policy by explicitly calling for development of certain space negation systems.

## CIVIL SPACE PROGRAMMES AND GLOBAL UTILITIES

Civil space programmes are a key aspect of space security as they have helped a large number of actors gain access to space. By 2004, 10 actors had demonstrated an independent orbital launch capacity and 44 states had accessed space independently or with the launch services of others. In 2005, China, the Russian Federation and the United States launched 24 civil spacecraft, of which nine were manned, and Iran became the forty-fifth state to launch a satellite.

While there has been growth in the number of states accessing space, civil space programmes have seen changing priorities and funding levels. The general trend in recent years has seen civil space expenditures increase in China and India and decrease in the European Union, Japan, the Russian Federation and the United States. In 2005, most space-faring states, except Japan, experienced modest increases in civil space budgets and these programmes increasingly include security and development applications. Indeed, Algeria, Brazil, Chile, Egypt, India, Malaysia, Nigeria, South Africa and Thailand are all placing a priority on satellites to support social and economic development.

Another aspect of space security has been the steady growth in international cooperation in civil space programmes. International civil space cooperation has played a key role in the proliferation of technical capabilities for states to access space. In 2005 alone, the Russian Federation reached agreements with Brazil, Canada, China, Egypt, India, Indonesia, Iran, Kazakhstan, the Republic of Korea and ESA. The United States established agreements with India, Japan, the Russian Federation and Sweden. ESA, a regional space agency that embodies the benefits of international cooperation, signed agreements with China, India, Morocco, the Russian Federation and Ukraine. Also, eight regional partners formed the Asia Pacific Space Cooperation Organization.

The use of space-based global utilities, including navigation, weather and search-and-rescue systems, has grown substantially since 1995. These systems have spawned space applications that are almost indispensable to the civil, commercial and military sectors as well as most modern economies. China, the European Union, the Russian Federation and the United States have been developing satellite-based navigation capabilities. In 2005, the European Union launched the first of its constellation of Galileo navigation satellites, while India, Israel, Morocco, Saudi Arabia and Ukraine announced their participation in the project. The Russian Federation made plans to cooperate with China and India on the GLONASS satellite navigation system. India also started development of its own separate civilian satellite navigation system called GAGAN.

## COMMERCIAL SPACE

The global commercial space sector has seen overall, albeit uneven, growth. The commercial space sector, including manufacturing, launch services, space products and operating insurance, accounted for an estimated US$ 2.1 billion in revenues in 1980 and exceeded US$ 100 billion by 2004. This growth is being driven by the satellite services industry, including telecommunications. In 2005, there were 17 commercial launches, an increase over 2004, and revenues for the year were expected to reach US$ 115 billion. In addition, 20 new commercial satellites were launched in 2005. The general trend to privatize government-owned telecommunications agencies and industry consolidation in the commercial space industry also continued apace.

Accounting for about one-third of the 60–70 annual space launches, the commercial space sector has played a role in the decreasing cost of space access. The costs to launch a satellite into geostationary orbit have declined from an average of about US$ 40,000/kilogram in 1990 to US$ 26,000/kilogram in 2000, with prices still falling. The European and Russian space agencies are the most active space launch providers. With the launch of Mojave Aerospace Ventures' SpaceShipOne in 2004, the private sector entered the suborbital manned spaceflight sector. Nonetheless, demand for commercial launchers stayed flat in 2005 as the United States continued to lose market share to Europe and the Russian Federation. Japan successfully tested a new launcher and China announced its imminent return to commercial space launch. More than 20 companies are developing a reusable suborbital launch vehicle for space tourism.

Government subsidies and national security concerns continue to play an important role in the commercial space sector. Governments significantly subsidize the space launch and manufacturing markets, including insurance costs. The European and US space industries also receive important space contracts from government sources. However, government administered export controls such as the Missile Technology Control Regime and the US International Traffic in Arms Regulations (ITAR) regime can complicate participation in international collaborative satellite launch and manufacturing ventures. In 2005, the US Department of Defense remained the world's largest commercial space client. At the same time, commercial space actors such as the International Space Business Council cited ITAR as the "industry's most serious issue". As a result of high insurance premiums, a number of commercial space actors have stopped insuring their in-orbit assets and/or purchased spare satellites.

## SPACE SUPPORT FOR TERRESTRIAL MILITARY OPERATIONS

Space played a critical role in ensuring strategic stability during the Cold War. As a result of the revolution in military affairs, space is increasingly supporting tactical terrestrial military operations. The Russian Federation and the United States lead in developing military space systems to provide military attack warning, communications, reconnaissance, surveillance, intelligence, navigation, and weapons guidance. The United States spends roughly 95% of all global military space expenditures and has approximately 135 operational, military-related satellites—over half of all the military satellites in orbit. The Russian Federation is believed to have some 85 dedicated military and 18 multipurpose satellites in orbit. The United States is, by all major indicators, the actor most dependent on its space capabilities. In 2005, 19 dedicated military space satellites were launched. The Russian Federation and the United States launched six and seven military satellites, respectively. However, 2005 also saw significant cutbacks to a number of US military space programmes and the Russian Federation experienced three failed launches and the loss of two military satellites.

Declining costs for space access and the proliferation of technology are enabling more states to develop and deploy their own military satellites using the launch capabilities and manufacturing services of others, including the commercial sector. European Union states have developed a range of military space systems. France, Germany, Italy and Spain jointly fund the Helios 1 military observation satellite system. France, Germany and Italy are planning to launch six low-orbit imagery intelligence systems to replace the Helios series by 2008. The United Kingdom maintains a constellation of three dual-use Skynet 4 communications satellites. France operates four signal intelligence satellites. The European Union Galileo satellite navigation programme, initiated in 1999, will have an inherent dual-use capability. In 2005, France continued development of the most advanced and diversified independent military space capabilities in Europe with the launch of the Syracuse 3A military communications satellite and ongoing work on the Spirale early-warning and Melchior military communications satellites.

Spain launched the XTAR-EUR communications satellite, and the United Kingdom launched a dual-use imagery micro-satellite called TopSat.

Asia is increasingly becoming the arena of military space rivalry. China provides military communications through its DFH series satellite and has deployed a pair of Beidou navigation satellites to ensure its navigational capability. China also maintains three ZY series satellites for tactical reconnaissance and surveillance functions, has deployed three military reconnaissance satellites and is believed to be purchasing additional commercial satellite imagery from the Russian Federation to meet its intelligence needs. Japan operates the commercial Superbird satellite, which provides military communications, and has two reconnaissance satellites. India maintains its Technology Experimental Satellite and a naval satellite, both of which provide military reconnaissance capabilities. In cooperation with a French company, Thailand will soon produce its first intelligence and defence satellite. In 2005, China launched the Beijing-1 (Tsingshua-1) Earth observation micro-satellite amid speculation that China's continued participation in the Galileo navigation system might eventually be used to improve the accuracy of its missiles. Taiwan announced plans to launch a Follow-On RSS reconnaissance satellite. In an effort to improve satellite images of the Democratic People's Republic of Korea's nuclear and missile facilities, Japan began research in 2005 on scaling down the size of reconnaissance satellites to enhance their manoeuvrability. Pakistan began construction of a remote sensing satellite.

Israel operates a dual-use Eros-A imagery system as well as the military reconnaissance and surveillance Ofeq-5 system. In 2005, Israel announced its intention to launch the Ofeq-7 and TechSAR surveillance and reconnaissance satellites. The Middle East also saw a proliferation of military space capabilities with the launch of Iran's Sina-1 satellite, which, although officially civil, has been claimed to have dual-use remote sensing functions. And in North America, Canada announced its intention to launch a radar surveillance satellite called RADARSAT-2.

## SPACE SYSTEMS PROTECTION

Space systems protection involves detecting, withstanding and recovering from attacks on the ground and space-based segments of a space system. The Russian Federation and the United States lead in general capabilities to detect rocket launches, while the United States leads in the development of advanced technologies to detect direct attacks on satellites. US Defense Support Program satellites provide early warning of conventional or nuclear ballistic missile-based attacks and it is also developing capabilities to detect in-orbit attacks on satellites. The Russian Federation began rebuilding its ageing missile launch warning system in 2001. France is due to launch two missile-launch early-warning satellites in 2008. Most actors have a basic capability to detect a ground-based electronic attack, such as jamming, by sensing an interference signal or by noticing a loss of communications. Directed energy attacks move at the speed of light, making advance warning very difficult to obtain. The United States maintained its lead in space situational awareness capabilities in 2005, announcing plans for the Space Surveillance Telescope and the Deep View radar of the Autonomous Nanosatellite Guardian for Evaluating Local Space (ANGELS) programme.

The most vulnerable segment of a space system is often the ground segment, where many systems lack protection from attacks. The protection of satellite communications links is also generally poor but improving. While many actors employ passive electronic protection capabilities, such as shielding and directional antennas, more advanced measures, such as burst transmissions, are exclusive to the military systems of more technically advanced states. China and the United States have been aggressively pursuing a variety of jamming protection capabilities. In 2005, the United States successfully tested the GPX airborne pseudo-satellite, employing an unmanned aerial vehicle to boost power of GPS satellite signals and overcome jammers.

The protection of satellites against some direct threats is improving, largely through radiation hardening, system redundancy and greater use of higher orbits. China and Japan are developing navigation satellites that will increase the global redundancy of such critical systems. The European Union and the United States have agreed to make their navigation systems interoperable. Increasingly, states are placing military satellites into higher orbits, where they are less vulnerable to attacks than in LEO. Most key European, Russian and US military satellites are already hardened against the effects of a high-altitude nuclear detonation. In 2005, the United States achieved improved radiation hardened microchips and began research to characterize the radiation environment in medium-Earth orbit in order to make better use of this environment. The United States is reportedly developing a stealth satellite with the ability to evade detection by the terrestrial space surveillance systems of other actors.

In addition, the Russian Federation and the United States lead in capabilities to rapidly rebuild space systems following a direct attack on satellites. The concept of so called responsive lift was pursued by Lockheed Martin and SpaceX through research and development of low-cost launch vehicles. The Russian Federation, for its part, continued research on air-launched responsive lift capabilities.

## SPACE SYSTEMS NEGATION

The negation of ground- or space-based segments of a space system can be achieved by electronic, conventional, nuclear and directed energy means. There has been a proliferation of capabilities to attack ground stations and communications links of space system. These remain the most vulnerable components of space systems, susceptible to attack by conventional military means, computer hacking and electronic jamming. In 2005, Libya and Iran sponsored the jamming of satellite communications and China continued to be a major target of satellite jamming.

The United States leads in the development of space situational awareness capabilities that could support space negation and, along with the Russian Federation, maintains the most extensive space surveillance capabilities. China and India also have satellite tracking, telemetry and control assets essential to their civil space programmes. Canada, France, Germany and Japan are all actively expanding their ground-based space surveillance capabilities. While this technology enhances transparency and enables space collision avoidance, it can also provide capabilities for targeting satellites and space negation. The United States increased its lead in space situational awareness technologies in 2005 with research and development into ANGELS and the Deep View radar. Some actors in Europe have begun discussions on the option of pooling existing space surveillance capabilities as well as developing additional independent capabilities of their own in order to be less reliant on US data.

Ground-based capabilities and precursor technologies to attack satellites are becoming more widespread. A variety of US and USSR/Russian programmes during the Cold War and into the 1990s sought to develop ground-based anti-satellite (ASAT) weapons. The capability to launch a payload into space to coincide with the passage of a satellite in orbit is a basic requirement for conventional satellite negation systems: 28 states have demonstrated suborbital launch capability; of those, 10 have orbital launch capability. As many as 30 states may already have the capability to use low-power lasers to degrade unhardened satellite sensors. The United States leads in the development of more advanced ground-based kinetic kill systems with the capability to directly attack satellites. It has deployed components for a ground-based ballistic missile defence system and is developing an airborne laser system, both of which have inherent LEO satellite negation capabilities.

In 2005, the China and the United States continued to work on directed energy technologies. The United States is pursuing lighter, smaller and more durable solid state laser designs. The existing American Starfire Optical Range was fitted with a sodium beacon laser with possible ASAT applications. Research in China continued on laser frequencies and adaptive optics, which can help to maintain laser beam quality over long distances. Though not a dedicated programme, this basic research could eventually support ground-based and airborne ASATs. In 2005, more advanced work on ground-based kinetic kill weapons was also conducted in China, the Russian Federation, the United Kingdom and the United States. The US conventional kinetic energy ASAT programme was awarded a contract to develop three advanced kill-vehicles. The United States continued to develop its Ground-based Midcourse Defense system and the Russian Federation upgraded the A-135 anti-ballistic missile system. China, the United Kingdom and the European Aeronautic Defence and Space Company conducted basic research into kinetic kill-vehicles for missile defence. Such kinetic kill interceptors could serve as ASATs.

Although less developed, there has also been a proliferation of space-based negation-enabling capabilities. Space-based negation would require sophisticated capabilities such as precision in-orbit manoeuvrability and space tracking, capabilities that have dual-use potential. The United States leads in the development of most of these enabling capabilities, though none appears to be integrated into dedicated space-based negation systems and enabling capabilities continued to proliferate in 2005. The US XSS-11 and DART micro-satellites demonstrated dual-use rendezvous and surveillance capabilities. Both Japan and the United States conducted asteroid interception missions in 2005, which used key negation-enabling capabilities such as tracking, firing and monitoring. Robotic technologies for on-orbit servicing such as the Robotic Components Verification on ISS (ROKVISS) system were demonstrated on the International Space Station. The Defense Advanced Research Projects Agency (DARPA) expressed interest in developing capacity for in-orbit servicing, repair and orbit manipulation using space robotics. Finally, China, Europe and the United States conducted research, development and testing of homing sensors that could be used for a range of space systems negation applications.

## SPACE-BASED STRIKE WEAPONS

Although the former Soviet Union and the United States developed and tested ground-based and airborne ASAT systems between the 1960s and 1990s, there has not yet been any deployment of space-to-Earth or space-to-missile space-based strike weapons (SBSW) systems. Under the Strategic Defense Initiative in the 1980s, the United States invested several billion dollars in the development of a space-based interceptor (SBI) concept called Brilliant Pebbles. The former Soviet Union and the United States directed energy programmes of the 1980s for SBSW systems have largely been halted. The US Near Field Infrared Experiment (NFIRE), originally due for launch in 2006, was to be the first fully integrated SBSW spacecraft with a sensor platform and kinetic kill-vehicle. In 2005, the Missile Defense Agency (MDA) removed the "kill-vehicle" portion of the planned NFIRE test saying it posed a risk of technical failure. Further MDA plans include the deployment of a test-bed of three to six integrated SBIs by 2011–2012.

Although no SBSW have been deployed, a growing number of actors are developing SBSW precursor technologies outside of SBSW programmes. The majority of SBSW prerequisite technologies are dual use. They are not related to dedicated SBSW programmes, but are sought through other civil, commercial or military space programmes. While there is no evidence to suggest that states pursuing these enabling technologies intend to use them for SBSW systems, their development does bring these actors technologically closer to such a capability. Both the number of such technologies being pursued in non-SBSW programmes and the number of actors doing so are increasing: 32 states have developed or are developing independent high-precision satellite navigation capabilities. Since 1994, nine states have deployed a first small or micro-satellite—a key SBI precursor technology. China and the European Union are developing re-entry technologies that are also required for the delivery of mass-to-target weapons from space to Earth.

In 2005, Europe, China, the Russian Federation and the United States maintained research and development on re-entry technologies relevant to potential orbital bombardment systems. Upgrades were made in 2005 to the Russian and US global missile tracking and warning systems—foundational technologies for any future space-based missile interceptor. While lagging far behind the Russian Federation and the United States on missile tracking, China conducted basic research on how to obtain greater missile-tracking precision and real-time accuracy. China, the European Union, India, the Russian Federation and the United States continued research and development on global positioning systems, a precursor technology of use in certain SBSW systems.

## Note

1 This article is based on a longer study of space security entitled "Space Security 2006"; the full report can be accessed at <www.spacesecurity.org/SSI2006.pdf>. The members of the Spacesecurity.org research consortium include the Cypress Fund for Peace and Security, the Institute of Air and Space Law at McGill University, the International Security Research and Outreach Programme of Foreign Affairs and International Trade Canada, Project Ploughshares, the Simons Centre for Disarmament and Non-Proliferation Research at the University of British Colombia and the Space Generation Foundation.

## CHAPTER 10

# LEVERAGING THE EXISTING UN SPACE MACHINERY FOR SUSTAINABLE AND SECURE ACCESS TO OUTER SPACE[1]

Gérard Brachet

## BACKGROUND

The Committee on the Peaceful Uses of Outer Space (COPUOS), established by the United Nations General Assembly in 1959, gathers 67 member states and addresses the applications of outer space such as scientific research, exploration, monitoring of the health of our planet, communications and navigation. Its terms of reference include promotion of international cooperation and developing an adequate legal framework for the use of outer space, a mandate that has been fulfilled by the development of the Outer Space Treaty of 1967. As the main pillar of international law regarding outer space activities, this treaty was supplemented by five additional treaties produced by COPUOS and transmitted for approval to the General Assembly before their signature and ratification by most major space-faring nations (except for the 1979 Agreement on Governing Activities):

- 1967: Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty; 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 (Astronaut Rescue Agreement; entered into force the same year);
- 1972: Convention on International Liability for Damage Caused by Space Objects (Liability Convention; entered into force the same year);

- 1975: Convention on Registration of Objects Launched into Outer Space (Registration Convention; entered into force in 1976); and
- 1979: Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement; entered into force in 1984, but signed and ratified by only 11 countries).

In addition to these international treaties, COPUOS addressed other issues over the years, which led to the development of "declarations" or "resolutions" that were submitted for approval by the General Assembly, seeking whenever possible unanimous approval. These documents do not carry the same legal weight as international treaties, but do carry political weight as they seek to encourage a practice resulting from an in-depth collaboration within member states of COPUOS:

- 1963: Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space;
- 1982: Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting;
- 1986: Principles Relating to Remote Sensing of the Earth from Outer Space;
- 1992: Principles Relevant to the Use of Nuclear Power Sources in Outer Space; and
- 1996: 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.

An interesting feature to be noted about these documents is that they attempt to address whenever possible both civilian and non-civilian activities in outer space, even though they sometimes had to be restricted to non-military activities. This was the case, for example, of the 1986 principles relating to remote sensing of the Earth (General Assembly resolution 41/65), which for obvious reasons did not attempt to address military reconnaissance satellites.

From a personal perspective, I remember well the time when COPUOS and its Legal Sub-Committee were debating the issue in 1984–1986, and it is remarkable that COPUOS was able to produce a document that satisfied space-faring nations as well as developing nations even though it addressed the rather sensitive issue of collecting information from outer space on other nations' territories and environment. Of course, image resolution achieved by remote sensing satellites was more modest in the 1980s than it is in 2006, but it is striking that the set of principles set in this resolution has survived quite well the test of time and of rapidly evolving technologies.

## THE FADING DISTINCTION BETWEEN CIVILIAN AND MILITARY

Now, the experience of the last 20 years has shown how much the distinction between civilian and military space systems is artificial, with many "civilian" satellites having demonstrated their dual use such as communication satellites or surveying satellites (for example, the SPOT series of satellites, and now the Ikonos, Quickbird and Orbview, among others). Conversely, military satellite systems, such as the US global positioning system, are widely used for civilian commercial applications, further blurring the historical border between so called "military" satellites and "civilian" ones.

Thus, developing the architecture for future space security is not something that should remain in the realm of the defence and security community, but has to involve all players and particularly those involved in civilian and commercial uses of outer space.

COPUOS does not address the military uses of outer space or the prevention of weapons deployment in space, but member states' delegations to COPUOS understand the importance of these issues as they may impact the future security of all activities in outer space. Some COPUOS delegations repeatedly stress the need to develop an international treaty banning the deployment of weapons in outer space. However, all nations involved in COPUOS are concerned with the damage already done to the outer space environment (space debris) over almost 50 years of space exploitation and to the potentially much larger damage that could result from offensive activities taking place in outer space. The proliferation of space debris has become a matter of concern to all players, whether government or private operators. As of 2006, there are about 13,000 objects larger than 10cm in low-Earth orbit, and objects larger than 1m in geosynchronous orbit are tracked, with a little more than 9,000 of them identified; of these, only 6% are satellites in operation and 40% are satellites that are no longer functional or are launcher upper stages! The rest, that is 54%, consists of fragments (41%) and other objects associated with spacecraft operations (13%). In addition, it is estimated that there are more than 100,000 debris between 1cm and 10cm that are too small to be tracked routinely by present space surveillance systems.

Since the 1980s, the Inter-Agency Space Debris Coordination Committee (IADC) has been the principal focus for the exchange of information on debris issues at the international level. It has developed a set of mitigation guidelines that were finalized and officially approved by IADC member agencies in October 2002.[2] These IADC guidelines form the basis for the draft COPUOS space debris mitigation guidelines proposed by the COPUOS Scientific and Technical Sub-Committee in February 2005.[3] I note here that the proposed guidelines address the issue of space debris that would be caused by potential anti-satellite activities in a rather indirect manner: Guideline 4 states that "the intentional destruction and other harmful activities which would lead to the creation of long-lived debris should be avoided".

According to the work plan established by COPUOS, these guidelines will be officially submitted to its member states before the next meeting of the Scientific and Technical Sub-Committee in February 2007, and if approved at the COPUOS plenary session in June 2007, will become part of a resolution submitted to the General Assembly in late 2007.

The excellent quality of the work done since 2003 by the Space Debris Mitigation Guidelines working group of the COPUOS Scientific and Technical Sub-Committee is a good illustration of a shared awareness by all states concerned that the future secure exploitation of space is not guaranteed, particularly in low-Earth orbit. This bodes well for further discussions on establishing the basis for an "Architecture for Sustainable Space Security".

## HOW COPUOS COULD CONTRIBUTE TO THE DEVELOPMENT OF THIS ARCHITECTURE

COPUOS gathers 67 member states and more than 30 "observer" organizations—UN agencies, international government organizations such as the European Space Agency and non-governmental organizations (NGOs)—which are all dedicated to improving the international framework for the peaceful uses of outer space, either by developing new legal conventions or principles or by facilitating international cooperation and capacity building in the development and exploitation of the space system.

It is, therefore, an ideal forum for information exchange on the potential threats to the secure use of outer space; not only threats resulting from the space debris problem, but also any other threat that might impact the freedom of access to space and exploitation of space infrastructure.

Thus, the first contribution that COPUOS can bring to building this architecture for sustainable space security is clearly to raise awareness among its member states and its community of observers.

Second, COPUOS can build on its experience with the discussion about space debris mitigation within its Scientific and Technical Sub-Committee. Beyond the guidelines that the sub-committee has developed, it is clear that more will need to be done to guarantee safe operations in outer space, perhaps some kind of "rules of the road" similar to those that were developed over many decades for high seas shipping and civil aviation. The International Academy of Astronautics Commission for Space Policy, Law and Economics has produced a study on the theme of "space traffic management", which considers this issue and proposes some preliminary recommendations. The study report will be officially presented in June 2006 at the COPUOS plenary meeting. Additional, and potentially very useful, experience will result from the process of the working group on nuclear power sources in space, which held a very enlightening workshop on safety aspects of such power sources during the Scientific and Technical Sub-Committee meeting in February 2006.

Third, COPUOS can contribute to confidence building via its current work on the application of the Registration Convention of 1975. It has appeared over the years that the implementation of the Registration Convention has not been done in a systematic and standardized fashion across states, even by those who have ratified the convention. This led COPUOS to establish in 2004 a working group on registration, reporting to the Legal Sub-Committee, whose work plan should lead to a set of recommendations in 2007. These would tend to harmonize states' practices and hopefully resolve the problem of the many commercial spacecraft that are launched but not registered.

Fourth, COPUOS can contribute to building an architecture for space security by promoting an open communication on such issues with the Conference on Disarmament (CD). It appears that this communication has not really existed so far, which may be due to the history and background of each organization. Now, and this conference is an excellent illustration, the debate on the prevention of an arms race in outer space (PAROS) issue at the CD has gone beyond the specific question of preventing an arms race in space; and COPUOS is obviously very much concerned by anything related to the secure use of outer space in the future. They both address the same issue, but from different angles, and while it would be unrealistic to modify their terms of reference, much could be gained by a more active exchange of information between the two organizations.

This conference is an excellent step in this direction. As incoming chair of COPUOS for the period from mid-2006 to mid-2008, I am committed to facilitating and encouraging such communication.

Thank you to the United Nations Institute for Disarmament Research and to the sponsors of this conference on “Building the Architecture for Sustainable Space Security” for inviting me to present my views.

## Notes

1. The views expressed here are the personal views of the author and do not necessarily reflect the views of the UN COPUOS or of the UN Secretariat.
2. IADC-02-01 IADC Space Debris Mitigation Guidelines, 15 October 2002.
3. Document A/AC.105/C.1/L.284.

## CHAPTER 11

# THE OUTER SPACE TREATY AND ENHANCING SPACE SECURITY

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The specific question that this paper was invited to address is "What progress could be made at a possible OST RevCon and how should a possible RevCon unfold?"[1] The answer to the question as framed is, with serious trepidation and extreme caution. However, the question contains the assumption that a revision conference for the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty)[2] ought to occur. The response to that assumption is, at this point in time, to leave the Outer Space Treaty alone. Regardless of how compelling or meritorious the reason for revising the Outer Space Treaty may appear to be, the fact is there is much more to lose than there is to gain. This paper begins with an overview of the Outer Space Treaty, a brief discussion of its provisions and its likely status during a revision conference. It then raises the hard questions that must be addressed in a discussion about potentially revising the treaty. A conclusion follows.

The Outer Space Treaty is, beyond any question, one of the most successful multilateral, international treaties ever promulgated.[3] It has been accepted by a large majority of the world's nation-states, including all of the world's space-capable states.[4] Nearly 40 years after it entered into force in 1967, the Outer Space Treaty still continues to garner signatories. As newly active and recently advancing space nations continue to emerge, they are also choosing to become treaty signatories.[5] "It is also generally agreed by legal scholars and governments that the earlier Declaration of Legal Principles (which were incorporated into the Outer Space Treaty) expresses general customary law, binding on all states."[6] Moreover, treaties that "provide for neutralisation or demilitarisation of a territory or area, such as

… outer space" "have been held to create a status or regime valid *erga omnes* (for all the world)".[7]

The Outer Space Treaty is quasi-constitutional, which means it functions like a constitution for space. "It is a quasi constitution, not only a culmination but also an initiation."[8] The principles it contains are the foundation of the Convention on International Liability for Damage Caused by Space Objects (Liability Convention),[9] the Convention on Registration of Objects Launched into Outer Space (Registration Convention)[10] and the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (Astronaut Rescue Agreement).[11] Because the Outer Space Treaty functions like a constitution, opening it for revision means that all of its provisions will be vulnerable to change. These provisions include some of the most important and fundamental principles in international space law. They include that the exploration and use of space is to be for the benefit and interests of all countries;[12] space is the "province of all mankind";[13] all states are free to explore, use and scientifically investigate space;[14] state appropriation of space is prohibited;[15] nuclear weapons and weapons of mass destruction are prohibited;[16] military bases, installations, fortifications, weapons testing and military manoeuvres are "forbidden" on the Moon and other celestial bodies;[17] states are responsible for all space activities undertaken by national and non-governmental entities;[18] and states can be held liable for damage caused by their space objects.[19] All of these would be at risk in a revision conference.

It has been argued that "revision" is a narrow approach that can be contained and controlled; and that it is unnecessary to assume revision can or will lead to an amendment process, which, according to this view, is a broader approach that can be avoided. This view fails to take into account that the Outer Space Treaty, unlike the Liability Convention and the Registration Convention, which do provide for revision,[20] provides only for amendment.[21] More importantly, to speak of "revision" rather than "amendment" is increasingly a distinction without a difference in international law. The International Law Commission, when considering the question of whether or not there is a difference between the two, "saw no essential *legal* difference in the processes of amendment and review, regarding amendment as including review".[22] Without a clear legal demarcation between "amendment" and "review", the true force that will be at play in an Outer Space Treaty revision conference is politics. A politically motivated revision process will guarantee no guarantees. All treaty provisions will be susceptible to change or elimination.

Interest groups are another force that will be activated in a treaty revision process. Some interest groups are seeking to change the Outer Space Treaty for their own reasons, including clarifying and establishing property rights in space.[23] If the Outer Space Treaty were opened for any reason, these groups would welcome the opportunity to introduce their own purposes into the process and would bring political pressure to open it up. Another force that will work to expand a revision conference is those nation-states in the current geopolitical environment that advocate eliminating all of the space treaties and beginning anew with one, single, comprehensive agreement.[24]

In addition to interest groups and nations that advocate a new, single space agreement, another indicator that an Outer Space Treaty revision process will inevitably expand to the entire space treaty regime is the treaty drafters' intention that the space treaties be interrelated.[25] "The Outer Space Treaty … provides a framework for a number of limited accords between individual countries and intergovernmental organizations as well as [the] subsequent [space] treaties."[26] The Astronaut Rescue Agreement is specifically based on Article V[27] of the Outer Space Treaty, the Liability Convention is based on Article VII[28] and the Registration Convention is based on Article VIII.[29] Together, these treaties create an interrelated legal framework that creates a legal whole that is greater than the sum of its parts—a rare condition in international law.

> The type of interrelation that exists among these treaties is unusual in international law, except in the case of the United Nations Charter and the Statute of the International Court of Justice, both of which are incorporated by reference into the Outer Space Treaty.[30]

Opening the underlying provisions of the Outer Space Treaty upon which the latter treaties are based will, of necessity, bring their status into question as well.

A critical aspect of the Outer Space Treaty that must to be raised in any discussion about its potential revision is the treaty's status in international law in the event of the outbreak of hostilities or armed conflict.[31] Today the status of the Outer Space Treaty during hostilities is crystal clear: it remains in force and its provisions are available during conflict. However, if hostilities were to begin while a review process was in progress, the treaty's status would be unclear.

The Outer Space Treaty is a law-making treaty[32] and is, therefore, a member of a very special category of treaties that remain in force and which do not terminate with the outbreak of hostilities.[33] It is a treaty "among a multitude of states that establish[es] a rule or system of rules that govern the conduct of states in a particular area of international law".[34] Moreover, it is "one of the outstanding lawmaking treaties of contemporary international law as a whole".[35] Nor will the Outer Space Treaty suspend during conflict. The twentieth century trend—which is continuing into the twenty-first century—is the growing presumption that treaties do not suspend with the commencement of hostilities. "The outbreak of armed conflict does not *ipso facto* terminate or suspend the operations of treaties in force."[36] Furthermore, in the case of the Outer Space Treaty, practice is consistent with jurisprudence. The Outer Space Treaty remained in force during both the 1991 Gulf War and the 2003 Gulf War. The former is widely recognized as the "first space war" and the latter as the "second space war"[37] having used various space-based assets for the first and second time in a conflict. However, if hostilities were to begin while a review process was in progress, the treaty's law-making status and the availability of its provisions specifically relevant to hostilities, including limiting military activity to scientific and peaceful purposes, the ban on nuclear weapons and weapons of mass destruction, and the right to remain free from interference while using space would also be unclear.

The non-interference principle in international space law and the neutrality principle in the law of war are, in essence, the same. Both of the principles are concerned with protecting peaceful activities in an area or region used by non-belligerents. In the Outer Space Treaty, states are afforded non-discriminatory access to, and non-interference with, their use of space.[38] Under the neutrality principle, states that are not part of a conflict can assert their right to remain neutral and not to be interfered with by the belligerents.[39] If hostilities were to start during a review process the treaty's guarantee against non-interference with the use of space would be placed in doubt.

This paper was also invited to address the question of how to best leverage the Outer Space Treaty to enhance space security. The response to that question is to not just focus on what the treaty does not provide, but also to appreciate how much it does provide. A discussion on how to best leverage the Outer Space Treaty to enhance space security must include asking hard questions. They begin with: Would the provisions that the Outer Space Treaty contains be achievable today?

Specifically, would there be agreement on banning nuclear weapons and weapons of mass destruction? Current events include rapidly developing situations in the constantly shifting geopolitical landscape that provide evidence that the nuclear regime is under stress. Developed and developing nations are realigning regarding what are considered permissible nuclear activities.[40] Ostensibly controlled nuclear access is now emerging in tandem with non-proliferation. The long-standing dichotomy between nuclear capable/developed nations and the non-nuclear capable/developing nations is shifting, as is the dichotomy between developed nation/spacefarer and developing nation/non-spacefarer.[41] Nuclear and space activities are being rearranged. In light of the changes in the terrestrial nuclear regime, it is not at all clear that the Outer Space Treaty's nuclear weapons ban in space would survive a revision conference.

Would there be agreement today on limiting military activity in space to peaceful or scientific purposes? The nature and role of military entities since the end of the Cold War have been undergoing questioning and changes all around the world. Recognizing and defining what constitutes "peaceful" or "scientific" activities will continue to test the limits of the Outer Space Treaty, but it will not expand the categories of permitted military actions. Revising the treaty can.

Is there a clear, present and credible threat that justifies the disruption that will inevitably occur by attempting to revise the Outer Space Treaty? In the 1960s, the nations of the world were brought to the negotiating table because both the former Soviet Union and the United States had successfully and pragmatically proven that they had existing and substantial launch and weapons capabilities. Existing rockets could have been either transportation vehicles for scientific experiments or weapons delivery systems. Existing payloads could have been scientific instruments or weapons. Does the current geopolitical landscape provide an analogous situation today? Are there any nations that now have *both* an independent, robust, long-term launch capability and proven advanced space weaponry that create a situation dire enough to risk the stability that the Outer Space Treaty provides?

Assuming, only for the sake of argument, that there is an existing space threat analogous to the former Soviet Union–United States Cold War capabilities: will it last as long as the time required to negotiate revised or amended treaty terms? The United Nations was first asked to consider the legal issues associated with space activities in 1958.[42] The Outer Space Treaty entered into force in 1967.[43] Even with the extreme pressures of the Cold War, it took nearly a decade to complete and activate the Outer Space Treaty. Nine years is definitely fast in terms of international treaty negotiations, however, the more significant fact is that at that time, space technology development was still in its early stages and less likely to outpace the speed of negotiations. Today, the intense, focused, urgent pressures of the Cold War have given way to a diverse, multipolar array of forces and space technology has advanced. Today, the likelihood is that discussions would be less focused and more wide ranging; and once opened, attempted revisions could lead to decades of debate and negotiations. At the same time, the ability to implement already developing technologies could outpace negotiations.

Also to be considered is that the original perceived threat that catalyses a revision conference could be readily overcome by more dynamic economic and political events including cyclical elections, changes of administration, changing foreign policies and national fiscal and budgetary constraints. Moreover, the original threat could be supplanted by a new, unforeseen one that might not have been activated but for the opportunity presented by the ongoing negotiations and the uncertain status of the treaty during that time. This leads to the next hard question.

What behaviour, practice or custom will develop to fill the legal ambiguity created during the revision process? Once revision begins and various political forces enter the process, the status of the Outer Space Treaty and specific provisions will be unclear for the duration of the process. Ambiguity regarding signatories' obligations will increase and some will be emboldened to take action to resolve the increased ambiguity in their favour. This is exactly what happened at the dawn of the space age. The legality of satellite overflight was not established at the time that the former Soviet Union and the United States embarked on their race to space.[44] With the successful launch of Sputnik I and lack of objection by the United

States, the precedent for satellite overflight without seeking sovereign consent was quickly set in a matter of days.[45] A variation on the theme of the role of ambiguity during a revision process is that there will be some nations that will have no incentive to resolve new ambiguities that, in their view, replace settled but inconvenient treaty obligations.

Finally, no treaty revision occurs in a legal vacuum. It must occur within the framework of the entire prevailing legal system, related agreements and general principles of law. This presents an infinite number of paths that a treaty revision conference can be made to take, increasing the likelihood of delay and uncertainty to an unquantifiable degree. Unquantifiable uncertainty ought to be risked only for the most menacing and most immediate of threats.

Taking a long look backward at the history of humanity, it becomes quickly evident that it is folly to say that anything should never change, even the Outer Space Treaty. However, for the foreseeable future, the Outer Space Treaty should be left alone. Opening it for revision now is a case of "be careful what you wish for".

## Notes

1 Building the Architecture for Sustainable Space Security, conference agenda, Council Chamber, Palais des Nations, Geneva, 30–31 March 2006 (on file with the author).

2 Outer Space Treaty, 27 January 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 (hereinafter Outer Space Treaty).

3 Sergio Marchisio, 2005, The Evolutionary Stages of the Legal Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), *Journal of Space Law*, vol. 31, pp. 219–226.

4 There are 192 Member States of the United Nations; as of 1 January 2006, 125 have accepted the Outer Space Treaty (98 ratifications and 27 signatories), a 65% majority. United Nations, *List of Member States*, at <www.un.org/Overview/unmember.html>, last accessed on 5 May 2006. See also *UN Treaties and Principles on Outer Space Addendum*, 2005, at 1–17, UN Doc. ST/Space/11/Add.1/Rev.2, UN Sales No. E.02.I.20 (hereinafter Outer Space Addendum), at

<www.unoosa.org/oosa/en/SpaceLaw/treatystatus/index.html>, last accessed on 1 May 2006.

5 For example, Nigeria ratified the Outer Space Treaty due to the successful launch of its first satellite, NigeriaSat 1, on 27 September 2003. See Outer Space Addendum, op. cit.

6 Lori F. Damrosch et al., 2001, *International Law Cases and Materials*, Fourth edition, Rule 15.1 and 15.4, American Casebook Series, Eagan, MN, Thomson West.

7 Antony Aust, 2000, *Modern Treaty Law and Practice*, Cambridge, Cambridge University Press, pp. 208–209, citing M. Raggazzi, 1997, *The Concept of International Obligations Erga Omnes*, pp. 24–27.

8 George S. Robinson and Harold M. White, Jr., 1986, *Envoys of Mankind: a Declaration of First Principles for the Governance of Space Societies*, Washington, DC, Smithsonian Institution Press, p. 181.

9 Convention on International Liability for Damage Caused by Space Objects, 29 March 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 (hereinafter Liability Convention).

10 Convention on Registration of Objects Launched Into Outer Space, 14 January 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 (hereinafter Registration Convention).

11 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched Into Outer Space, 22 April 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119 (hereinafter Rescue and Return Agreement).

12 Outer Space Treaty, op. cit., Article I.

13 Ibid.

14 Ibid.

15 Ibid., Article II.

16 Ibid., Article IV.

17 Ibid.

18 Ibid., Article VI.

19 Ibid., Article VII.

20 Liability Convention, op. cit., Article XXVI; Registration Convention, op. cit., Article X.

21 Outer Space Treaty, op cit., Article XV.

22 Antony Aust, op. cit., p. 220 (emphasis in original).

23 Robert A. Fabian, 2003, Space Economic Development in the Province of All Mankind: If No One Goes, We All Lose, *Astropolitics*, vol. 1, pp. 89–98. Here, the Outer Space Treaty is characterized as

"the current legal obstacle to any effort to develop space resources like asteroids or solar power." Ibid.

24 Joanne Irene Gabrynowicz, *Space Law: Its Cold War Origins and Challenges in the Era of Globalization*, 2004, Boston, Suffolk University Law Review, pp. 1041–1053.

25 Walter A. McDougall, 1985, *The Heavens and the Earth, a Political History of the Space Age*, New York, Basic Books, Inc., p. 431.

26 Robinson and White, op. cit., pp. 181–182. The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement) also relates back to the Outer Space Treaty. However, the Moon Agreement relates back to the Outer Space Treaty as a whole, without reference to a specific article.

27 Outer Space Treaty, op. cit., Article V: States' Parties to the Treaty shall regard astronauts as envoys of mankind in outer space and shall render to them all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas. When astronauts make such a landing, they shall be safely and promptly returned to the State of registry of their space vehicle. In carrying on activities in outer space and on celestial bodies, the astronauts of one State Party shall render all possible assistance to the astronauts of other States' Parties. States Parties' to the Treaty shall immediately inform the other States' Parties to the Treaty or the Secretary-General of the United Nations of any phenomena they discover in outer space, including the Moon and other celestial bodies, which could constitute a danger to the life or health of astronauts.

28 Ibid., Article VII: Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the Moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies.

29 Ibid., Article VIII: A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. Such objects or component parts found beyond the limits of the State

Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

30 Robinson and White, op. cit., p. 182.

31 Much of the research for this particular topic was done by LaToya Tate, a third year law student at the University of Mississippi School of Law and a researcher at the National Remote Sensing and Space Law Center. The subject is examined in depth in her paper, see LaToya Tate, 2006, The Status of the Outer Space Treaty at International Law During "War" and "Those Measures Short of War", *Journal of Space Law*, vol. 32.

32 Marchisio, op. cit., p. 226.

33 Lord McNair, 1961, *The Law of Treaties*, Oxford, Clarendon Press, p. 723. See also L. Oppenheim and H. Lauterpacht, 1952, *International Law a Treatise*, Seventh edition, London, Longmans, Green and Co Ltd, p. 304; J. Delbruck, 1982, War, Effect on Treaties, in: R. Bernhardt (ed.), *Encyclopedia of Public International Law*, Amsterdam and New York, Max Planck Institute for Comparative Public Law and International Law, p. 310–312; US Supreme Court, *Society for the Propagation of the Gospel in Foreign Parts v. New Haven*, 21 U.S. 464, 8 Wheat. 464 (1823), Washington, DC.

34 McNair, op. cit., p. 723.

35 Marchisio, op. cit., p. 226.

36 Institut de Droit International, *The Effects of Armed Conflicts on Treaties*, Articles 2 and 5, 28 August 1985, at <www.idi-iil.org/idiE/navig_chon1983.html>.

37 The Second Space War, *Space News*, 31 March 2003, at <www.space.com/spacenews/archive03/editarch_033103.html>.

38 Outer Space Treaty, op. cit., Articles I, IX and XII.

39 Leslie C. Green, 1993, *The Contemporary Law of Armed Conflict*, Manchester, Manchester University Press, p. 259.

40 *US and India Seal Nuclear Accord*, BBC News, 2 March 2006, at <news.bbc.co.uk/1/hi/world/south_asia/4764826.stm>; *Australia, China Sign Nuclear Deal*, News.com.aun, 3 April 2006, at <finance.news.com.au/story/0,10166,18692623-31037,00.html>; *Security Council, in Presidential Statement, Underlines Importance of Iran's Re-establishing Full, Sustained Suspension of Uranium-Enrichment Activities; Calls on Iran to Take Steps Required by IAEA Board of Governors*; *Requests Report from IAEA Director General in*

30 *Days*, Press release, UN Doc. SC/8679, 29 March 2006, at <www.un.org/News/Press/docs/2006/sc8679.doc.htm>.

41 Joanne Irene Gabrynowicz, *Comments on the Discussion Paper, Space Law and Remote Sensing Activities*, Workshop on Space Law Disseminating and Developing International and National Space Law: the Latin America and Caribbean Perspective, United Nations Office of Outer Space Affairs (UNOOSA), Rio de Janeiro, 22–25 November 2004, UN Doc. ST/SPACE/28, at <www.unoosa.org/oosa/en/SpaceLaw/workshops/index.html>.

42 McDougall, op. cit., p. 184.

43 The Outer Space Treaty opened for signature on 27 January 1967 and entered into force on 10 October 1967. See United Nations Office of Outer Space Affairs, *United Nations Treaties and Principles on Space Law*, at <www.unoosa.org/oosa/en/SpaceLaw/treaties.html>.

44 McDougall, op. cit., pp. 119–120.

45 Ibid., pp. 134, 187.

## CHAPTER 12

# THE POTENTIAL FOR OUTER SPACE CONFIDENCE-BUILDING MEASURES[1]

Phillip J. Baines

## INTRODUCTION

If there is a single phrase that could sum up the arms control phenomena of the Cold War it would be the "trust, but verify" dictum of former US President Ronald Regan. The shared aim of the two superpowers was to minimize the risk of a runaway crisis leading to the exchange of nuclear weapons through the promotion of strategic stability. Formal arms limitation agreements were seen as the preferred vehicle to achieve and maintain the required parity, although many of these achievements were predated by a number of bilateral confidence-building measures. The Hotline Agreement arising from the Cuban Missile Crisis of 1962 marks the beginning of these efforts. Looking back, it seems as though the habituated superpowers were able to concentrate on the latter portion of the "trust, but verify" dictum.

The security environment in 2006 is considerably different from that of the Cold War era. The current threat matrix contains not only numerous state actors in possession of nuclear and conventional arsenals, but also non-state actors based in failed and failing states. Front lines do not exist anymore as terrorists operate domestically and from offshore havens. Some of these many threats are not amenable to either deterrence or diplomacy strategies. The response to these new threats has spawned new forward defence and dissuasion strategies. With an increasingly uncertain threat matrix facing all states, the negotiation of formal arms control agreements now seems to have become a harder prospect than it was during the Cold War era. Looking forward, the international community might decide to first pursue confidence-building measures to concentrate on the first half of the "trust, but verify" dictum as was also done during the Cold War.

Recall now that a threat can be defined as the product of intent times capability. A threat is low if either the intent or capability or both can be assessed to be low. A non-proliferation, arms control or disarmament approach to security seeks to eliminate, reduce, cap or prevent the deployment of new capabilities via negotiated agreements. It is well recognized that a threat takes on a minimum value by the verified absence of a capability within a universal legally binding agreement.[2]

A confidence-building approach to security, however, can also reduce a threat by seeking to minimize the intent variable in the aforementioned threat definition. A confidence-building measure approach is particularly well suited to situations where it is impossible to negotiate the elimination, reduction, cap or prohibition of certain capabilities, or when the existence of ubiquitous dual-use capabilities must be mitigated by operational practice. A prime example of such a confidence-building measure would be the Incidents at Sea Agreement between the former Soviet Union and the United States, especially given the paucity of arms control agreements that limit surface vessels on the high seas. Confidence building is, therefore, usually understood to be:

> A security management approach employing purposefully designed, distinctly *cooperative* measures intended to help clarify participating states' military intentions, to reduce uncertainties about their potentially threatening military activities, and to constrain their opportunities for surprise attack or the coercive use of military force.[3]

Transparency and engagement become the primary means of confidence-building measures to establish trust between nations.

Typical confidence-building measures possess declaratory, consultative and operational attributes such as inspection opportunities to validate that observed actions do in fact accord with prior declarations. More importantly, confidence-building measures seem to arise when fundamental or transformative shifts occur in the way that leaders, bureaucracies and the public think about dangerous neighbours and the threats that they might pose. The Conventional Forces in Europe Treaty and the Open Skies Treaty are excellent models of regionally agreed, conventional armament confidence-building measures undertaken at a time of great transformation. Fashioning outer space as a transformative agent might help to establish sufficient trust between the nations of the

Earth to subsequently attain space security, commonly understood as "secure and sustainable access to space and freedom from space-based threats".

The Conference on Disarmament had also previously examined confidence-building measures for outer space. The United Nations Institute for Disarmament Research (UNIDIR) summarized related work of the Ad Hoc Committee on the Prevention of an Arms Race in Outer Space in a 1991 report.[4] To many, the re-worked proposals presented in this effort will reverberate with some of the better-known proposals from that period of study. In 2006, three revamped proposals, in particular, could merit action by a coalition of willing stakeholders. These initiatives have been coined the rescue agreement reprise, the pre-launch notification of rockets and a space traffic management system.

## RESCUE AGREEMENT REPRISE

Outer space is a hostile environment for humans of its own accord. The possible future presence of weapons based in outer space would make it doubly so and yet humanity has tenaciously established a permanent presence in outer space with the International Space Station. Bold new visions for national space programmes are beginning to call for a return to the Moon and onward to Mars.

One of the first confidence-building measures to be developed after the conclusion of the Outer Space Treaty of 1967 was the Rescue Agreement. Article II of the Rescue Agreement calls on all contracting parties to "immediately take all possible steps to render assistance to rescue them [personnel of a spacecraft] and render them all necessary assistance" should a spacecraft land in the territory under the jurisdiction of a contracting party. The scope of this treaty seems to be limited to the activities of contracting parties on the Earth, given the apparent lack of detailed coordination procedures that would be needed for contracting parties to mount rescue missions in outer space. Nevertheless, "prompted by sentiments of humanity", the necessity of mounting rescue missions in outer space might lead to an agreed understanding between those capable of doing so as several nations reach out to the Moon and beyond.

Recent accidents in outer space, such as the Columbia shuttle's re-entry in 2003 and the MIR–Progress incidents before it, remind us of the need to protect our space-bound emissaries from unwarranted risks. And yet, it is not as if we had not been forewarned of this need when we recall the drama of the Apollo 13 mission in 1970. Subsequent to that successful rescue effort by the United States using the lunar module and the command module of the Apollo mission as a lifeboat to save three brave astronauts, and further capitalizing on the opportunity of the "détente" environment for the two superpowers of the day, the Soviet Union and the United States embarked on the Apollo–Soyuz Test Project flight in 1975. This cooperative space project exchanged data, designs, procedures and training to subsequently enable the American and Soviet spacecraft to rendezvous and dock in orbit. According to a current National Aeronautics and Space Administration (NASA) web site:

> … the Apollo Soyuz was the first international manned spaceflight. It was designed to test the compatibility of rendezvous and docking systems for American and Soviet spacecraft, to open the way for international space rescue as well as future joint manned flights.[5]

Russian and American spacecraft now routinely dock with the International Space Station. Future European and Japanese human-rated spacecraft will be capable of this same function. In 2003, China demonstrated human spaceflight capabilities with the successful flight of its first taikonaut. China has, thus, become the third country after the Soviet Union and the United States to demonstrate such technological prowess. Future Chinese space missions will further demonstrate indigenous rendezvous and docking technologies, first as unmanned test flights and then as manned spaceflights. China is not, however, currently a member of the International Space Station project.

The congruence of factors such as three nations now possessing human-rated spaceflight capabilities, other aspirants soon being able to duplicate these achievements and the marginal utility of human spaceflight in supporting military operations on the Earth all tend to support making manned spacecraft capable of docking with one another as a sound contingency plan to enable future space rescue attempts. Indeed, submariners of the North Atlantic Treaty Organisation member states and of the Russian Federation are accorded a similar vow pursuant to an agreement signed in 2003 for submarine rescues. If we are to be "prompted by sentiments of humanity" as was the Rescue Agreement, should not our astronauts, cosmonauts and taikonauts deserve the same professional consideration afforded our submariners? A first potential confidence-building measure for outer space would, therefore, appear to be a voluntary offer to provide search, rescue and assistance activities in outer space, on the Moon and on other celestial bodies by those states that are in a position to do so.

## PRE-LAUNCH NOTIFICATION OF ROCKETS

Current medium-, intermediate- and intercontinental-range ballistic missiles can reach into outer space, while space launch vehicles can place artificial satellites in orbit, on the Moon and on other celestial bodies. Two Pioneer satellites are also about to leave the solar system for the vastness of the interstellar medium. While it is easy to imagine that outer space is a really big place, in fact outer space is becoming very crowded near our home world. Pre-launch notification confidence-building measures can, thus, help to ensure the safety of space missions in terms of both life and property as more and more human activity takes place in outer space.

A renewed call for a universal pre-launch notification confidence-building measure would not be without some degree of precedence. A bilateral agreement between the former Soviet Union and the United States requires each of these state parties to provide the other party with notification no less than 24 hours in advance of the planned date, launch area and area of impact for any launch of a strategic ballistic missile: an intercontinental ballistic missile or a submarine-launched ballistic missile.[6] India and Pakistan announced in the Lahore Declaration of 1999 that they would provide each other with pre-launch notifications for their ballistic missiles. On 16 December 2000, the Russian Federation and the United States signed a Memorandum of Understanding on Notifications of Missile Launches that extended the scope of the former bilateral agreement to include launches of all ballistic missiles and space launch vehicles and to provide both pre-launch and post-launch notifications. The Hague Code of Conduct on ballistic missiles was opened for subscription in November 2002. States subscribing to the code all agree to exercise restraint on ballistic missile holdings and transfers, to circulate annual declarations and to issue pre-launch notifications of missile and space launch vehicle flights. Over 117 nations have agreed to subscribe to the code. More states are encouraged to join this multinational voluntary confidence-building measure.

Subscription to a confidence-building measure, such as the Hague Code of Conduct, provides transparency into both military holdings and the intentions of states possessing ballistic missile and space launch vehicles. The pre-launch notification regime specifically helps states to assess the capabilities and the intentions of their neighbours. National technical means of information collection can also help validate these declarations with observations of actual activities to provide some objective measure of the intentions of the rocket possessing states. As such, the Hague Code of Conduct helps to constrain arms races caused by a lack of information. Intelligence gaps during the early Cold War era, first with strategic bombers and then with intercontinental ballistic missiles, contributed much to the numerical and cost excesses of the Cold War arms race between the former Soviet Union and the United States.

In addition to the regular Notice to Airman and to Mariners for the safety of air and marine traffic under existing international conventions, rocket pre-launch notifications can assist domestic public safety organizations planning and executing space object debris emergency preparedness plans for those launches that are expected to pass overhead. Greater transparency into the type and quantity of hazardous materials on board of rockets, their expected flight trajectories inclusive of staging drop zones and the precise timing of the launches will all aid in the protection of persons and property. Fragile environments, such as Canada's high Arctic, can also benefit from specialized environmental remedial procedures in the event of a space object debris event.

Confidence-building measures could also put into practice a 3D process to better build trust between nations possessing rockets and their neighbours. A 3D process would consist of three steps: "declare what you will do", "do what you have declared" and "demonstrate that you did what you had declared". A 3D pre-launch notification confidence-building measure, for example, could first require a pre-launch notification obligation of a subscribing state. A subscribing state would then perform the launch of the ballistic missile or the space launch vehicle as it had previously notified. Subsequent to the actual launch event, the subscribing state could then demonstrate its compliance to the other subscribing states using data collected by a cooperative monitoring system established by all of the subscribing states. Over time, these statistics would produce estimates of both the intent and capabilities of the state possessing ballistic missiles and space launch vehicles. This novel proposal to implement a cooperative monitoring system for rocket launches and placing the onus of compliance demonstration on the subscribing state could avoid the confrontational approach typical of prior confidence-building measure proposals reliant on challenge inspections or “coerced” invitations for observer visits.

In the search for possible cooperative monitoring system technologies we can first note that rockets, whether ballistic missiles or space launch vehicles, make a substantial amount of noise as they ascend through the Earth’s atmosphere. A portion of this noise is infrasound noise. Infrasound is simply sound at a range of frequencies well below that which the human ear can hear. Infrasound can travel vast distances in straight lines and can also be detected by sensitive pressure detectors such as those used by the Technical Secretariat of the Provisional Comprehensive Nuclear-Test-Ban Treaty Organization in their mission to detect atmospheric nuclear explosions. This promises the ability to determine the origin of a rocket launch event from a series of measurements taken from a variety of locations. An infrasound system, being a relatively low technology system, might not necessarily entail the transfer of high technology to a recipient nation under relevant export control laws. Alternately, states that possess the relevant technologies could authorize their export under the umbrella of a cooperative monitoring launch effort. An infrasound system would not necessarily provide real-time information that could support a ballistic missile defence or early warning system, since missiles would travel at supersonic speeds while the rocket noise would be limited to the speed of sound in the atmosphere. There is, therefore, a reasonable prospect of creating a universal cooperative launch monitoring system as a needed international confidence-building measure for space security.

Two relatively recently published papers hint at the emergence of this capability. The first paper states that sounding rocket launches from NASA’s Wallops Flight Facility were detected by the Blossom Point Research Facility infrasound monitoring arrays of the US Army Research Laboratory located about 150 kilometres from Wallops Island.[7] The Black Brant XI class of rockets described in the paper produce about 512 kN of lift-off thrust at sea level, have an exit plane velocity of 2,085 metres per second and produce sound levels of about 113 dbA when measured at 1 kilometre range.[8] The second paper affirms that a large space launch vehicle of the Soyuz class launched from Baikonur Cosmodrome was detected by an International Monitoring System (IMS) infrasound monitoring station located at Aktyubinsk, Kazakhstan, about 650 kilometres from Baikonur.[9] The Soyuz class of space launch vehicle with four RD117 engines has a lift-off thrust of approximately four times 840 kiloNewtons at sea level. It has also been reported by the US Army Research Laboratory that NASA shuttle launches from the Kennedy Space Center in Florida are routinely detected at a distance in excess of 1,200 kilometres from the laboratory.

Detection of rocket launches from such distances should not be surprising given that the overall sound power due to a rocket launch is typically estimated at one-half of 1% of the mechanical power of a rocket. The mechanical power of a rocket is simply one-half of the product of the rocket thrust and the gas velocity at the rocket exit plane. Since the gas exit plane velocity does not vary too much for different rockets, thrust is the variable that will mainly determine the sound power. Consequently, the detection of relatively small sounding rockets is very promising for the detection of larger more tactically important rockets at longer distances. Confirmation of detection at range with larger rockets is equally exciting. The opportunity to use a relatively low technology means, such as infrasound, within a cooperative monitoring system for the detection of rocket launches, could become a confidence-building measure in support of space security and could also make a substantial contribution in combating ballistic missile proliferation.

## A SPACE TRAFFIC MANAGEMENT SYSTEM

Knowledge of launches into outer space would help to validate the inventory of new space objects in orbit and could complement the existing Registration Convention in maintaining a current registry of space objects. A system to monitor the return of space objects from outer space would also help to keep an active registry current on the number of active and inactive space objects in orbit. Finally, observation of the movements of space objects would help to build confidence that the dual-use activities that occur in outer space would not constitute a threat to any nation's orbital assets.

The launch of space launch vehicles, ballistic missiles and sounding rockets that reach into or pass through outer space can pose a hazard to existing space objects in low-Earth orbit whether or not they carry personnel. Similarly, the discussion of emergency preparedness plans for the debris caused by space launch vehicles can be extended to situations of returning spacecraft and the stages of spent launch vehicles. The space debris events of Cosmos 954, the Skylab Space Laboratory and, more recently, the Columbia shuttle tragedy argue for a pre-notification and monitoring regime for space objects returning to the Earth from outer space. Public safety and security of the environment and of property will come to the fore as the commercial exploitation of outer space accelerates with "barnstorming" spaceship rides offered by a host of visionary entrepreneurs promoting space tourism.

Current artificial satellites in orbit are generally protected from direct physical harm by the difficulty in reaching them, either from the Earth below or from another orbit plane in outer space. The laws of physics can make it very difficult for a space object in one orbit plane to move to another orbit plane. The cost of large angular motions can be expressed in great lengths of time or in great amounts of fuel to move from one orbit plane to the next. This is especially true for satellites in low-Earth orbit, but not as true for satellites in the geostationary orbit. Thus, some artificial satellites enjoy a relative degree of protection by Newton's laws of motion and the expense of rocket equation. Expressed in another way, artificial satellites can be threatened by close-proximity operations enabled by new miniature satellites, exotic propulsion techniques or large orbit transfer stages. Thus, great concern can arise over the security of satellites in the geostationary orbit by the development and deployment of micro-satellites with modest fuel capabilities into that region of outer space.

New dual-use missions such as the XSS-11 mission of the US Defense Advanced Research Projects Agency (DARPA) or NASA's Demonstration of Autonomous Rendezvous Technology mission can generate new angst for the security of satellites by the new found ability of satellites to conduct automatic rendezvous and close-proximity operations. Responsive space lift capabilities can likewise be a cause for concern given their ability to launch-on-demand into any low-Earth orbit without much prior notice. Such dual-use systems can, however, help to ensure the security of a nation's access to space and its use by developing a capability to rapidly reconstitute a constellation of satellites lost to natural or artificial hazards. Re-entry capsules for micro-gravity return missions could also become mistaken for more threatening payloads delivering conventional armaments when nations arm themselves with ballistic missile defence systems to confront the current threat of ballistic missiles.

What appears to be needed by the international community to accommodate future spaceflight is a space traffic management system just as air traffic management arose to ensure the safety of air traffic in a prior century. According to an International Academy of Astronautics (IAA) study, the following is a working definition of a space traffic management system:

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

A space traffic management system encompasses three phases of space traffic: the launch phase; the in-orbit operation phase; and the re-entry phase. It envisages a regulatory system comprised of what could be described as "rules of the road" for outer space as well as the technological system to monitor them. It acknowledges that space situational awareness systems reside mainly within the Russian Federation and the United States, but that there are growing capabilities in Europe, China and Japan. The study notes that there are "interfering factors, in particular military doctrines, which might hinder the establishment and working of a space traffic management system". The study also alludes to a transformative event such as "if a major collision occurred that affected high-value spacecraft or even astronauts (cosmonauts, taikonauts)" could alter this initial perception. There is, thus, a great potential for value-added work to be performed by the Conference of Disarmament, as an example of preventative diplomacy, to study the benefit of a space traffic management system for space security and how to address the military dimensions of a system that must, in any event, be built by individual space-faring nations intent on the human exploration of outer space.

A space traffic management system is not without prior genesis. France, for example, in a 1989 letter to the Conference on Disarmament proposed that the international community should set up an international trajectography centre under the auspices of the Secretariat of the United Nations. The concept became known as UNITRACE. This international trajectography centre would have been responsible for:

- Receiving and storing, without publication, the orbital data declared at the time of registration and updated in the event of any subsequent change of trajectory;
- Calculating permanently all the trajectories of the objects on record;
- Spontaneously warning the parties concerned where objects were too close in the same orbit or expected to pass too close; and
- Serving, through consultation machinery, to provide proof of the good faith of a party should doubt arise concerning the cause of an accident.[11]

The UNITRACE proposal ran into certain difficulties, namely associated with the degree of confidentiality necessary for the data collected by the centre. The environment in 2006 is much different. For example, reconnaissance satellite architectures are moving away from single large satellites to a constellation of smaller satellites to provide a persistence of vision over the Earth. There is also today an entire stable of commercial remote sensing satellites that can provide dual-use information to a variety of paying customers. Consequently, foreknowledge of where a satellite is located in outer space to enable denial and deception activities to defeat these observations is lessened by the persistence of observation by many satellites. Similarly, the proliferation of space surveillance technology to more and more actors means that the concerns UNITRACE developed over collecting information that could aid in the anti-satellite activities of rivals will become a moot point when rivals will have attained sufficient technology to enable such tracking capabilities of their own accord.

With around 10,000 man-made objects larger than about 10 centimetres in orbit in 2006, and with the expectation that space debris will only increase in the future, the need for a space traffic management system will grow. The acknowledged regulatory need, the increasing proliferation of space surveillance technology and the potential for multilateral cooperative monitoring all bespeak to the attractiveness of a space traffic management system as an outer space confidence-building measure to assure space security in the twenty-first century.

## CONCLUSION

The potential for outer space confidence-building measures can become great with the likelihood of demonstrated needs. The uniqueness of outer space and the degree of international cooperation there could actually result in the use of outer space as a transformative agent to bring about space security. This paper has selected three candidate proposals ranging from what should be relatively easy to implement to what would be much more challenging. The rescue agreement reprise proposal acts out of concern for the safety of our astronauts, cosmonauts and taikonauts as they venture further into outer space. It proposes engagement by states on the basis of our common humanity. The security challenges of ballistic missiles and space launch vehicles confronting many nations today were addressed by the proposed establishment of an enhanced pre-launch notification of rockets confidence-building measure implementing a declare, do and demonstrate process. A promising rocket launch detection technology based on infrasound was identified as a possible basis for a multilateral cooperative rocket launch monitoring system. Upon these initial modest efforts, a space traffic management system could be established to enhance transparency and engagement sufficient to maintain humanity's sustainable and secure access to outer space in an era populated by a plethora of dual-use capabilities.

### Notes

1 The views expressed in this paper may not necessarily represent the views of the Department of Foreign Affairs and International Trade or the Government of Canada.

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## CHAPTER 13

# TRANSPARENCY AND CONFIDENCE-BUILDING MEASURES IN OUTER SPACE

Anton V. Vasiliev and Alexander A. Klapovsky

The application of Transparency and Confidence-Building Measures (TCBMs) in outer space activities is not a new issue. TCBMs have long been recognized as a significant element of international law and order in outer space. This is reflected, in particular, in the United Nations General Assembly resolutions 45/55B, 47/51 and 48/74B, which reaffirm “the importance of confidence-building measures as means conducive to the attainment of the objective of the prevention of an arms race in outer space”. The annually adopted General Assembly resolution on the prevention of an arms race in outer space (PAROS) recognizes that “the concrete proposals on confidence-building measures could form an integral part of an international agreement or agreements to prevent an arms race in outer space”.

In one form or another, TCBMs are already incorporated in a number of international instruments on outer space. These instruments provide for, inter alia, informing the UN Secretary-General as well as the public and the international scientific community of the nature, conduct and results of activities in outer space; providing data on the launched outer space objects as well as outer space objects that ceased to exist in orbits or changed their earlier reported orbits; and cooperation in joint management of emerging problems. Several TCBMs—in the form of annual statements on key policy lines in the field of space launch vehicles (SLVs), annual reporting of the number and category of the launched SLVs, invitation of international observers to the ground launching sites, and preliminary notifications of SLV launches and of their test flights—are applied as norms in the sphere of missile non-proliferation.

TCBMs have recently enjoyed an increased interest. Some states have started implementing a number of TCBMs on their own initiative. Since 2003, the Russian Federation has been informing the international community via the Internet of the forthcoming launches of spacecraft and their mission. And in 2004, the Russian Federation made an important unilateral pledge not to be the first to place any type of weapons in outer space. This initiative was supported by the member states of the Collective Security Treaty Organization, which made a similar declaration in June 2005. Elsewhere, Norway is providing notifications of the planned launches of probe rockets into upper atmospheric layers from a launching site in the Arctic Ocean and India and Pakistan have an agreement on early notification of rocket launches.

These measures, however, are not comprehensive either in relation to different types of space activities or to participation of states in their implementation. This fact was one of the reasons behind the Russian Federation's decision to submit to the sixtieth General Assembly session a draft resolution entitled "Transparency and Confidence-Building Measures in Outer Space Activities", which was adopted by an overwhelming majority. In its operative part, resolution 60/66 invites all Member States to inform the Secretary-General before its sixty-first session of their views on the advisability of further developing international outer space TCBMs in the interest of maintaining international peace and security and promoting international cooperation and the prevention of an arms race in outer space.

What are the reasons behind the international community's attention to the concept of TCBMs at this stage? We believe that the following needs to be borne in mind in this context.

TCBMs as such minimize the risk of erroneous perception and assessment of military activities of another state. They help to prevent military confrontation, to implement on this basis the principle of no threat or use of force and to foster regional and global stability. Although TCBMs are no substitute for either arms limitation, disarmament or arms control measures, nevertheless, they are able to contribute to developing disarmament commitments and verification measures.

Developing recommendations on possible TCBMs in outer space is a relatively easy first step toward strengthening outer space security. If success is achieved here, it could be easier to agree on further steps. The joint endeavour on possible TCBM recommendations would, by itself, promote deeper understanding of states' intentions regarding the current and prospective state of affairs in the area of outer space. In this sense, the joint work on TCBMs would itself enforce mutual confidence.

Predictability of the military activities in outer space would objectively reduce the probability of the emergence of sudden unexpected military threats in and from space, would remove ambiguity in the strategic situation in outer space and, consequently, would eliminate the need for early preparation of states to neutralize such threats. TCBMs can be worked out and applied by states individually, bilaterally and multilaterally; they can be either voluntary or binding—if the international community deems it necessary. But, evidently, the multilateral character of TCBMs substantially increases their practical value.

Working out TCBMs does not weaken the development of an eventual legally binding agreement on the prevention of placement of weapons in outer space or distract from it, but, on the contrary, serves it. It should be borne in mind that the working out of verification measures in relation to such an agreement is not a simple task. It might prove preferable—for the sake of quickly addressing an urgent problem—to initially draft a treaty without verification measures, which could be prepared at a later stage. In this case, TCBMs could, to a certain degree, make up for the lack of verification measures in the new treaty, especially since what is meant by verification here is a confirmation of non-placement of weapons in outer space, which is so far weapons-free. TCBMs would enhance the confidence of the parties to the treaty that its obligations are complied with.

Confidence building is, in essence, a phased process. It is impossible to create a universal and comprehensive model of TCBMs. They should be developed to suit particular areas of activities. It would be advisable to consider the experience of the UN Group of Governmental Experts, which met between 1990 and 1993, as a basis for updating the current thinking on TCBMs in outer space activities. The results of the group's work are a source of many ideas that are still relevant today. We can also revisit proposals put forward in the 1990s by Canada and France that remain interesting and promising.

Some TCBMs seem applicable today. Though this list is not inclusive, it might be regarded as a starting point for further discussions. Eventual TCBMs can be divided into several categories:

- Measures aimed at enhancing transparency of outer space programmes;
- Measures aimed at expansion of information on outer space objects in orbits; and
- Measures related to the rules of conduct during outer space activities.

Such measures can be carried out in various ways: information sharing; demonstrations; notifications; consultations; and thematic workshops.

Information sharing:

- On main directions of the states' policy in outer space activities;
- On major outer space research and use programmes; and
- On orbital parameters of outer space objects.

Demonstrations:

- Expert visits, including to space launch sites, mission command and control centres and other objects of outer space infrastructure;
- Invitation of observers to launches of spacecraft; and
- Demonstration of rocket and space technologies.

Notifications:

- Planned spacecraft launch;
- Scheduled spacecraft manoeuvres that may result in dangerous proximity to spacecrafts of other states;
- Beginning of descent from orbit of unguided outer space objects and on the predicted impact areas on Earth;
- Return from orbit into atmosphere of a guided spacecraft; and
- Return of a spacecraft with nuclear source of power on board, in case of malfunction and the danger of radioactive materials' descent to Earth.

Consultations:

- To clarify the provided information on outer space research and use programmes;
- On ambiguous situations as well as other issues of concern; and
- To discuss the implementation of the agreed TCBMs in outer space activities.

Thematic workshops:

- Workshops could be organized on various outer space research and use issues, arranged on a bilateral or multilateral basis and with the participation of scientists, diplomats, military and technical experts.

In conclusion, it should be emphasized that at the current stage the work on TCBMs in outer space activities could become an important unifying factor for all states with respect to outer space and generate practical outputs for a prudent and responsible approach to the exploration and use of outer space.

## CHAPTER 14

# EUROPEAN SPACE SITUATIONAL AWARENESS

Gerhard Brauer

## THE NEED FOR SPACE SITUATIONAL AWARENESS

Space technology and space systems have become a vital part of our daily lives and they hold the answer to many of the most pressing security problems. They are used by a wide spectrum of civil and defence communities. Space assets are major and vital enablers for many operational capabilities. Unrestricted access to space and to space services is a common interest of humankind. Accordingly, the need for sustainable space services and possibly the need to take actions to guarantee the unrestricted use of space are vital and recognized worldwide.

In the civil, commercial and defence sectors, the dependency on space assets increasingly raises concern due to their vulnerability. This vulnerability has to be considered during the development, deployment and operation of space systems. Some measures for the protection of space assets, for instance, hardening of components, redundancy and positioning of critical parts within satellites, have been applied. However, passive protective features are not sufficient to guarantee safe space operation; it is still possible to disturb the function of a satellite or a satellite system.

In view of the diversity of space users, each needs to realize that sustainable space security cannot be achieved by one nation or one user alone; it should be the goal for the community of all space users to provide a safe environment for space assets. Regardless of specific measures to be taken—for example, codes of conduct, international treaties, protection measures—information on what is happening in space is the key to any decision-making process regarding space security.

Europe has invested considerably in space. There is the need to maintain this investment and to have sufficient information on the environment of its space assets, that is, to develop a space situational awareness (SSA).

## STATUS OF SPACE SURVEILLANCE IN EUROPE

In Europe, space surveillance aiming at a comprehensive SSA is seen as a multinational task not limited to the civilian or military user communities. Until now, some capabilities have been developed and are operational. These mainly nationally available assets, that is, ground-based monitoring capabilities, have proven to be very effective, but they are not linked. In 2001, the European Space Agency (ESA) director general tasked the Network of Centres Coordination Group on Space Debris to assess the feasibility of a European space surveillance system being able to routinely detect, track and characterize space objects, determine their orbits and correlate them with launch or release events. In support of this activity, ESA initiated definition studies resulting in proposals for a "concept of a European space surveillance system". However, these studies could not take into account recent developments regarding space policies, in particular, developments within the European Security and Defence Policy and progress in that field at the national level.

## THE ROLE OF THE EUROPEAN SPACE AGENCY

ESA, an agency representing 17 member states charged with developing major European space programmes, has proven its competence in defining and conducting the development of space systems and to identify preparatory technology programmes. Although not being a demander for or user of European space systems, ESA is perfectly suited to support the definition of needs for space systems at the European level and to develop solution options serving all European citizens. In this context, space systems are inherently of a multiple-use nature. European space developments may have been driven largely by the demands of civil applications, but many of them are also used by defence organizations without constraining or compromising military operations.

The notion of “peaceful purposes” in the ESA Convention reflects the international space law binding all actors in space activities. It is commonly interpreted to permit using space for non-aggressive military activities respecting the terms of the UN Charter and respecting the specific prohibitions expressed in the Outer Space Treaty.

ESA’s flexible management rules allow for the execution of programmes in different manners, for instance, as mandatory programmes (all member states participating) or as optional programmes (member states decide on a case-by-case basis how and to what extent they participate in a given programme). It is very well suited to manage complex space programmes at the European level and is open for cooperation worldwide.

## SPACE-RELATED EUROPEAN SECURITY AND DEFENCE POLICY DOCUMENTS

The European Security Strategy document “A Secure Europe in a Better World” proposed by the General Secretary/High Representative of the European Union, Javier Solana, and endorsed by the European Council in Brussels on 12 December 2003 clearly states that the European Union needs to be more active, more coherent and more capable. It defines the main threats that need to be addressed, among them:

- The terrorist threat, and its linkages with international organized crime;
- The proliferation of weapons of mass destruction, addressed, inter alia, through verification of the provisions of the treaties; and
- Regional conflicts and their consequences.

It also recognizes that the first line of defence and security will often be abroad, though interconnected with European home security. This is true for all major threats. The causes, if not the actors, are most often rooted in remote countries.

Based on these identified threats and recognized capability gaps regarding European Union-led crisis management operations, the Headline Goal 2010 was established. It presents the European Union as a global actor, ready to share in the responsibility for global security, putting emphasis on timely crisis prevention and on responsiveness in all phases of

Crisis Management Operations suggesting the use of observation, communication and navigation from space.

The implementing document "ESDP and Space" of 16 November 2004 recognizes the added value of space systems for the realization of the European Security and Defence Policy, but notes that:

> … too much reliance on space based assets, including in the economy sector, could induce new vulnerabilities in case these systems are defeated. This should be taken into account when considering European security and appropriate measures envisaged to identify, prevent, or at least to limit, these risks. Such measures could include space surveillance, space-based detection, monitoring and identification of illicit activities.

## FUNCTIONS OF SSA AS DEFINED BY THE PANEL OF EXPERTS ON SPACE AND SECURITY

On 11 November 2003, the European Commission presented a White Paper on the implementation of the European Space Policy, dedicating one chapter to "Space as a Contribution to the Common Foreign and Security Policy, the European Security and Defence Policy and to Anticipation and Monitoring of Human Crisis". Among other things, this document states the need for Europe to develop a space surveillance system allowing the European Union an autonomous capacity to detect and to identify space objects. It also states that a specific effort might be needed to ensure that Europe has the capacity to supply to the different users critical information on solar flares, near-Earth objects and space debris. In order to further assess the needed investments for a comprehensive European Union space-based defence and security capability, one of the actions was to set up a panel of experts on space and security that included ESA experts. This expert panel submitted its report in March 2005, stating that the growing importance of space in every facet of life in Europe means that the protection of our space asset is a fundamental need. The panel identified the lack of a space surveillance capability as a serious capability gap that must be one of the priorities of the future European space programme. Beyond the security of the European space assets, this system must contribute to the control of the application of international space treaties and to the evaluation of the activities of space-faring nations or organizations. The protection of critical infrastructure in the space sector is a priority and services and capabilities of surveillance of space-based assets are needed. The panel recommended the integration of a European space surveillance capability into the European space programme in the short term.

Specifically, there is a need for a sufficiently independent European space surveillance system to:

- Acquire and maintain a sufficient knowledge of the environment in space in order to safeguard the functional capabilities of any European satellite assets;
- Monitor European satellites in order to detect any damage risk due to either aggression or collision with debris;
- Characterize any threat to these satellites;
- Observe and possibly forecast space weather (for example, solar activities) in order to protect space-based assets;
- Verify the application of international treaties in outer space;
- Participate in the strategic evaluation of technological and operational capabilities of other countries/organizations; and
- Provide decision makers with pertinent information regarding the situation in space within the decision process or the planning/ conducting of operations.

The space surveillance system could provide information concerning:

- The main characteristics of satellites (for example, orbital parameters, activity status);
- The main characteristics of potentially threatening debris (for example, trajectory, physical parameters); and
- Pertinent information related to space weather and near-Earth objects.

Quasi-real-time responsiveness is required for all operations related to atmospheric re-entry of satellites or debris.

## DEVELOPMENT OF A PROGRAMME PROPOSAL FOR AN SSA SYSTEM

There are very specific requirements regarding the need for information about ground-, air- or sea-based assets and events. Regarding SSA, there is the shared view that it is needed, but specific common requirements for such a complex system, which could lead to necessary measures, are not yet in place. The civilian user seems to be mainly concerned with space debris and space weather, while the military interest seems to focus on "complete" SSA and early warning. Some civilian capabilities (only space debris related) are available in Europe. The military staffs are developing space-related needs for military operations including the need for space surveillance. The definition of a European space policy encompassing both civilian and defence demands requires the definition of a comprehensive SSA system that serves all user communities and takes advantage of the multiple-use character of space systems. In addition, recent technological developments—for instance, small, agile satellites—should be included in the considerations regarding space surveillance.

In view of this diverse scenario, there is a need for a coordinated discussion at the European level and initiating an activity aimed at generating a detailed common understanding of needed space surveillance capabilities and at the development of a characterization of SSA, with a mutually accepted requirement list. This activity is based on the assumption that military and civilian interests overlap. In any case, duplication should be avoided and only one space surveillance system should be developed. It is foreseen that a group of experts representing all space surveillance user communities will compile a list of needs as a first step. Considering this list of needs, the already available and planned assets that could support an SSA system will be assessed in order to identify detailed capability gaps. In parallel, architectural/feasibility studies will be conducted to support the identification of user needs and requirements by offering technical solution options, including ground- and space-based components, serving all user communities. The activity should result in a credible programme proposal for the development of a space surveillance system serving national and common interests.

In parallel, it will be necessary to address policy issues related to the foreseen multiple uses of SSA. An agreed data policy accommodating the specific operational needs of the defence and civil users is seen as a precondition for a possible multiple-use development and operation. In addition, cooperative options within a European context should be addressed, for instance, the identification of national and common European elements.

## CONCLUSION

Shared information on the situation in space is essential for confidence building regarding the conduct of space-faring nations. It is a precondition for making necessary decisions in case of events affecting the free operation of space systems in accordance with international law. The future realization of an SSA system should be seen as a common/multinational goal contributing to the reliable and secure use of space, offering unhindered access to space services for every user.

## CHAPTER 15

# CONFIDENCE-BUILDING MEASURES: PREVENTING THE GREAT FROM STANDING IN THE WAY OF THE GOOD

Theresa Hitchens

With several nations considering the possibility of future war fighting in space, the time is now for the international community to start laying in place the foundation stones of a future space security architecture that will promote continued peaceful exploitation of space and dampen the drivers of conflict that already have emerged.

As options for doing so are being debated among diplomats, non-governmental organizations (NGOs) and other space stakeholders, the question has been raised as to whether efforts to craft a set of confidence-building measures for space would undercut the chances of reaching a treaty to ban weapons from space. For more than two decades, the majority of member nations have been supporting the establishment of negotiations on such a treaty under the auspices of the United Nations. However, such negotiations on the prevention of an arms race in outer space (PAROS) have been a non-starter—with the United States the chief obstacle. Under the administration of President George W. Bush, the US position against any discussions of a space weapons ban has, if anything, hardened—both due to renewed interest within the Defense Department and the Air Force in space weaponry and the administration's deeply held antipathy toward arms control treaties. Meanwhile, some governmental officials in other countries—including China, France, India and Israel—are beginning to consider whether or not their countries should also begin to prepare for what might be the "inevitable" weaponization of space. Given the continued expansion of space access to more and more countries and non-governmental entities, the inherent dual-use nature of space technology, and the increasing importance of space to modern day militaries, the seeds for future conflict in space are beginning to sprout in earnest. Under such conditions, the growing lack of trust between space-faring powers must be addressed. Until confidence and trust has been rebuilt, it is inconceivable that any progress will be made toward what under even the best of political conditions would be a hard-fought ban on weapons in space.

Indeed, the establishment of confidence-building measures between space-faring countries and the wider international security community is not only a necessary prerequisite for a future weapons ban, but also critically important to improving space security for all in the near and medium term.

There are several alternate options to the confidence-building approach, but each of these options has drawbacks. One option that has been discussed among supporters of a space weapons ban would be for dedicated nations to pursue a ban treaty on their own, *à la* the Ottawa process used for land mines. For various reasons, the central one being that the United States is the dominant military space power; this approach would be neither workable nor wise. A treaty without the United States would be worth little; and one cannot imagine that if the United States goes forward with deployment of anti-satellite and/or space-based weapons that other military space powers would be willing to stick with such a treaty. Furthermore, pursuit of a treaty that would be viewed by the United States as a statement of political hostility and an attempt at isolation would likely backfire in US domestic politics—playing into the hands of those forces who see it as in the US interest to weaponize space as soon as possible.

Another approach could be for interested nations simply to continue to work to define a possible treaty approach, creating draft legal instruments and verification protocols, among other things, to have ready when the political time is more ripe. This is, of course, a useful process. However, it also falls short by failing to engage the attention and input of the United States; and it does nothing to remedy the underlying political dynamic that makes current progress all but impossible. Thus, the crux of the situation is that at the moment, the United States government—and, as alluded to above, perhaps some other nations that simply have not spoken out because they can shelter behind the US position—remains unconvinced that a weapons-free space environment would be either achievable or necessarily in its interests. No nation is going to sign a treaty or international agreement that it does not feel serves its interests, particularly in the area of national security.

This is where confidence-building measures come into the equation. Confidence-building measures are a tried-and-trusted method to dampen national threat perceptions and establish consensus about mutual interests among stakeholders. There are myriad methods and types of confidence building that could be pursued relevant to various aspects of the space arena. The most immediate would be in the area of space debris, which is a known hazard to operations in space. Even tiny pieces of debris can destroy a satellite. And space debris recognizes no nationality; it does not distinguish between military and commercial satellites or between enemy and friendly assets. Already, the Committee on the Peaceful Uses of Outer Space (COPUOS) has approved a draft set of basic voluntary guidelines for debris mitigation that national governments will now consider adding to their own bodies of regulation and practice on space flight. But there is more that could be done. In order to battle debris, better data sharing is needed across the gamut of space stakeholders, from industry to the scientific community to space agencies to militaries. Improved technology for locating and tracking small-sized debris, particularly in the geostationary belt of Earth's orbit, where most high-value communications satellites are placed, is urgently required—and could be the subject of multinational research efforts. International practices and protocols for collision avoidance must be worked out, both between governments and in the globalized space industry. There are also opportunities for joint research to combat the debris problem. A recent National Aeronautics and Space Administration (NASA) study has suggested that due to the ongoing levels of space pollution expected during the twenty-first century, the time is now for scientists to begin working on ways to remove debris. But as such technologies, including space tugs for de-orbiting large debris in low-Earth orbit, by and large could also have weapons applications, unilateral national approaches could be seen as suspicious and destabilizing. Therefore, international collaborative approaches could be of real value in more ways than one. Another issue, with direct relevance to the weaponization question, is the potential use of debris-creating kinetic energy or directed energy weapons in space. Space experts, including many in the US Air Force and other national militaries, understand that weapons that create space debris are undesirable and in no one's interest. With that mutual understanding in mind, there ought to be room for efforts to work out international agreements to prevent the testing, deployment and use of debris-creating anti-satellite and space-based weapons.

There are other forms of confidence building that have been widely discussed by NGOs and various governments in the margins of COPOUS meetings in Vienna and at the Conference on Disarmament in Geneva. These include such efforts as the establishment of so-called rules of the road for curtailing dangerous behaviour in space, as perhaps most comprehensively detailed by the Henry L. Stimson Center, a Washington, DC-based NGO, in the booklet "Space Assurance or Space Dominance". These include identifying dangerous behaviours—such as unannounced close approach to a satellite of one country/owner by a satellite of another country/owner—and establishing protocols for limiting such behaviours. Space-faring powers could establish regular mechanisms for bilateral and/or multilateral consultations about their programmes, both civil and military, to enhance transparency. As a first step, space-faring nations could establish a shareable database of contacts from the various space organizations in each nation and ensure that it is up to date. Indeed, the identification of potential measures of confidence building in space is something that could be set as an immediate goal for both the Conference on Disarmament and COPUOS.

As noted, some proponents of a space weapons ban have expressed concerns that current work on confidence-building measures might undercut that pursuit. For example, Nancy Gallagher from the University of Maryland's Center for International Security Studies at Maryland argues that such "incremental" approaches are fundamentally inadequate as they would have little effect on security relationships between space-faring powers and do nothing to rein in what some consider is currently a dangerous US unilateral, coercive security approach, including toward outer space. In other words, such incremental efforts would be little more than a distraction. Her concerns are not to be dismissed; however, there are also reasons to believe that just the opposite may be the outcome. Again, to the extent that space-faring nations, especially the United States, become more aware that mutual interests in space far outweigh any strictly national interests, they will come to understand that, indeed, unilateral pursuit of short-term military superiority in space actually undercuts long-term security in space for all. And to the extent that nations feel less threatened in space as transparency improves and cooperative endeavours move forward, the drivers toward pursuing short-term national military advantages in space become less imperative.

There are others who argue that if work is launched to reach international agreements on a rules of the road, a "code of conduct" for space or even a debris-prevention treaty, not only would precious time, money and intellectual capital be sidetracked into these endeavours, but also that actually reaching such "limited" agreements could remove any pressure upon nations and the international community to go forward with efforts to establish a space weapons ban. Again, there are sound reasons for these concerns. It is certainly true that international agreements almost always end up representing the least common denominator and nothing more; this is realistically to be expected.

However, it seems obvious that if the international community is truly worried about maintaining space for peaceful purposes in the future, the time is now to get serious about finding ways to achieve those goals before it is too late. If a meaningful weapons ban treaty is not feasible, and it is not for the foreseeable future, does it make sense to simply continue to do nothing but bemoan that fact? If steps can be achieved—even small ones—toward greater space security in the face of paralysis on the ultimate goal, should those steps not be pursued? The bottom line here is that the international community cannot afford to let the great stand in the way of the good. Nor should anyone be fooled by those who would use insistence on weapons ban treaty negotiations or nothing as a clever form of political cover for their own military ambitions in space, which is a danger under the current geopolitical situation in space.

Furthermore, it seems obvious that a combination of transparency regimes, confidence-building measures, codes of conduct and strictures against debris-creating weapons, would, taken together, go almost as far as a weapons ban in ensuring future space security. Certainly, such a multifaceted regime would be an improvement by huge orders of magnitude over the situation emerging today. It, therefore, behoves space-faring nations to overcome the current inertia and begin to address the fundamental problem at hand: the growing tension between space-faring and would-be space-faring powers caused by military ambitions, lack of transparency, political distrust and the rapid dissemination of dual-use space technologies with both potentially beneficial applications and potential applications as anti-satellite and/or space-based weapons. Confidence building is required today as well as tomorrow.

## ACRONYMS

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| 3D | Declare, Do, Demonstrate |
| ABM | anti-ballistic missile |
| ANGELS | Autonomous Nanosatellite Guardian for Evaluating Local Space |
| ASAT | anti-satellite weapon |
| BMD | Ballistic Missile Defense |
| CBM | confidence-building measure |
| CD | Conference on Disarmament |
| COPUOS | Committee on the Peaceful Uses of Outer Space |
| CTBTO | Comprehensive Nuclear-Test-Ban Treaty Organization |
| DARPA | Defense Advanced Research Projects Agency |
| ESA | European Space Agency |
| FCC | Federal Communications Commission |
| GEO | geosynchronous orbit |
| GPS | global positioning system |
| HCOC | Hague Code of Conduct |
| IAA | International Academy of Astronautics |
| IADC | Inter-Agency Space Debris Coordination Committee |
| IAEA | International Atomic Energy Agency |
| ICBM | intercontinental ballistic missile |
| IMS | International Monitoring System |
| ISRO | Indian Space Research Organisation |
| ITAR | International Traffic in Arms Regulations |
| KEASAT | kinetic energy ASAT |
| LEO | low-Earth orbit |
| MDA | Missile Defense Agency |
| MIRACL | Mid-Infrared Advanced Chemical Laser |
| NASA | National Aeronautics and Space Administration |
| NFIRE | Near Field Infrared Experiment |
| NGO | non-governmental organization |
| NPT | Nuclear Non-Proliferation Treaty |
| NTM | national technical means |
| OST | Outer Space Treaty |
| PAROS | prevention of an arms race in outer space |
| SBI | space-based interceptor |

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| SBSW | space-based strike weapon |
| SLV | space launch vehicle |
| SSA | space situational awareness |
| SSI | Space Security Index |
| SSTL | Surrey Satellite Technology Ltd |
| SUMO | Spacecraft for the Unmanned Modification of Orbits |
| TCBM | transparency and confidence-building measure |
| UNIDIR | United Nations Institute for Disarmament Research |
| WMD | weapon of mass destruction |