CHAPTER 12

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

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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.

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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.

2 P.J. Baines, *Adequate Verification: the Keystone of a Space-Based Weapon Ban*, conference report for Safeguarding Space Security: Prevention of an Arms Race in Outer Space, United Nations Institute for Disarmament Research, UNIDIR/2006/1, Geneva, 21–22 March 2005, pp. 87–99.

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5 See the Apollo Soyuz Test Project web site at <www-pao.ksc.nasa.gov/history/astp/astp-goals.htm>.

6 Agreement Between the United States of America and the Union of Soviet Socialist Republics on Notifications of Launches of Intercontinental Ballistic Missiles and Submarine-launched Ballistic Missiles, Moscow, 1988.

7 J.M. Noble and S.M. Tenney, *Long Range Detection and Modeling of Sounding Rocket Launches*, Adelphi, MD, United States Army Research Laboratory, at <www.nrlmry.navy.mil/BACIMO/2003/presentations/Session%20Day-2%20Posters/P%202-01%20Noble.pdf> and <www.tornadochaser.net/research/dection%20infrasonic%20device.pdf>.

8 NASA Final Supplemental Environmental Impact Statement for Sounding Rocket Program, 1998, at <www.wff.nasa.gov/~code810/docs/environmental.pdf>.

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10 Corinne Conant, Petr Lála and Kai-Uwe Scrogl, 2004, *First Draft of the IAA Study on Space Traffic Management*, Paper No. IAC-04-IAA.5.12.4.01, 55th International Astronautical Congress, Vancouver, 4–8 October 2004.

11 Péricles Gasparini Alves (ed.), 1995, *Building Confidence in Outer Space Activities: CSBMs and Earth-to-Space Monitoring*, UNIDIR and Aldershot, Dartmouth Publishing Company.