Promising Confidence- and Security-Building Measures for Space Security[1]

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Introduction

In the last 50 years, outer space has become a domain of critical national infrastructure and of vital strategic and tactical importance. Outer space provides communication, navigation, remote sensing and a myriad of other services to both civil and military clients. Due to the emergence of space as an essential part of modern life, there has been growing discourse concerning the subject of space as a "contested environment", in which states compete for control of space, rather than allowing space to be used "for the benefit and interest of all countries."[2] This discourse has led to such initiatives as the Prevention of an Arms Race in Outer Space (PAROS) in the Conference on Disarmament (CD). Given this increasing interest in space both from countries, such as China, who are beginning to exploit and benefit from outer space, and veteran space-faring nations, such as the United States and Russia, who are becoming increasingly dependant on outer space, it is surprising that there is not yet an arrangement or treaty designed to protect the space environment and ensure its continued use for future generations, given the very real potential for armed conflict in this newly contested domain.

This paper seeks to address the issue of space security by laying out the foundations of a Space Security Treaty (SST) aimed at preventing physical conflict in outer space in order to preserve its continued use today and well into the future. This paper will address the reasons why a treaty is necessary, the threats currently facing humanity's collective use of outer space, and postulate suggested Confidence- and Security-Building Measures for space security. Although the idea of a Space Security Treaty is new, the concepts being presented here are not. Many are taken from other disciplines or issues and applied to outer space. One can hope that by building on these ideas it will make it easier for countries to adopt and comply with for the benefit and interest of all countries.

The Scourge of Space Debris

Outer Space offers a unique challenge to the concept of conventional conflict among states. Namely, by destroying the satellite of another state,

[1] The views presented in this paper are those of the authors and do not represent those of Foreign Affairs and International Trade Canada or the Government of Canada.

[2] "Treaty on principles governing the activities of States in the exploration and use of outer space, including the moon and other celestial bodies," January 27, 1967, *Treaty Series: Treaties and International Agreements Registered or Filed or Recorded with the Secretariat of the United Nations* 610, Article 1.

aggressors are also destroying their ability to further use space. Space debris can travel at excessively high speeds (upwards of 7.8 km/s in Low Earth Orbit), turning pieces of damaged or destroyed satellites, as small as 10 centimetres in diameter, into destructive forces, capable of delivering the same amount of energy to an object as a 35,000 kilogram truck traveling at 190 km/hour.[3]

Furthermore, once space debris is created, it will remain in orbit – sometimes indefinitely.[4] Outer space cannot cleanse itself of debris as quickly as mankind is able to make it. This fact leads to a cascade effect of debris, where old debris is hitting new satellites, thus creating more debris.[5] Without efforts to curb this problem, entire areas of space could become unusable for hundreds or thousands of years.[6] Since there is no way of effectively removing large amounts of debris from orbit, it is essential that states preserve its utility through efforts to control the amount of debris that is created in that domain. This is especially true with respect to the potential for armed conflict in outer space. For this reason, it is crucial to have in place a set of agreements coupled with verification and compliance governance methods to ensure the security of outer space.

Security Challenges for Outer Space

The security challenges facing outer space can be broken down into two distinct types of threats: irreversible and reversible. Irreversible refers to the permanent damaging of a satellite, or the destruction of that satellite. Reversible refers to temporarily disrupting signals to or from a satellite, or the denial of such signals to or from that satellite.

Irreversible

Lt. Col. Bruce M. DeBlois, in his article, "Space Sanctuary: A Viable National Strategy," contends that space weaponization is not an "'all or nothing' affair."[7] DeBlois argues that space threats lie on a continuum, ranging from relatively low threats to relatively high threats. In his continuum, DeBlois argues that space-based weapons (whether able to engage other space objects or targets on or above the Earth) pose the greatest threat to space security.[8] This refers to the need to control debris in space. It is estimated that the destruction

[3] West et al., *Space Security 2007* (Waterloo: Project Ploughshares, 2007), 21.
[4] Wright et al., *The Physics of Space Security: A Reference Manual* (Cambridge: American Academy of Arts and Sciences, 2005), 22.
[5] Wright et al., 22.
[6] Wright et al., 22.
[7] Lt. Col. Bruce M. DeBlois, "Space Sanctuary: A Viable National Strategy," *Airpower Journal* (Winter 1998): 41.
[8] DeBlois, 42.

of a 5 to 10 ton satellite could double the amount of debris orbiting the Earth.[9] As such, any full scale conflict in space would render parts of outer space unusable. Earth-to-space weapons pose a similar, if lesser, threat. However, Earth-to-space weapons are able to cause the same catastrophic effects as space-based weapons and should therefore be treated as an urgent threat to space security. Most importantly, is the need not to purposefully create space debris or even derelicts in outer space that can subsequently collide with space debris to produce even yet more debris.

Certain dual-use satellites that could also damage or destroy objects pose a pertinent threat to space security. Dual-use satellites refer to satellites that serve a legitimate civil purpose in space, but can gain the effects of a weapon when used for a military objective, for example, by purposefully colliding with another satellite. This threat can arise to the extent that such satellites possess the necessary pursuit sensors and the fine control rocket engines to otherwise enable close proximity operations with a non-cooperative satellite, or alternately, can otherwise illuminate an object with sufficient electromagnetic energy to cause damage due to the susceptibility of sensitive electronics or optics. The vast majority of satellites do not possess such capabilities and therefore make poor suicide bombers and rather ineffective ray guns.

Finally, the threats of accidental collisions are ever present in space and steps should be taken to attempt to reduce the probability and consequence of accidental collisions in space.

To summarize, humanity's use of outer space is plagued by four major irreversible threats. They consist of the:

(1) Threat of space-based weapons that are specially designed or modified to damage or destroy;
(2) Threat of weapons that reach into outer space from the Earth to damage or destroy;
(3) Residual threat of certain dual-use satellites that could also damage or destroy; and the
(4) Residual threat of accidental collisions in outer space or on the surface of the Earth.

Any space security regime worth pursuing should address these four threats in a comprehensive manner – not only preventing states from creating excess amounts of debris, but also determining compliance with its provisions. Here an obligatory governance structure using verification methods based on a collection of space situational awareness systems is highly recommended.

[9] David Wright, "Orbital Debris Produced by Kinetic Energy Anti-Satellite Weapons," in *Celebrating the Space Age: 50 Years of Space Technology, 40 Years of the Outer Space Treaty* (Geneva: United Nations Publications, 2007), 160.

Reversible

In addition to the irreversible or destructive threats for space systems are threats of a reversible or disruptive nature. Reversible threats can include jamming or spoofing uplink or downlink communications channels of satellites.[10] For example, states use outer space for military purposes in the form of intelligence, surveillance, reconnaissance, navigation and timing, and communications among other activities.[11] Powerful states rely upon the use of these satellites to ensure strategic stability, as was the case during the Cold War[12], or to gain tactical military advantage for Earth-based military missions, evidenced by communication and positioning satellites.[13] These military uses of space can pose security threats for other states on the Earth that may require negation under conditions for which the self-defence provision of Article 51 of the UN Charter could be expected to apply.

It is argued that strategic stability is crucial to the maintenance of international peace and security (and indeed life) on the Earth. The world need not be reminded of the frightful days of the Cuban Missile Crisis. Early warning detection, strategic communication and reconnaissance systems are vital to the maintenance of strategic stability. Purposeful interference with these satellite systems risks triggering an escalatory response. In the case of nuclear war, it is difficult for a state to credibly threaten a large scale nuclear attack, due to the concept of Mutually Assured Destruction (MAD).[14] However, states may engage in limited wars in which they seek to substantially raise the risk of escalation to nuclear war.[15] Given the inherent difficulties of defending satellites in outer space, a state is more likely to engage in retaliatory or escalatory behaviour should their space assets be interfered with or attacked with weapons.[16] Any escalatory behaviour would be a significant threat to both space and Earth security. For this reason, purposeful interference with satellites that ensure strategic stability is an important security threat that should be addressed, especially by states in possession of nuclear weapons. Here, the security of space is best maintained through, "stability more than superiority,"[17] if states are to avoid missteps during crises that could lead to an actual nuclear war.

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[10] Wright et al., 118.
[11] DeBlois, 42.
[12] Mission and Spacecraft Library, "DSP (Defence Support Program)," NASA, http://msl.jpl.nasa.gov/Programs/dsp.html (accessed June 12, 2009)
[13] Mission and Spacecraft Library, "Global Positioning System (GPS)," NASA, http://msl.jpl.nasa.gov/Programs/gps.html (accessed June 12, 2009)
[14] Robert Powell, "Nuclear Deterrence Theory, Nuclear Proliferation, and National Missile Defense" *International Security* 27 no.4 (Spring 2003): 89.
[15] Powell, 90.
[16] See Powell, 89 and Harrison et al., "Space Deterrence: The Delicate Balance of Risk" *Eisenhower Center for Space and Defense Studies*, (2009): 12.
[17] James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests* (Stanford: Stanford Security Studies, 2008) 56.

Outer space is also becoming essential to conducting tactical military operations on the land, sea and in the air. Satellites such as communications and navigation satellites provide invaluable information to troops on the ground in real-time. In times of peace, satellites provide reconnaissance information which can aid in averting crises. By keeping a continuous watchful eye on rival states, it becomes more difficult for a state to misinterpret the actions of their rivals. Interference with these satellites during peace time has the potential to be interpreted as an "act of aggression" under the UN Charter.[18] Should a state be attacked in this fashion, Article 51 of the UN Charter would permit it to engage in self-defence.[19] This poses a space security threat since interference with tactical military satellites during peace time has the potential to trigger a crisis or a conventional war. Should a state already be responding to aggression on the surface of the Earth or elsewhere, Article 51 of the UN Charter would enable the defending state to purposefully interfere with the satellites, sensors and signals that are taking part in that aggression. The need to assure humanity's continued use of outer space, including a state's own use, should prevent any state from physically destroying satellites. Thus a space security treaty should codify this common understanding. A space security treaty should not, however, prevent states from temporarily or reversibly interfering with satellites, sensors or signals for reasons of self-defence, as is allowable under the UN Charter and the Outer Space Treaty.

Finally, inadvertent interference with satellites from radio-frequency or electro-optic frequencies remains a growing problem in space and measures should be taken to ensure that this residual threat is also minimized. Here a collection of space situational awareness systems are important for crisis stability, as they will help discern inadvertent accidents from being misconstrued as purposeful attacks.

To summarize, outer space is subject to two kinds of reversible threats. They are the:

(1) Threat of purposeful interference with respect to:
    a. Reliance upon the use of satellites to ensure strategic stability;
    b. Use of satellites to gain a tactical military advantage on the Earth, and
(2) Residual threat of inadvertent interference from:
    a. Radio-Frequency; and
    b. Electro-Optic Frequencies.

[18] United Nations, "Charter of the United Nations," http://www.un.org/en/documents/charter/chapter7.shtml (accessed June 15, 2009)
[19] United Nations, "Charter of the United Nations," http://www.un.org/en/documents/charter/chapter7.shtml, Article 51 (accessed June 15, 2009)

Confidence- and Security-Building Measures (CSBM) for Space Security

Having established the threats that need to be addressed for space security, this paper will now focus on proposing possible confidence- and security-building measures aimed at laying the foundation for a comprehensive space security treaty.

Irreversible

The first and most significant irreversible threat to space security is the threat of space-based weapons that are specially designed or modified to damage or destroy targets in outer space, on a trajectory above the surface of the Earth, or on the surface of the Earth. In order to address this threat, one simply needs to build upon the existing Outer Space Treaty (OST). By expanding upon Article IV of the OST, one can address the threat of space-based weapons.[20]

> **CSBM (1)** States shall not place in orbit around the Earth any weapons or objects carrying weapons, install weapons on the Moon or any other celestial body, or station weapons in outer space in any other manner.[21]

This proposal raises a couple of questions: one concerning the definition of the word "weapon", and another concerning what such a prohibition would encompass. For the purposes of a space security treaty, a "weapon" is defined as "a device based on any physical principle, specially designed or modified, to injure or a kill a person, damage or destroy an object, or render any place unusable." This definition is comprised of a combination of the ordinary meaning of the word "weapon" and select parts of the Anti-Ballistic Missile Treaty and the Missile Technology Control Regime.[22]

To assist with discerning a space-based weapon from an ordinary satellite, the concept of "form follows function" may be employed. Coined first by Louis H. Sullivan in 1896, form follows function is the idea that the design or look

[20] Outer Space Treaty, Article IV.
[21] Note that this prohibition has been written using legally-binding language through the use of the words "shall not". A non-legally-binding CSBM could express the vision as "should not", as is demonstrated in later CSBMs.
[22] "…based on any physical principle…" See "Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems", May 26, 1972, *Treaties and Other International Acts Series* 7503. "…specially designed or modified…" See Missile Technology Control Regime, "Guidelines and Equipment and Technology Annex," MTCR, http://www.mtcr.info/english/index.html (accessed June 11, 2009)

of something directly relates to the purpose it serves.[23] Sullivan writes, "All things in nature have a shape, that is to say, a form, an outward semblance that tells us what they are, that distinguishes them from ourselves and each other."[24] In essence, objects of the same class tend to look alike. Sullivan further writes, "Where function does not change, form does not change."[25] As such, there is no *need* to change the design of something if the function does not change.

Nam P. Suh, of the Massachusetts Institute of Technology, further developed this idea in his article "Designing-in of Quality Through Axiomatic Design". Suh establishes a direct mathematical relationship between the functional requirement of an object and the design parameters of that object. [26] Suh further argues that the best designs are ones that fit one functional requirement with one design parameter.[27] Anything beyond this represents improper design.

Using these design theories we can discern space-based weapons from satellites, as they imply that a satellite that is designed to be a weapon will also look like a weapon, and a satellite that is designed to be benign, will look benign. [28] One recognisable example of these design principles drawn from our ordinary experience is revealed in the comparison of a butter knife with a bayonet. A butter knife is short and it is dull. It does not have a pointed tip and it can only cut on one side of the blade. Clearly this implement has been designed for the purpose of benign kitchen tasks and the use of human safety factors are in ample evidence. A bayonet, on the other hand, is sharp, pointed, very long, double-edged and possesses the structural rigidity necessary to repeatedly harm human beings. A similar type of analysis can be performed by experts, aerospace engineers and other intelligence analysts, to distinguish the functions of objects in outer space. Indeed, even in the absence of a space security treaty, states must maintain a vigilant watch on activities in outer space in order to maintain an ordered targeting list for the negation of space objects that could project harm in outer space or onto the Earth.

These ideas have already been used in the Strategic Arms Limitations Talks (SALT) II Treaty between the US and the USSR. [29] In this treaty, these design principles were referred to as Functionally-Related Observable

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[23] Louis H. Sullivan, "The Tall Office Building Artistically Considered," *Lippincott's Magazine*, (March 1896)
[24] Sullivan.
[25] Sullivan.
[26] Nam P. Suh, "Designing-in Quality Through Axiomatic Design," *IEEE Transactions on Reliability*, 44 no. 2 (June 1995)
[27] Suh.
[28] For an example of this, one needs to look no further than the Multiple Kill Vehicle (MKV) versus the GFZ-1.
[29] Multilateral Treaty on the Limitation of Strategic Offensive Arms and Protocol Thereto, June 18, 1979, United States Treaties and Other International Agreements 220, First Common Understanding.

Differences (FROD's). FROD's suggests that certain airplanes could be distinguished from other airplanes as being able to perform functions that fell into the domain of the SALT II Treaty. As such, FROD's became a standard method of verification. If it looked like it might be able to violate the SALT II Treaty, then it fell to the two countries to discuss and consult with each other to find a resolution to the compliance issue. Observations by national technical means can ascertain, based on FROD's, whether a space object is "specially designed or modified" to serve as a weapon. Should situations arise in which the observable difference is too close to call by national technical means alone, the use of the treaty's executive council structure as a means to consider these compliance issues would be far more beneficial for international peace and security than the alternative reliance on a deterrence strategy based on threats, retaliation, reprisals and other uses of force among nuclear-armed powers.

In addition to form, satellites are deployed in highly specialized orbits. The relation of a satellite to others or to the surface of the Earth tells a great deal about the function the satellite is to perform. For example, satellites are deployed in the geostationary orbit in order to gain a view of one-third of the surface of the Earth. This location makes it ideal for strategic communication and early warning missions. Likewise, satellites deployed in low Earth orbit gain proximity to the surface of the Earth that can be exploited by remote sensing satellites to gain sharp resolution images of the Earth. In addition to the specific orbits that are used to perform specific functions, the behaviour of satellites within these orbits can indicate their purpose. For example, most satellites have no need to approach other satellites. Future in-orbit repair or refuelling missions, requiring rendez-vous or docking functions, would exhibit behaviours (and forms) that are different from most satellites. Like form, behaviour in space and in time can be used to distinguish a belligerent satellite from a benign satellite.

In terms of prohibitions, referring to DeBlois' oft-cited article, this CSBM addresses the highest level of threats.[30] These include orbital bombardment systems, orbital anti-satellite (ASAT) weapon systems, and space-based, missile defence interceptors or directed energy weapons. This prohibition on weapons in outer space also makes the second prohibition more possible, since the second prohibition will prohibit the anti-satellite weapon needed to negate the space-based weapon.

Moving along DeBlois' continuum, the threats of weapons that reach into outer space from Earth to damage or destroy are the next most significant threat.

> **CSBM (2)** States shall not test or use a weapon on any satellite so as to damage or destroy it.

Once again, clarification is needed on a certain aspect of this CSBM. As was the case in the first CSBM, the definition of weapon remains the same. The

[30] DeBlois, 42.

word test, however, should be restricted to a validation activity conducted in the open. That is," test" means "to field or flight test in a manner observable by the national or multinational technical means of observation available to a State." This helps to ensure that the prohibition, as worded, can be verified by national technical means of observation.

In terms of prohibitions, this CSBM would prohibit inflicting damage or destruction on a satellite, *regardless of the weapon's location*, but would still allow Ballistic Missile Defence (BMD) systems located on the surface of the Earth to pass through outer space and engage ballistic missiles also passing through outer space. As such, this CBSM would prohibit dedicated land, sea or air-based ASAT's or modified BMD interceptors that are tested or used in an anti-satellite weapon role. The CSBM also prohibits the test or use of directed energy weapons on satellites that can harm them at a distance. This ensures, then, that satellites placed into outer space may serve their natural lives and, at the end of their useful lives, execute their pre-arranged disposal plans to protect against the further production of space debris. This CBSM therefore would prohibit all activities that could deliberately create a derelict in orbit that may subsequently collide with space debris to produce even more space debris, as well as the direct production of space debris from a deliberate collision with an interceptor. It would not impede the development or test or use of ballistic missile defence systems against sub-orbital ballistic missiles.

Certain dual-use satellites, as articulated above, pose an interesting and different threat to space security than the two previous threats. This is due to the nature of certain satellites and their intended uses.

> **CSBM (3)** States shall not test or use a satellite, itself, to gain the effects of a weapon through any direct action.

Such an undertaking would prevent satellites, themselves, from inflicting damage or destruction, but would still permit the use of outer space for the aid of military forces on the Earth. The main challenge for this CSBM is maintaining sufficient awareness to provide accountability for activities in outer space. If, for example, a state uses a satellite that is capable of executing a pursuit to purposefully collide with another satellite in an attempt to damage or destroy that satellite, how will the world know who caused the resulting collision? For the most part, awareness of an attack in space currently only comes when people on Earth notice its effects.[31] That is to say, in space, it's very hard to see an attack coming if you are not looking. By the time one satellite has collided with the other, it may be difficult to properly attribute the attack, assuming it was an attack at all and not just an accident. It is for these reasons that robust Space Situational Awareness (SSA) systems are fundamental to determining compliance with this and other CSBMs. SSA is crucial to attributing attacks and

[31] Harrison et al., 15.

distinguishing attacks from accidents.[32] Moreover, SSA is essential to deterring such attacks. If a state is aware that it *will* get caught by engaging in such action, it will be less likely to do so.

Accidental collisions in outer space or on the surface of the Earth pose the least significant threat for the security of space. However, they pose a great threat to the continued use of space. Space debris is created from accidental collisions the same as from purposeful ones and efforts must be taken in order to reduce these occurrences. Likewise, to obtain crisis security, it is important to be able to distinguish between an accident and a deliberate attack. The following series of CSBMs address this residual threat.

> **CSBM (4)** States should undertake to provide at least 72 hours prior notice of all space launch attempts from the territory, vessels, aircraft or satellites under its jurisdiction and control.
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> **CSBM (5)** When a State has reason to believe that a satellite maintained on its registry may re-enter the atmosphere of the Earth sooner than within the next thirty (30) days, such a State should provide notice without delay, to all States that it has reason to believe may be affected.
>
> **CSBM (6)** A State should not test or use a satellite maintained on its registry to purposefully approach, rendez-vous, or otherwise operate in close proximity of another satellite, without providing sufficient prior notice to the State of registry of that other satellite.
>
> **CSBM (7)** When a State has reason to believe that an active satellite maintained on its registry has a significant risk of collision with another satellite that is also believes is active, the State shall provide notice, without delay, to all other States that is has reason to believe may be affected.
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> **CSBM (8)** In the isolated event that a single satellite maintained on the registry of one State collides with another satellite maintained on the registry of another State, or one satellite purposefully approaches another satellite without giving the prior notice required under CSBM 6, each affected State should consult with one another under without delay.

Adhering to these CSBM's will significantly reduce accidental collisions in outer space and on the surface of the Earth, as well as misunderstandings that could accrue from such accidents. The origins of these proposed CSBM's have their roots in Article IX of the OST, which calls on states to mutually assist and

[32] Harrison et al., 16.

cooperate with each other.[33] In effect, these CSBM's provide timelines and best-practices to follow when operating in the outer space environment. Under these CBSMs, a state acquires the commitment to provide notice to other states that may be affected by its activities in outer space. These notices enable the affected states to make better use of the consultation mechanisms that are available to them under Article IX of the OST. Increased communication opportunities, coupled with multiple robust SSA systems will go a long way in reducing both the number of instances, and possibly the severity, of accidental collisions in outer space.

Reversible

In order to deal with reversible threats to outer space, it is important to ensure the continuity of communication, observation and early warning signals. When discussing satellites that provide strategic stability, it is important for all states, nuclear or not, to ensure that these crucial systems remain free from purposeful interference. Strategic stability is considered in two facets: observation and communication. The loss of one or both of these abilities can threaten the strategic stability among states that possess nuclear weapons.

> **CSBM (9)** All States that possess nuclear weapons should use redundant and independent early warning systems that are based on more than one type of sensor.
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> **CSBM (10)** No State should purposefully interfere simultaneously with two or more early warning systems of any State that possesses nuclear weapons.
>
> **CSBM (11)** No State should purposefully interfere with national or multinational technical means of observation operating in accordance with the generally recognised principles of international law.

These CSBM's address the observation facet of strategic stability and ensure that states in possession of nuclear weapons maintain at least *two* early warning systems based on separate indicators in order to ensure that any nuclear launch can be verified. If only one indicator were to be used, a malfunction in that system could be misinterpreted as a hostile launch. In order for this fail-safe to function properly, it is important that no state interfere with two or more of these systems at once. If a state is able to deceive both systems simultaneously, it may force the defending state to launch its nuclear weapons. The idea of redundant early warning systems as a necessary fail-safe measure has been in place since the early days of the Cold War.[34]

[33] Outer Space Treaty, Article IX
[34] Wallace et al., "Accidental Nuclear War: A Risk Assessment," *Journal of Peace Research* 23 no. 1 (March 1986) 25.

CSBM (12) States that possess nuclear weapons should establish redundant and independent communication channels among their respective national command authorities consistent with their national security and foreign policy interests.

CSBM (13) No State should purposefully interfere with the signals of any such communication channels.

CSBM (14) No State should purposefully interfere with the command and control signals between the national command authorities of States that possess nuclear weapons and their military forces in possession of such weapons.

In terms of communication, it is important for states in possession of nuclear weapons to establish communication links between themselves in an effort to avert possible misinformation or misinterpretation of activities, especially during crises or conventional hostilities. During the Cold War, the US and the USSR established the Hotline Agreement to facilitate such communication.[35] Extending this to other states in possession of nuclear weapons is recommended. Furthermore, interference with these lines of communication should be avoided at all times, as should interference between those with the authority to launch nuclear weapons, and those military commands in possession of them.

These CSBM's described above were self-evident to the US and USSR during the Cold War as both superpowers defined "red lines" of international behaviour which were designed to signal that certain activities were threatening vital interests.[36] In fact, it is argued that the maintenance of peace during the Cold War was due in part to this series of conditions (communications, rational decision making, informed strategic planning and a mutual sense that nuclear war was not in the interest of either country).[37] It is evident that the measures outlined in CSBMs 9 through 14 are simply restating already recognized international norms. As such, they would not necessarily need to be included in a space security treaty. The states that possess nuclear weapons may also want to retain the communication of redlines within their normal conduct of international relations in order to control the escalation ladder during situations that they might face in the future. A benefit of this reservation is that a space security treaty can more simply address reversible threats as outlined below.

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[35] Dianne DeMille, "Accidental Nuclear War: Reducing the Risks," *Canadian Center for International Peace and Security* 16 (January 1988) 7.
[36] Giandomenico Picco, "The UN and the Use of Force: Leave the Secretary General Out of It," *Foreign Affairs*, 73 no.5 (Oct. 1994) 18.
[37] Ilan Berman, "The Iranian Nuclear Crisis: Latest Developments and Next Steps," *Testimony before the US House of Representatives*, (March 15, 2007) 4.

The use of satellites for tactical military objectives, as discussed earlier, can be considered differently during peace and during hostilities, including the outbreak of such hostilities. Actions of states taken against satellites performing these roles can differ both in terms of legality, as well as consequence, depending on this divide established by the UN Charter. As such, proposed CSBM's must reflect this divide.

> **CSBM (15)** No State should purposefully interfere with any satellite sensor or signal that is operating in accordance with the generally recognised principles of international law, except when it considers that such purposeful interference is necessary and allowable by the UN Charter.
>
> **CSBM (16)** No State should use a satellite to originate, from itself, any purposeful interference, except when it considers that such interference is necessary and allowable by the UN Charter.

These two measures would help mitigate the initiation of a crisis by one state interfering with another state's satellite's sensors or signals, but they can each engage in this behaviour should they need to respond to an "act of aggression" pursuant to Article 51 of the UN Charter. In such instances, it would normally fall to the UN Security Council to seek a resolution to the outbreak of hostilities. CBSM 15 is recognizable as a variant of similar provisions within the ABM Treaty and in the Conventional Forces Europe Agreement.[38]

A further discussion of CSBM 16 is warranted by its further clarification of CSBM 15. The prospect of purposeful interference originating from a satellite is that it will act as an accelerant for the development of dedicated anti-satellite weapons or the modification of ballistic missile defence interceptors to negate the source of the interference in outer space with means that could produce space-debris. After all, radio-frequency or electro-optic jammers on the surface of the Earth during hostilities are often engaged with bombs or other explosive devices. To prevent physical conflict in outer space, such interference should only originate from the surface of the Earth where terrestrially-based weapons may ultimately deal with its source. In as much as ballistic missile defence interceptors may be modified to serve as anti-satellite weapons, much like for the defence of aircraft, satellites could be equipped with jammer pods or flares to address this residual threat. By using electronic warfare measures against these residual threats, states would be adhering to both the UN Charter and a space security treaty.

[38] See "Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems," Article 12 and "Treaty on Conventional Armed Forces in Europe," US State Department, http://www.state.gov/www/global/arms/treaties/cfe.html, Article 15 (accessed July 9, 2009)

The final threat to address is that of inadvertent interference between states. To address this issue, this paper suggests building upon the consultation mechanism of Article IX of the OST with a series of best practices for dealing with inadvertent interference.

> **CSBM (17)** A State should co-operate, without delay, in the resolution of radio-frequency or electro-optic frequency interference with another State upon the receipt of a notice of such interference.
>
> **CSBM (18)** A State should give at least 72 hours prior notice of any high power laser or microwave illumination of any point in outer space originating from the territory, vessel, aircraft or satellite under its jurisdiction and control, where it has reason to believe that there would be a significant risk of disrupting or denying the observation or communication signals of an active satellite maintained on the registry of another State.

The Promise of CSBMs

The international community can go a long way towards ensuring the security of space for this generation and for generations to come by implementing a space security treaty that encompasses the CSBMs postulated above. Simply put, these CSBMs reflect a grand bargain that is necessary to attain the security of a state's continued use of assets in the especially fragile domain that is outer space without sacrificing one's own national security interests with respect to threats originating from that domain. However, simply signing and ratifying a treaty based on these principles would not be enough. To be complete and effective, a treaty would therefore need prohibitions and obligations, a verification process and a governance structure to ensure adherence to, and the viability of, a space security treaty.

Verification and Governance

Verification and governance are crucial to the success of any space security treaty. A violation of the international obligations could undermine the purposes of the agreement. In the context of outer space, there are two types of verification – adequate and effective. Although the differences between the two are not explicitly spelled out, it is generally understood that effective verification entails stricter requirements and more rigorous inspections.[39] Adequate, however, is a verification standard consistent with the same verification standard

[39] Michael Krepon, "The Politics of Treaty Verification and Compliance," in Kosta Tsipis, David W. Hafemeister and Penny Janeway eds. *Arms Control Verification: The Technologies that Make it Possible*, (Elmsford, NY: Pergamon-Brassey's International Defense Publishers, 1986) 21.

needed to wage war in outer space.[40] Essentially, in order to conduct physical conflict in space, one would need to be able to discern between military and civilian targets (as required by the Geneva Conventions and Common Article 3).[41] Moreover, in the absence of a ban on space weapons, militaries would be required to have robust space situational awareness in order to maintain a targeting list of possible threats. As such, this same ability to discriminate between military and civilian targets, or to establish an order of priority for targets based on their ability to harm other objects, can also be used as a verification standard for ensuring that space-based weapons are never deployed.

The first step towards a robust verification and governance system is a collection of robust space situational awareness systems. As discussed above, it is important to know what functions objects perform in outer space, who is in control of them, what orbits do they occupy and how do they behave in these orbits. This knowledge will act not only as a deterrent to the weaponization of space, but also reduce the risk of accidental collisions or interference.[42]

The independent space situational awareness systems of China, Russia and the United States could become the basis for Regional Space Operation Centers (RSpOCs) that would each maintain extensive knowledge of what activities are taking place in outer space on a real-time basis. These RSpOCs could serve as a form of "clearing-house", in which sufficient space information would be available to other states in a format that is consistent with the national security and foreign policy interests of these three major space powers. As every state will have a significant relationship with at least one of these powers, every space-faring state could gain access to the necessary and sufficient information for its safe and sustainable use of outer space. This would be particularly true were both China and Russia to make similar data available to third parties as the United States currently does under its Commercial and Foreign Entities project.[43] Looking forward, these RSpOCs enhanced by Joint Data Exchange Centres established among them, could serve as the foundation for the multilateral verification of a space security treaty.[44]

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[40] Phillip J. Baines, "Adequate Verification: The Keystone of a Space-Based Weapon Ban," in *Safeguarding Space Security: Prevention of an Arms Race in Outer Space*, (Geneva: United Nations Publications 2006) 92.

[41] "Geneva Convention Relative to the Protection of Civilian Persons in Time of War," August 12, 1949, *Treaty Series: Treaties and International Agreements Registered or Filed or Recorded with the Secretariat of the United Nations* 75, Article 3.

[42] Harrison et al., 16.

[43] "National Defense Authorization Act – Fiscal Year 2004," Celestrak, http://celestrak.com/NORAD/elements/Section913.pdf, (accessed July 9, 2009)

[44] Office of the Press Secretary, "Memorandum of Agreement Between the United States of American and the Russian Federation on the Establishment of a Joint Center for the Exchange of Data from Early Warning Systems and Notifications of Missile launches," The White House, http://clinton5.nara.gov/WH/New/Europe-0005/factsheets/memo--joint-warning-center.html, (accessed July 9, 2009)

The second step towards a robust verification and governance system for space security is an executive council established under a space security treaty designed to report to the UN Security Council on compliance matters relating to the treaty. This executive council could serve as a basis for consultations concerning compliance and whether or not any given satellite qualifies as a weapon based on its design and behaviour. This sort of governance system would be much more mutually beneficial and adhere to the spirit of Article IX of the OST than a system of deterrence and tit-for-tat reprisals which may, in turn, lead to an arms race in outer space.

Conclusion

The production of space debris is a serious threat to humanity's continued use of outer space. Only through control of this debris can the world ensure the use of space for future generations. As such, it is important to achieve the security of space as a means of controlling debris. States must not fight the first war in outer space, since humanity could lose their use of this domain for centuries or millennia to come. In addition, the use of space is only made possible through international co-operation in the coordinated use of the radio-frequency spectrum. Interference with this aspect of space should be done only in conformance with international law and pursuant to the UN Charter. When necessary, any interference should be temporary, localised and reversible.

This paper has proposed that a grand bargain be struck in order to preserve our continued use of outer space for all humankind. Physical violence in outer space must be prohibited and purposeful interference should be restricted to reasons of self-defence as is permitted by the UN Charter. A space security treaty has been proposed with prohibitions and obligations to codify this balance of interests. While the principles have been presented in the form of a legally-binding treaty, the principles could be first codified in a Code of Conduct in order to begin state practice and attain space security for the benefit of all humankind.