CHAPTER 10

ADEQUATE VERIFICATION: THE KEYSTONE OF A SPACE-BASED WEAPON BAN[1]

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I plan to take a circuitous route in this paper, but by the end of it, I hope to have demonstrated the necessity of adequate verification provisions for a space-based weapon ban. In doing so, I also hope to have dispelled the notion that unwillingness to expend political capital, technical difficulties or high monitoring costs need necessarily impede the adoption of verification measures for an increasingly urgently needed non-proliferation regime for outer space. In fact, improved space situational awareness means that are necessary to engage from space in military intelligence terms could very well enable the negotiation of a space-based weapon ban as a preferred risk management strategy for safeguarding space security.

On a prior occasion when I spoke about the deleterious consequences of waging conflict in outer space, I faced a vocal sceptic challenging me as to whether a space-based weapon ban would enhance the national security of a major military power that is increasingly reliant upon the secure use of outer space for its national security. This person believed that "the weaponization of outer space is all but inevitable" based on the last 40,000 years of human history. I instead argued that since the establishment of the United Nations after the Second World War, and with humanity still facing the imminent prospect of nuclear annihilation, civilized men and women have worked steadfastly to build collective security for all nations through international legal regimes. These treaties have placed universal, equitable and verifiable constraints on the behaviour of both the great and the small powers for application in times of peace as well as in times of war.

In deciding these important matters, we should be willing to turn to rigorous objective rational thought to analyse the merits of extending

Published in *Safeguarding Space Security: Prevention of an Arms Race in Outer Space—Conference Report, 21–22 March 2005*, United Nations Institute for Disarmament Research (UNIDIR), 2006.

military conflict into outer space. The great Chinese general Sun-Tzu once wrote: "Warfare is the greatest affair of state, the basis of life and death, the Tao to survival or extinction. It must be thoroughly pondered and analysed."[2] There is no analysis more objective than that of mathematical logic and it is this stream of thought to which I turn in order to demonstrate the aforementioned conclusions.

The achievements of humanity's great mathematicians have been developed from the foundation of a few axioms—fundamental truths that cannot be proved or disproved, but whose fundamental essences are acknowledged to be true. Upon this foundation, towering theorems of mathematics have been developed by the strictest rules of logic. No proposition can be accepted as true without a rigorous proof. A proposition so proved then becomes an established theorem. These theorems then enable the further proof of far more complex propositions.

Several methods of mathematical logic have been developed to establish proofs of propositions, but no method is as elegant as the method of contradiction, and it is this method that I will use to "prove" that it is really a space-based weapon ban that is inevitable. In doing so, it will become apparent that verification is the keystone of any arms control agreement, including one for outer space. Even in the absence of an arms control treaty for outer space, it will be further established that technology, funding and political capital will eventually coalesce to develop the national technical means necessary to verify a suitably framed arms control agreement for outer space. Improved space situational awareness means will present a low-cost, low-risk off-ramp from an arms race in outer space, and will thus serve to reinforce the likelihood of negotiating an arms control agreement banning weapons from outer space. After all, no state would rationally spend billions of dollars on weapon systems once it is recognized that the strategic advantage it thought it would gain through such an expenditure would quickly be lost to strategic parity, and once it was realized that the efficacy of defending satellites with weapons was likewise questionable given the vulnerability of these systems themselves to opposing weapons.

The method of proof by contradiction first begins with a proposition. The proof proceeds by assuming that the proposition is false or by assuming that the opposite of the original proposition is true. The proof then proceeds by presenting a line of argument that necessarily leads from this assumption

to a contradiction. Hence, the conclusion that the original proposition is false must be false or, in other words, that the original proposition must be true.[3]

Let me begin with the original proposition that I desire to "prove":

A space-based weapon ban is possible.

The proposed "proof" of this proposition is to be established by contradiction. Therefore, assume that the original proposition is false by declaring that its opposite is true:

The weaponization of outer space is inevitable.

I will now attempt to develop a line of argumentation that will establish that this second proposition is false.

If the weaponization of outer space is inevitable, then it is logically also true that no single nation will possess a monopoly on space-based weapons. I cite humanity's experience with nuclear weapons to support this conclusion. In 1945, the United States had a monopoly on the possession of nuclear weapons and by 1949 the Soviet Union had possessed its first nuclear weapon. This date was from 1 to 4 years earlier than some US intelligence analysts had predicted in 1946.[4] Then, in 1957, the Soviet Union launched the world's first artificial satellite and by 1961, the United States had followed suit. History therefore demonstrates that asymmetric advantages are quite fleeting when the subject concerns technological development in support of national security.

This leads to an argument that outer space is of the same order of strategic importance for states in the twenty-first century as nuclear weapons were to states during the twentieth century, if only because of the great utility of outer space for the prosecution of both conventional and nuclear war on the Earth. I am supported in this assessment by the fact that outer space best enables the use of information technology to support mobile, global military operations on the Earth, whether conventional or nuclear. According to Bruce Berkowitz in 2003:

> Today the ability to collect, communicate, process and protect information is the most important factor defining military power. In the

> past armour, firepower, and mobility defined military power, but now it often matters less how fast you can move or how much destructive force you can apply. Stealth trumps armour, precision trumps explosive force, and being able to react faster than your opponent trumps speed . . . to defeat your opponent you must first win the information war. You can do this by making your own information systems more capable, reliable, and secure, or by attacking your opponents systems so that they are less capable, less reliable, and less secure.[5]

The global reach and relatively secure access provided by outer space makes it the preferred location to build the information networks necessary to win the information wars of the twenty-first century. Consequently, the doctrine of exercising "space control", "space superiority" or "space dominance" today will be as strong an impetus as holding the "fatal terrain" at the time of Sun-Tzu:

> In general, whoever occupies the battleground first and awaits the enemy will be at ease; whoever occupies the battleground afterward and must race to the conflict will be fatigued. Thus one who excels at warfare compels men and is not compelled by other men.[6]

Given the clear strategic importance for any great power of securing the use of outer space for itself and denying it to its adversaries, and given the dire consequences that would similarly be borne by any other great power willing to cede this fatal terrain to a rival, it is logical to conclude from humankind's nuclear weapon experience that:

> Any initial space-based weapon deployment will face off against an opposing space-based weapon deployment.

At first, space-based weapons could be directed at negating current satellites that supply crucial information to military missions on the Earth. Current military force support systems in outer space, such as reconnaissance, navigation and communications satellites, are not weapons in themselves, but nevertheless the ability to negate these targets can at first blush appear to be profitable in denying an opponent access to the information it needs to prosecute a modern war. Subsequently, however, once space-based weapons targeted on orbital military assets are deployed opposite one another, opposing military strategists will also be forced to develop counterforce space-based weapon systems, lest an adversary's

deployment of similar counterforce space-based weapon systems secure a significant military advantage for that opponent. This demand to find and negate an opponent's space-based weapons before that opponent finds one's own weapons, together with the fragility and vulnerability of one's own satellites and space-based weapons to such negation weapons, will force the development of an ability to discriminate a weapon system deployed in outer space from a non-weapon system deployed in outer space.

This ability to discriminate targets in outer space will also quickly develop because:

- the moral constraints of the Laws of Armed Conflict militate against a doctrine directing weapons indiscriminately at counter-value targets;
- there is no advantage to be gained from the stalemate represented by parity in strategic weapons; and
- one's own space-based weapons will be vulnerable to a first strike by an adversary's counterforce space-based weapons.

Prospects in this regard will therefore echo those found during the Cold War with first-strike nuclear counterforce weapon systems, such as the Soviet SS-18 Satan and the American MX Peacekeeper intercontinental ballistic missiles. In the absence of prior agreed constraints, this posture would become necessary for weapons in outer space, just as it was for nuclear weapons on the Earth, in order to limit dire consequences of allowing counter-value targets to remain at risk of destruction by counterforce weapons maintaining freedom of action to attack. Ergo,

> It will become possible to discriminate space-based weapon systems from non-weapon space-based systems.

This ability to discriminate a weapon from a non-weapon space-based system will be further assured by the development of national space situational awareness means to ascertain the threats to orbital assets supporting currently accepted military uses of space—the navigation, remote sensing and communications satellites necessary to support military operations on the Earth with global, time-critical information. These national technical means could also be needed both to protect current assets from harm through reinforcing the capabilities of non-offensive defences and to guard against the emergence of space-based weapons that

could threaten internationally accepted military uses of outer space. Given the strategic importance of outer space, I contend that the necessary human, technical and financial resources will be devoted by all of the major space-faring states to obtain the ability to know what is going on in outer space to a degree of certainty sufficient to identify the emergence of new military threats against satellites and against facilities, forces and other military assets on the Earth.

In addition, it is also possible to portray the development of such space monitoring assets as pre-cursors to a terrestrially-based anti-satellite system as a further military hedge against an adversary populating a constellation of orbital weapons designed to suppress all launches into outer space, whether ballistic missiles or space launch vehicles, or to negate critical satellite functions involved in the sensor-to-shooter decision cycles of modern military conflict. Twenty-first century military conflict is increasingly focused on winning the observation, orientation, decision and action (OODA) loops through the use of global, high-speed information networks. The victor in any modern military conflict will be the state whose OODA loop is faster and more secure than the OODA loops of any other state. In doing so, the development of these national space situational awareness technologies will further serve as a demonstration of resolve by states to possess the targeting means to deny sanctuary to any future space-based weapon system.

During the Cold War, however, then-President Ronald Reagan directed that the United States would be willing to negotiate an arms control agreement for outer space if three conditions could be satisfied. First, any arms control agreement must be in the national security interests of the United States; second, it must require equitable obligations on all participants; and third, it must be effectively verifiable.[7] These rational criteria are still suitable for use by all states in their own national security calculus. Let us deal with them in reverse order.

If it is possible to discern a weapon from a non-weapon deployed in outer space, then it is also logical to deduce that:

> A treaty banning the deployment of weapons in outer space is adequately verifiable.

This is known to be true because simply by using the surveillance means that would otherwise be necessary to wage conflict in outer space to determine that all space-based objects are in fact not weapons can discern the absence of a weapon. A standard of verification equal to the standard needed for armed conflict in outer space should be sufficient, since both defence- and arms control-oriented solutions for safeguarding space security seek to ensure that no nation gains a consequent military advantage over others. This standard is termed adequate verification and differs from effective verification in that its objective is to be sufficiently robust to deter all cheating as opposed to detecting all possible forms of cheating. Adequate verification is focused on detecting militarily significant incidents and not every minor non-compliance with a treaty.[8] In short, adequate verification is the same standard used to discern a military threat based on capability as opposed to discerning a political threat based on intent.

It now becomes possible to conclude further that the ability to discriminate a weapon from a non-weapon space system, given concerns over the possibility of a pre-emptive attack on satellites, will also lead to an ability to establish the absence of space-based weapons at any point in time, including the time prior to the entry into effect of a universal treaty banning the testing, deployment and use of space-based weapons. To the best of anyone's knowledge at the present time, no nation has operationally deployed a long duration space-based weapon. Hence:

> The initial absence of space-based weapons would impart equal obligations on all state parties to a universal treaty banning the testing, deployment and use of weapons in outer space.

The national security interests of a state party to an arms control agreement stands as the last test to be surmounted and it is here that I resort to the principles of risk management—a well-known practice in the affairs of state. Risk, as it is understood in the context of risk management, is defined as the probability of an event occurring times the consequence of that event occurring. The probability is a number between zero, representing impossibility, and one, representing certainty. The consequence can be expressed as the unbounded cost needed to restore the situation to a state prior to the occurrence of the event. These two variables are independent of one another. The probability of an event can be low and yet risk can be quite high because the value of the consequence can be very great. A terrorist detonating a nuclear weapon is one such

example of a low-probability but a high-consequence event. Conversely, a highly probable event with low consequence does not necessarily constitute a significant risk. A terrorist with a belt of conventional explosives stands as an example of a high-probability but a relatively low-consequence event, considered at a national level (discounting psychological impact).

The probability of an event occurring is equated to the threat in the context of a threat analysis. The variable threat is defined as the product of intent times capability of an opponent. Both intent and capability variables range between zero, representing no intent or no capability, and unity, representing certain intent or full capability. Intent and capability are again independent variables, since an opponent can be all bluff and no capability, or all capability and little inclination. If an opponent can be assessed to be all intent and little capability, the threat can be judged quite low. If a state consists of all capability but little intent, as in the case of a military ally, the threat can also be judged quite low. If an opponent has little intent and little capability then the threat is of even less of a concern than that of the first two cases.

When this threat equation is inserted into the equation for risk, it is clear that a low threat will always reduce risk regardless of the value of the consequence. Said differently, a high consequence does not necessarily equate to a high risk because the threat can be quite low. The benefit of an arms control treaty now becomes obvious. Despite the reliance of any great power upon space-based assets to conduct its terrestrial military operations on the Earth (amounting to high consequence), the verified absence of an opponent's space-based weapon (little capability) positioned within the confines of a universally adhered to treaty (little intent) produces a risk that is comparatively low. In the absence of a treaty, the consequence variable remains high; capability can also be high as there is no legal constraint to prohibit the testing, deployment and use of space-based weapons by any state; intent can also be high because an opponent must also hedge against the unconstrained intent of its rival in addition to seeking its own strategic advantage.

A numerical example might help to illustrate this conclusion. Suppose that a powerful state has 100 active satellites in orbit and that each of these satellites is worth US$ 250 million. The consequence for conflict in outer space is therefore valued at US$ 25 billion. This enormous figure includes neither the cost of launching the replacement satellites, nor the cost of

removing space debris from orbit after a conflict (assuming that it is possible to do so), nor the cost of replacing lost information from other sources (if any). Suppose now the intent to do harm by an adversary is one, or absolute certainty, and that this adversary has developed, tested and operationally deployed space-based weapons, so capability is also assessed as being equal to unity. Then, in the presence of these weapons, the risk equals one times one times US$ 25 billion, or simply US$ 25 billion. Alternately, imagine that a state wishes to use its own space-based weapons to defend some of these satellites from other weapons and that its defence system is as effective as the average of prior Soviet and US anti-satellite testing results, or 75%. The risk has now been reduced to US$ 6.25 billion or just 25% of the original ante. Of course the belligerent state might also be exposed to a comparable risk from the defending state.

In contrast, consider the opposite case of an arms control agreement that bans the testing, deployment and use of space-based weapons. Intent, expressed as a proportion of states outside the agreement, might now be reduced to 10%, a number in the same range as the proportion of states outside the Non-Proliferation Treaty. The probability of a weapon capability could also be as low as 10%, based on a 90% confidence level goal for verifying the absence of weapons. (This confidence level appears, for example, to be borne out by the United Nations Monitoring, Verification and Inspection Commission's investigations and conclusions on Iraqi weapons of mass destruction.) Under this scenario, the risk could be as low as US$ 250 million. This amount is 1% of the full risk scenario, or 4% of the limited defence scenario above, and it does not encumber any national treasury with the cost of developing, deploying or maintaining weapon systems in outer space—the most expensive domain in which to operate military systems. Instead, an arms control strategy only seeks to use a verification system equal to the monitoring system that would be needed in any event to ascertain the threat to a state from any other state's space activities (therefore representing little or no additional expenditure). The arms control approach would also sharply reduce the risk of generating space debris that could threaten the sustained use of outer space for the support of military and other operations.

Contrasting the above scenarios clearly illustrates that the risk is significantly lower with a universal, adequately verified arms control agreement prohibiting an entire class of weapons from a pristine domain. This analysis also does not include the further benefits accruing to the use

of non-offensive defences, which equate to protection measures as understood in the context of risk management.[9] This simplified analysis generates the penultimate conclusion that:

> It is in the national security interest of every state to prohibit the deployment of space-based weapons before the threat emerges.

Thus far in the "proof", the three criteria for a space-based weapon ban, established by an iconic former US president, appear to have been met. As the current US national space policy of 1996 echos these earlier three criteria for arms control agreements[10], one must conclude that:

> A space-based weapons ban is possible.

Given the contradiction of a conclusion that an arms control treaty banning the weaponization of outer space is possible with the converse premise that the weaponization of outer space is inevitable concludes the proof by contradiction.

> Quod erat demonstrantum (QED).

The key conclusion of this analysis is that the verified absence of a capability produces little risk regardless of the consequence or the intent. It is important to recognize from this analysis that risk tends to vanish as the capability tends to zero. This analysis also demonstrates that verification is the key requirement for the success or failure of a risk management strategy based on risk avoidance through an arms control agreement banning a whole class of weapons. In addition to the avoidance of risk based on a ban on capabilities, an arms control agreement with adequate verification provisions will also validate a low intent of the signatories to the agreement by detecting any militarily significant non-compliance early enough to elicit an appropriate response. This too will serve to reduce risk even further by deterring cheating or break-out situations. Available non-offensive protection measures for outer space can further reduce the risk of any state party's non-compliance with an agreement by lowering consequence through hardening and other measures. Adopting a diversification strategy for information technologies other than satellites will also decrease risk (just as the Internet remains robust against systemic failure by being based on a dispersed network of computers). By diversifying information network capabilities to include land, air and sea assets in addition to space systems,

a risk management strategy of coping with failures through creation of a failure-tolerant network will reduce risk and further diminish the need to protect space systems with weapons. This total risk management strategy, which is not based on weapons, accords with strategies of risk avoidance and risk protection. In President Reagan's era this calculus became expressed as "Trust, but verify".

Some opponents of the arms control approach seek instead to adopt risk transfer strategies and risk acceptance strategies through a reliance on weapons. Under classic risk management principles, risk transfer seeks to transfer the risk to other parties and risk acceptance strategies are strategies based upon simply coping with the attendant risk. Threatening an opponent's space systems with weapons in a deterrent posture is tantamount to a risk transfer strategy as one's own assets are "defended" by the threat of retaliation. This strategy also, however, results in higher risk because the certainty of weapons is always a more risky proposition than the uncertainty of an adequately verified absence of weapons. In addition, the simplified analysis above demonstrates that reliance upon active defence with weapons comes with an attendant higher consequence of accepting the risk because no defence is perfect. Finally, protecting satellites with escort weapons in outer space in no way addresses the greater risks to space systems and the electromagnetic links to and from satellites posed by the existing terrestrial threats of conventional weapons. In short, the verified absence of weapons is a less risky proposition than the defence of a capability through reliance on manifest weapons.

The analysis above also illustrates that, in the absence of an arms control agreement for outer space, lack of good will or trust among major space-faring powers will likely lead to the development of national technical means for intelligence collection to ascertain the space capabilities of rival states. The demonstrated consequence of ceding the "fatal terrain" of outer space to rivals in this analysis is so risky to the survival of states in the twenty-first century that great sums of money and vast amounts of effort will be spent on securing the technical and human means necessary to assess the threats to one's own space systems. These strategic needs will consequently bring about the necessary technologies, monies and political capital for space situational awareness assets that could (arguably better) be put to use verifying a space-based weapon ban. A space-based weapon ban enabled by improved situational awareness would present an attractive off-ramp for a fruitless arms race, whose most

probable end-state would be either the stalemate of strategic parity or high levels of uncertainty resulting from asymmetric responses.

Given that the absence of weapons in risk avoidance and protection strategies will result in lower risks than strategies based on risk transfer and risk acceptance using weapons, an arms control agreement for outer space becomes an increasingly likely means to safeguard space security. The calculus has been made obvious. What remains is whether Sun-Tzu's further wisdom will be recognized:

> If a general follows my [methods for] estimation and you employ him, he will certainly be victorious and should be retained. If a general does not follow my [methods for] estimation and you employ him, he will certainly be defeated, so dismiss him.[11]

Notes

1 The views presented in this paper do not necessarily represent the views of the Government of Canada or those of Foreign Affairs Canada.

2 Ralph D. Sawyer, 1994, *Sun-Tzu The Art of War*, New York, Barnes & Noble, Inc.

3 Peter J. Eccles, 1997, *An Introduction to Mathematical Reasoning*, Cambridge, Cambridge University Press.

4 Central Intelligence Agency, 1946, *Soviet Capabilities for the Development and Production of Certain Types of Weapons and Equipment*, Report number ORE 3/1–31 October, Washington, DC, Office of Public Affairs.

5 Bruce Berkowitz, 2003, The New Face of War, How War will be Fought in the 21st Century, New York, The Free Press, p. 21.

6 Ralph D. Sawyer, 1994, op. cit.

7 See *Presidential Directive on National Space Policy*, 11 February 1988, at <www.hq.nasa.gov/office/pao/History/policy88.html - 38k> that reads as follows: "The directive also states that the United States will consider and, as appropriate, formulate policy positions on arms control measures governing activities in space, and will conduct negotiations on such measures only if they are equitable, effectively verifiable, and enhance the security of the United States and its allies".

8 Charles A. Appleby and John C. Baker, 1992, Verification and Mobile Missiles: Deterrence, Detection, or Assurance?, in John. G. Tower,

James Brown and William K. Cheek (eds), *Verification: The Key to Arms Control in the 1990's*, McLean, VA, Brassey's, Inc.

9 Phillip J. Baines, 2004, Non-Offensive Defences: Space Protection without Space-Based Weapons, *Astropolitics*, vol. 2, no. 2 (summer).

10 Current US space policy as documented in the White House *National Space Policy: Fact Sheet*, 19 September 1996, at <www.ostp.gov/NSTC/html/fs/fs-5.html - 34k> that reads in part: "The United States will consider and, as appropriate, formulate policy positions on arms control and related measures governing activities in space, and will conclude agreements on such measures only if they are equitable, effectively verifiable, and enhance the security of the United States and our allies".

11 Ralph D. Sawyer, 1994, op. cit.