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Space and Verification

Ambassador Roger G. Harrison

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KEY POINTS

- Governments will have to take steps to stabilize the space environment or space will become more contested and congested. The idea that this can be done *without* reciprocal constraints on behavior of all major actors is an illusion.
- Any regime in space requiring constraints can only be sustained over time if the parties have sufficient assurance of the compliance of others. This includes systems of "norms," "best practices" and "codes of conduct" as well as treaty limitations.
- Accordingly, U.S. policy on specific proposals for normative measures in space whether of the "hard" or "soft" variety should be based from the outset on consideration of whether or not compliance can be verified within reasonable limits, i.e. that the U.S. will detect non-compliance that alters, or might in future alter, the relative strategic position of the U.S. in time to respond appropriately.
- Based on this standard, the technical means are at hand to monitor compliance with a wide range of arms control and other measures (see part two).
- No other major space actor, viz. China, will accept meaningful constraints on freedom of action in space if it cannot verify compliance independently. Accordingly, agreement on constraints will be limited to those measures verifiable by the *least* capable major party.
- As the country with the *most* capability, the U.S. is unlikely to be confronted with serious proposals (as opposed to diplomatic feints) that exceed its verification capability.
- Verification depends on both technical capability and *precision* of language in delineating *specific* measures. If specificity is sacrificed to consensus, the resulting regime of non-binding, qualified and/or vaguely-worded "norms" may undermine rather than increase stability in space.
- Verification is also critically linked to enforcement. If non-compliance is detected but not charged, verification becomes simple monitoring and the effectiveness of reciprocal restraints is lost. Non-compliant actors may be "lulled" into thinking non-compliance is the norm; the international community may become convinced that TCBMs are improving security, when in fact they are not.
- The Outer Space Treaty (OST) has had minimal impact on preventing the rise of congested and contested space in part because all major players have favored maintaining freedom of action over enforcement of constraints.
- The use of space has instead been structured by the Limited Test Ban Treaty (LTBT, which mitigated the threat of a nuclear arms race in orbit) and by the non-interference provisions of nuclear arms control agreements. Non-interference has played the greater role. It formally exists only in the bilateral U.S./Russian context, but could be extended.
- The question now is: does the threat of congested/contested space outweigh the disadvantage of accepting constraints on U.S. freedom of action such as would be involved in agreements limiting specific and observable behaviors in space? If so, effective verification regimes can be devised to ensure that the U.S. strategic position in space is not compromised by such agreements.
- The most effective such regime (i.e. that which will provide the most certain verification, and the best chance of creating negative consequences for non-compliance) will include elements of unilateral, multilateral, cooperative and "open" verification.
- Verification provides the U.S. with an opportunity to fulfill the pledge in the 2010 National Space Policy to renew its leadership in international space forums by delineating a workable structure for a more stable space environment and asserting leadership in an area of its relative and enduring strength.

SPACE VERIFICATION

The purpose of this study is twofold. First, to determine to what extent multilateral agreements to limit disruptive actions in space and/or establish norms of behavior are verifiable; second, to consider under what circumstances space verification serves U.S. interests.

Introduction

It is commonly said, especially by military spokesmen, that space is becoming more congested, contested and competitive. These trends are predicted to have increasingly negative consequences for national security. If this is the case, three alternatives present themselves for policy makers: do nothing, in which case the negative trends presumably will continue until all of space becomes more dangerous and some of it un-useable; hope that a rough order emerges as independent players attempt to maximize their interests – a sort of "invisible hand" solution; or take positive steps to create order out of the emerging chaos. This last alternative will probably require that all major actors accept some inhibition on freedom of action in space. This has been clear for some time regarding mitigation of space debris. In an increasingly congested and contested environment, it may become true of other activities as well. But no sovereign actor will accept such limitations unless it can be assured of the compliance of others. Hence, verification becomes a key factor.

Definitions

Verification is any process designed to demonstrate a party's compliance or non-compliance with an agreement or treaty. For our purposes, verification is relevant to all agreements that place constraints on *specific and observable actions* in space or directed at space, including deployment, testing and/or maneuvers of weapons or other systems as well as physical or electro-magnetic interference with the operation of satellites. It therefore differs from monitoring, which is the technical ability to observe activity. *Intentions* are not verifiable, although an effective verification regime can detect patterns of activity from which intent may be inferred. The same is true of unilateral declarations of good faith, best behavior or resolve to promote various laudatory outcomes in space. Multilateral agreement on norms of behavior represents a gray area. Those that grow over time to create political inhibitions against certain actions in space may be a proper subject for verification, and knowledge of behavior in space created by verification regimes may help in building the case that such norms exist. But this applies only to norms against *specific and observable* behaviors and may be more apparent than real. It can be argued, for example, that a norm against kinetic ASAT tests in space existed for more than two decades after the mid-1980s, when both the U.S. and the USSR ceased testing. As the Chinese ASAT test of 2007 showed, however, one nation's norm may be another's target of opportunity.

Verification does not apply to rogue actors whose intent is to disrupt the system and whose actions can only be monitored. A verifiable regime among major actors does not, therefore, eliminate the possibility of disruptive actions in space. It does, however, create a common interest among the most influential space powers to isolate outliers and bring international pressure to bear against such behavior.

Both arms control and verification of compliance can contribute to strengthening deterrence, since well-conceived measures make it more difficult for an adversary to test and deploy offensive weapon systems, and may enhance warning of potential threat. It should be emphasized that such measures limit behavior in peacetime, but not in war. If deterrence fails, only those agreements specifically applicable to hostilities (like the Geneva and Hague Conventions) continue legally to apply. Accordingly, arms control, norms, rules of the road and other schemes to foster a stable and predictable environment in space do not limit war-time options, any more than laws of peaceful transit at sea or in the air limit freedom of action if hostilities occur.[1]

Premises

- Any regime in space requiring U.S. self-restraint can only be sustained politically over time if the U.S. can be assured of the compliance of others. This includes systems of "norms," "best practices" and "codes of conduct" as well as treaty restraints.
- Accordingly, U.S. policy on specific proposals for normative measures in space whether of the "hard" or "soft" variety should be based from the outset on consideration of whether or not compliance can be verified within reasonable limits.
- No major space actor is likely to accept meaningful constraints on its freedom of action in space unless it can verify independently the compliance of others. The capability of verification by the least capable major actor will therefore define the limits of agreed constraints. [2]

What are "reasonable limits"? All agree that verification can never be exact. Even in the absence of intention to evade (which cannot, of course, be discounted) there can be non-compliance at the margins, viz. operator mistakes, disputes about how agreements apply in particular circumstances[3] or ambiguity in the terms of the agreements themselves.[4] Parties may push the edges of the interpretive envelope or probe the capabilities of the others' sensors. The term of art is "circumvention" and refers to "exploitation of imprecise treaty language, loopholes, omissions or ambiguities" that may have military significance.[5] The question is: when does such behavior cross the boundary from nuisance, or the normal friction of competitive relationships, to become a concern for national security?

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[1] On this point, see *inter alia*, Jonty Kasku-Jackson and Elizabeth Waldrop, "Understanding Space Law," in the Eisenhower Center's book, *Space and Defense Policy*, (London: Routledge Publishing, 2009), p. 65.

[2] Hays describes how nuclear limitations "could only be as precise as could be 'seen' by national technical means" in Peter L. Hays, *United States Military Space: Into the Twenty-First Century*, INSS Occasional paper #42, (Maxwell AFB, AL: Air University Press, September 2002), p. 57. Hence, according to Hays' account, limitations of nuclear testing in space only became possible with the deployment by the United States of the Vela Hotel satellite series that allowed such activity to be detected. The assertion here, in short, is that neither the U.S. nor other major actors would rely on data from potential adversaries effecting real national security interest.

[3] On this point, Chayes and Chayes argue nations may simply not have enough information to comply. *The New Sovereignty: Compliance with International Regulatory Agreements*, (Cambridge: Harvard University Press, 1995)

[4] For a discussion of the negative impact of ambiguity on verification of arms control agreement see "Verification and Compliance" in Albert Carnesale and Richard Haass, *Superpower Arms Control*, (Cambridge: Ballinger Publishing, 1987), Chapter 11, where Haass argues that the pressure to achieve agreement may result in purposeful ambiguities in language which are then reflected in disputes about verification.

[5] *Ibid*, p. 304.

For the purposes of this analysis, verification within "reasonable limits" means the ability to detect non-compliance that alters or might in future alter the relative strategic position of the United States in space, with sufficient warning time to respond appropriately. This includes restrictions on the orbiting of certain types of satellites, the use of certain critical orbits, the maneuvering of satellites, and the testing of either ground based or space based ASAT capability. A verification regime that met this standard might not detect individual instances of non-compliant behavior. But the contention here is that the constellation involved in U.S. security space, both government and commercial satellites, has expanded to the point that it presents a dispersed and difficult target for any would be attacker. Weakening the relative strategic position of the United States in space by attacks on satellites would therefore require patterns of behavior over protracted periods of time in space and directed at space.[6] Such patterns would create opportunities for detection and make the larger effort visible. Many claim that this process is currently underway. Supposing this analysis is based on fact, it underlines the conclusion that the problem is not detection, but concerting action both nationally and internationally to respond.

Space as a Domain for Verification

From the point of view of verification, the most obvious attribute of space is also the most relevant: space is transparent.[7] Moreover, space is a medium and long-term environment where the process of research, development and deployment is measured in decades. The provision that the U.S. be aware of significant changes "in time to respond" is therefore less stringent, especially since the appropriate response may be in domains other than space.

Technology has sometimes held out the hope (or the threat) of making space less transparent as a way of bestowing unilateral strategic advantage. This would be the effect, for example, of "stealth" technology in space. There are reports in open sources of programs to create stealthy satellites, as well as reports that such programs proved technology infeasible and have been abandoned. Such technologies would obviously pose challenges for verification; indeed, the proliferation of stealth technology might well hasten the trend toward congested and contested space, with no obvious remedy. The unilateral possession of stealth technology (or its equivalent) by the United States could well provide military advantage. But history teaches that such a technological edge – from tanks to ballistic missiles to nuclear weapons to SLBMs to MIRV's – is usually short lived. The general proliferation of stealth technology in orbit would make establishing a stable environment much more difficult, if not impossible, and would be very disadvantageous to the United States as the predominate player. It would, by definition, defeat efforts for constraints on specific and *observable* behaviors and would necessarily degrade situational awareness for all actors.

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[6] As distinguished from denying space services to a particular battlefield at a particular time, a capability which military planners should assume potential adversaries have or will soon have.

[7] The contrast is with the terrestrial arms race, where crucial behavior was often opaque. The U.S. had no physical description of the Soviet SS-20 MRBM (which changed the strategic balance in Europe) until it was deployed, and no imagines of it until the INF treaty was signed. Chemical and biological weapon production can, and has been, successfully disguised. There is not direct analogue in space.

There are also stealth implications in the recent trend toward miniaturization of satellites. Small satellites could in theory be used as co-orbiting kinetic kill or close proximity explosive devices (the euphemism is "non-cooperative rendezvous") and in this guise would be, in effect, intelligent space mines. They might not be too small to see, but conceivably too small to track and therefore to counter. There is no restriction in international law against orbiting a space mine in proximity to military satellites. It has been technologically feasible since the advent of maneuverable satellites, but the option - though explored by the Soviets in the 1970s - has not been pursued.[8] Making such devices small in size would, in theory, also make them deployable in larger numbers at lower cost. Still, a *program* significant enough to meet our threshold of verifiability "within reasonable limits" would have to be extensive and involve launch, command and control and testing activities that would potentially leave signatures observable in a variety of domains, including the electromagnetic spectrum. If very small satellites do represent a potentially undetectable threat, they would fall into the category of those things – like bans on laboratory-based research and development – which are neither observable nor verifiable and therefore fall out of the realm of any regime of reciprocal constraints. This is a judgment for others with better access to information about actual programs.

A Short History of Verification and of Space Arms Control

All treaties that contain binding obligations are subject to verification, whether or not the treaty language includes verification provisions.[9] The Limited Test Ban Treaty (1963) – the first arms control agreement that mentions space – contained no reference to verification. Verification had been a central issue in negotiations, but distrust between the two sides, and the closed society that was the Soviet Union, made cooperative measures impossible, and space reconnaissance was still in its infancy. The Soviets took the position that both sides possessed adequate means to verify compliance without intrusive measures like on-site inspection, and that compliance would be compelled by the pressure of international public opinion. President Eisenhower responded that only the largest tests could be detected with certainty and that an effective test ban would therefore require "inspection and control" – i.e. that adequate verification would require a combination of unilateral, cooperative and multilateral measures, including seismic monitoring stations and a multilateral control commission empowered to make on-site inspections on demand.

In the end, the scope of the treaty was limited to nuclear explosions in the atmosphere, in outer space and under water – i.e. the scope of constraint was reduced to what the parties were confident each could verify unilaterally without the more intrusive verification measures that more extensive constraints would have required. In the aftermath, each of the superpowers made considerable effort to monitor compliance, and each raised compliance issues with the other, although there is no evidence that either side was ever in violation. For our purposes, the LTBT was both the first agreement constraining activities in space, and the first Cold War example of the practice of limiting constraints to those that could be verified unilaterally by the

[8] Nicholas Johnson, *Soviet Military Strategy in Space,* (London: Jane's Publishing Company, 1987), p. 172.
[9] By the same token, voluntary or declaratory measures that our not specific and not binding cannot be verified in the sense the term is used here.

parties.[10] That practice continued through the nuclear arms negotiations of the following decades, viz. as national technical means improved, counting rules evolved from counting launchers to counting warheads, the key being, as Hays comments, "what could be seen." An exception to this pattern was the Biological Weapons Convention (1972) which, like the LTBT, contained no verification regime, but, unlike the LTBT, constrained activities (the production of biological weapons) that were inherently undetectable by outside observers.

The BWC was the last agreement in the Cold War era that did not include specific verification measures. The trend beginning with bilateral U.S./Soviet nuclear limitation agreements in the 1970's was to incorporate verification measures of increasing complexity and intrusiveness in treaty language, including a variety of "cooperative measures" by which the parties were obliged to take steps to enhance the visibility of their programs. Generally speaking, the extent and intrusiveness of verification measures depended on:

- The "transparency" of the domain involved, (i.e. the inherent ease of disguising or difficulty in observing non-complaint behaviors);
- The "criticality" of agreed constraints, i.e. whether small changes in the existing balance of forces might be difficult to detect and have disproportionately serious consequences;
- The general state of relations or "trust factor" between the parties, and therefore the possibility of cooperative verification measures to increase transparency.

Verification also became more prominent in the negotiations of arms control as skepticism grew, particularly in the U.S. Senate, about the reliability of the Soviets as a partner, and the benefit of arms control regimes in general. This trend is well illustrated by the detailed on-site, on-demand inspection regime of the last of the Cold War treaties, that dealing with chemical weapons, but it had already been evident in the treaty eliminating intermediate range nuclear forces in Europe (INF).

The Outer Space Treaty

The Outer Space Treaty contains only one provision that might be said to have the purpose of verification: a provision that all parties with facilities on the moon allow reciprocal visits by others with similar facilities (Article VII). The background was fear of the strategic value of the moon both as a base for nuclear attack and for the surreptitious testing of nuclear weapons. Such fears proved unfounded. Otherwise, the OST was silent on the issue of verification, although it contains several provisions that impose constraints on freedom of action in space. The most prominent example is the stationing of nuclear weapons or other weapons of mass destruction in space, on the moon or on other celestial bodies (Article IV). But states parties are also enjoined to carry on their activities "with due regard to the corresponding interests of all other States Parties to the Treaty" and to avoid "harmful contamination" of the space environment (Article IX), provisions that might be interpreted to apply to debris-causing ASAT tests in space. The OST also obligates parties to consult with others when they have reason to believe their activities in space will cause "harmful interference" with the space

[10]Clay Moltz argues that the LTBT, and the subsequent agreement (General Assembly Resolution 1884) not to deploy weapons of mass destruction in space were "critical" to allowing the further development of space for satellite reconnaissance and manned missions. See Moltz, p. 141.

operations of other parties (Article IX), a provision that Hays interprets as forbidding jamming, blinding or otherwise disrupting space activities without prior consultation.[11]

The absence of verification provisions reflected U.S. confidence that it possessed the independent means to verify satisfactorily the constraints contained in the Outer Space Treaty. The absence of verification measures was also a function of limited superpower interest in undertaking banned activities and U.S. desire to minimize focus on its NTM capabilities or expose them to international scrutiny. During ratification hearings for the OST in the Senate, Administration witnesses argued that although the U.S. national technical means (NTM) could not verify the purpose or content of any particular object in space, it could detect mass deployments before they became "militarily significant." Chairman of the Joint Chiefs Wheeler also said that the U.S. would prefer using its own resources for verification rather than relying on any international on-site inspection regime, and Secretary of State Rusk claimed that the U.S. was confident of its ability to detect any deployment of nuclear or weapons of mass destruction in space.[12]

ASAT Negotiations

The Carter Administration undertook ASAT limitation negotiations with the Soviet Union beginning in 1978. Three sessions were held, but the results were inconclusive. The U.S. opened with a proposal for a complete prohibition on anti-satellite weapons. The Soviets seemed to have been without specific instructions, but generally opposed an outright ban. The Soviets alleged that the Space Shuttle could be viewed as a potential ASAT weapon. They also argued that certain satellite operations by third parties could threaten state sovereignty and anti-satellite capability was a legitimate means of self-defense;[13] the Soviets had begun to consider the threat posed by Chinese space capability, against which their ASAT program was also directed.[14]

Verification was a subject of concern, but other factors were more important, among them asymmetry in capability.[15] By 1978, the Soviets had an operational ASAT system, which they refused to dismantle; the U.S. capability was in development but a conventional system had not yet been tested or deployed. The Pentagon was also concerned about the vulnerability of the U.S. security space constellation which at this point was still relatively small. According to John Wertheimer, OSD and JCS preferred to rely on U.S. technological superiority rather than arms control to address what they saw as a dangerous ASAT imbalance.[16] In response to DoD concerns, President Carter adopted a "two-track" policy, i.e. continuation of ASAT development while negotiations on banning ASAT continued. Like most "two-track" approaches (the INF negotiations of the 1980's are another example) the tactic was intended as much to assuage

[11] The range of possible activities requiring prior consultation are described by Hays as "should not jam, blind, or otherwise disrupt unless required for self-defense or during hostilities." See Hays, p. 51. Hays also points out that the International Telecommunications Convention prohibits "jamming or disruption" except in self-defense or war.
[12] Hays, p. 70 describes the Administration arguments on verification during the Senate debate on ratification of the OST. General Wheeler elsewhere noted for the record that the "Joint Chiefs of Staff remain concerned about the assurance of verification capability with regards to weapons in orbit," quoted in Stares, p. 104.
[13] Carnesale and Haass, pp.144-145.
[14] *Ibid.*
[15] Stares claims that DoD concerns focused not on verification difficulties, but on limitations to U.S. freedom of action. See Paul B. Stares, *Militarization of Space*, (Ithaca: Cornell University Press, 1985), p. 197.
[16] Carnesale and Haas, p. 146-147.

differences of opinion within the Administration as to impress the Soviets with U.S. resolve. Given fears about Soviet plans to deploy systems in space to launch or facilitate attacks in the atmosphere—particularly satellites to enable targeting of carrier battle groups—there was also reluctance to give up U.S. offensive ASAT options.

In terms of our analysis, none of the variables conducive to agreement on verification were optimized. Rudimentary capability of space situational awareness meant that space, though inherently transparent, was not practically so. Because the U.S. relied on a very small number of military satellites, small changes in the balance had potentially disproportionate consequences. And trust between the parties was very low.

Stares, who conducted a number of interviews with U.S. negotiators, reported fundamental disagreement between key players on the U.S. side. The State Department and Arms Control and Disarmament Agency pressed for comprehensive ASAT restrictions; DoD coalesced around a non-use/non-interference ban. The Soviets were unwilling to discuss a non-use ban extending beyond the two superpowers; the U.S. wanted to extend coverage to its allies. This mutual recalcitrance and the failure of the U.S. to agree on a unified position (rather than concerns about verifiability) were the chief impediments to agreement. With the Soviet invasion of Afghanistan, the climate for arms control deteriorated and after adjournment the ASAT talks were never resumed.[17]

In the intervening thirty years, some of the projected threats to, and military uses of, satellites have proved illusory.[18] Weapon platforms in space continue to have proponents, but vulnerability issues have not been resolved and feasibility has not been proven. Predictions that armadas of orbiting ASAT vehicles were inevitable if negotiations failed proved unfounded. Formal arms control limitations aimed at space were replaced by tacit agreement between the superpowers. Of this tacit approach it might be said that the two sides decided independently that an arms race in an offense-dominant environment like space would be technologically challenging, ultimately futile and meanwhile would divert vital resources in large amounts from more immediate security needs. Research continued; testing and deployment did not.

Categories of Arms Control and Normative Restrictions

Because the general nature of threats to satellites has been well understood for decades, the categories of possible arms control and limitation agreements is also well known. These include limitations on orbiting in proximity to certain satellites (so-called "keep out zones"),[19] operations in transfer orbits or other critical regions of space, the testing or deployment of

[17] This account is taken from Stares who also claims that a draft non-use agreement was prepared, seemed to represent "common ground" but was not concluded. Regarding the two-track strategy he comments: "But like all bargaining chip arguments, the two-track policy could be maintained so long as the question of what the US wanted to prohibit, or put differently, what it was willing to forego, did not need to be addressed. Once negotiations with the Soviets began in earnest, the basic incompatibility of goals within the administration made conflict inevitable." See Stares, p. 200.

[18] A High Frontier civilian panel noted "strong indications" in the early 1980's that the Soviet Union was going to deploy "power directed energy weapons" in space and thereby "alter the balance of world power." (RAND, p. 14)

[19] Keep out zones might be challenged as violations of the OST prohibition on claims of sovereignty in space (Article 11)

dedicated ASAT weapons (whether in space or within the atmosphere) or of other systems such as BMD "in ASAT mode," and on electro-magnetic or other interference with satellites. The last of these is arguably already prohibited by the OST and the International Telecommunication Convention.[20] The verification requirements of various regimes would differ in intrusiveness depending on the inherent visibility of prohibited actions; verification of bans on some categories of weapons, viz. ground based laser generators, might require on-site inspections. Other constraints – for example, bans on kinetic ASAT testing - could be verified with less intrusive measures.[21] Activities grouped under the general heading of research and development are inherently ambiguous and therefore probably outside any regime of mutual constraint. Probably for this reason, no ban on research and development has been proposed by any responsible player.

A prohibition on stationing of weapons of any nature in orbit or on celestial bodies (although not of potential ASAT devices on the surface) is the central feature of the Chinese/Russian "Draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects" (PPWT). The sixth article of that draft treaty does not so much deal with as dismiss the question of verification, putting it off to "possible future protocols."

Verification and the Current Regulatory Regimes in Space

Characterizing space as the "last frontier" may blind us to the fact that it is already, at least in theory, a highly regulated environment.[22] Requirements for and constraints on behavior in space are subject to a variety of administrative requirements, U.N. resolutions and treaty law, including, most prominently, the Outer Space Treaty of 1967. The OST grew out of a UN "Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space" (1962) and had the effect, as described by William Durch, of "(transforming) a nonbinding, international consensus on the political/military conduct of space into legal obligations."[23] But the Treaty was perhaps less foundational than often described, in part because it placed specific constraints on activities (such as the stationing of nuclear weapons in orbit or on celestial bodies, or creation of military installations on the moon) that the only two significant space powers had already decided not to pursue. Even in areas of Treaty-imposed

[20] There is an obvious overlap in capability between air defense, ballistic missile defense, and anti-satellite weapons. The distinction comes not so much in the capability as in the testing of such weapons and is based on the assumption that no country will rely on a system which has not been tested in its intended role. The use of this approach as a means of distinguishing SAM and ABM interceptors during ABM negotiations is discussed in Johnson, pp. 184-185.

[21] It has been argued that a viable kinetic kill ASAT capability could be tested via near encounters without impact and the resultant, and highly visible, debris field. This argues for equipping satellites with sensors to detect activity within the neighborhood of their obits. Deploying a system to threaten a significant portion of U.S. satellites with this sort of single encounter, hit to kill capability would be an extensive and time-consuming effort.

[22] A full description of the regulatory regime in space can be found in Kasku-Jackson and Waldrop, Chapter 4 of *Space and Defense Policy* (*op cit*).

[23] Durch, William J. *National Interests and the Military Use of Space* (Ballinger Publishing, 1984) pg. 176. Hays and others argue that the OST provided reassurance to U.S. policy makers that space would not be an arena of strategic completion, and sent the message that the U.S. itself did not see space has having 'a great deal of military utility' (see Hays, p. 71).

constraint that were remained pertinent, particularly the prohibitions against "interfering with other states' space-related activities" and "damaging the space environment," the OST had less than decisive impact – not because of an inability to verify, but an unwillingness to enforce. This unwillingness apparently stems from concern about disclosing sources and methods, and a reluctance to contribute to the establishment of norms that might limit freedom of action. For example, although there have been numerous cases in the last forty years of heedless creation of debris and crowding of spectra, none of the major space actors has ever accused another of violating the Treaty. Even in the case of the most flagrant recent example of "damage" to the space environment – the debris created by the 2007 Chinese ASAT test - only the Japanese protested on the basis of the Outer Space Treaty. While the OST can reasonably be read as prohibiting "jamming, blinding or otherwise disrupting unless required for self-defense or during hostilities,"[24] it has not been interpreted by any major party to prohibit the sorts of activities that have led officials to describe space as increasingly "contested." Indeed, far from strengthening verifiable norms of behavior in space, lack of enforcement of the OST has arguably weakened them - to the point the authors of the European Code of Conduct thought it appropriate to include a highly qualified and voluntary pledge to refrain from intentional interference, even though most nations are already bound to such a provision in the OST as a matter of treaty law.

Why is this? Moltz comments on the modus operandi that arose between the Soviet Union and the United States during the Cold War that each side appeared to value its own assets more than it valued the ability to destroy the assets of its adversaries.[25] So it might be said of the parties to the OST that all seem to value their own freedom of action in space more than they value constraining the freedom of action of others.

Another agreement from the Cold War Era, on the other hand, had considerable – though generally unacknowledged – effect on ordering the space environment. That is the agreement by the U.S. and the Soviet Union not to interfere with "national technical means of verification" (NTM). This was a key element in the verification regimes of nuclear arms control agreements. It appeared in successive strategic arms limitation and reduction agreements and in the INF agreement of 1987.[26] Because neither of the two Cold War superpowers wished to specify which of its satellites were engaged in verifying compliance, both extended the general ban on non-interference to the entire national security space constellation of the other. It can be argued that restrictions on interference with NTM reflected rather than caused the modus operandi in space between the United States and Soviet Union that began in the 1970s and continues to our day. What is clear is that such a modus operandi did emerge. Despite a period of extended development and testing in the 1970s and early 1980s, both sides eventually abandoned kinetic ASAT programs. Some ASAT weapons imagined in the 1960s, like rail guns and directed-energy weapons, were not pursued. There was no offensive arms race in space, and neither side made space a primary focus of either offensive or defensive action in the case of hostilities. There were also technical, political and budgetary reasons for this of course. But, as Moltz argues, both sides saw the benefits in mutual restraint, and constantly improving NTM technology meant increasing confidence that restraint was reciprocated and not a source of

[24] Hays, p. 51.
[25] Moltz. p. 50.
[26] A discussion of arms control treaties and their relationship to NTM is found in Jonty Kasku-Jackson and Elizabeth Waldrop, "Understanding Space Law," *Space and Defense Policy*, p. 73 as well as Pete Hays, "Space and the Military," *ibid*, pp. 56-59.

strategic disadvantage. The nuclear sanctuary in space fostered by the LTBT provided further assurance of stability, and therefore encouragement to exploit the domain for both military and civil purposes.

A Typology of Verification Regimes

This brief history leads to the conclusion that verification and enforcement are inextricably linked. It is not enough to detect non-compliance, it must also have negative consequences for the perpetrator. That requires both publicizing violation and concerting international efforts to respond. Some verification regimes are more likely to be effective in this regard than others, and combinations of several types might solve what emerge from our analysis as the twin problems of detection, on the one hand, and deterrence on the other.

We have identified four categories of verification regimes, three of which have been well studied in the past, and one of which (at least in its emerging form) is new. These are:

- Unilateral Verification: This includes National Technical Means (NTM) discussed above, but can also include other forms of reconnaissance, intelligence and surveillance carried out by assets under U.S. control or that of trusted partners.

- Cooperative Verification: Cooperative verification requires that participants agree to forego certain measures to disguise behavior, and/or take other steps to enhance transparency. Verification "regimes" in arms control agreements are usually composed of such cooperative measures. For example, the INF Treaty required the parties to allow on-site observation of destruction of the systems by means specified in the treaty. Non-interference with means of verification is an essential element in any cooperative regime. Cooperative measures are also useful as early indicators that one or more parties may have decided than an agreed regime is no longer in its interest, i.e. that the equilibrium sought in the agreement is no longer applicable. In that case, friction may arise in the system as cooperative measures become *less* cooperative.

- Multilateral Verification. Multilateral verification is usually by on-site inspection by groups of international observers. The principal example is the nuclear non-proliferation regime incorporated in the Non-Proliferation Treaty and overseen by the International Atomic Energy Agency. Multilateral verification has the advantage of allowing concerted international action for enforcement of violations. It can also create new norms or strengthen existing ones. It has the disadvantage of requiring agreement between multiple international actors who may have differing interests or interpretations of events.

- "Open" Verification: With regard to space, open verification is a new concept, leveraging the increasing transparency of space to private observers. A precedent was established in the 1970s by the spontaneous organization of "Helsinki Watch Groups" to monitor Soviet compliance with the human rights provisions of the Helsinki Agreement on European Cooperation and Security (CSCE). The reports of these groups were both more detailed and more credible than information other CSCE member nations had been able or willing to provide. The groups were enabled by the mandatory publication in all CSCE member states of the provisions of the CSCE agreement, and by the existence of

new (albeit still rudimentary) channels for communicating their findings to the West. The potential of "open" verification increases enormously because of the instant and worldwide cyber connectivity, as was graphically demonstrated by in the recent past by DARPA and its Network Challenge experiment.[27] It also increases with the volume and accuracy of orbital information made available by governments. With regard to space, an "open" verification regime would be based on the worldwide private space observer community. This community already collects volumes of information about the behavior of objects in space and discusses it over the web, noting anomalies to include spotting satellites not registered as required by international agreement, the United Nations' Registration Convention. If international "norms" for behavior in space, such as those suggested by private groups and the European Union, are to be adopted, open verification is the obvious, and perhaps the only, verification method that would be applicable. It might provide a vehicle for calling attention to aberrant behavior in space without compromising sources and methods. But open verification lacks any enforcement component except for "public pressure," and might therefore create more obstacles for open, democratic societies where public pressure can be brought to bear than in closed societies where it has little relevance.

These categories of verification are obviously not mutually exclusive. Generally speaking, all treaties or agreements of any kind that require nations to engage in or forego specified activities are subject to verification by unilateral means. The fact that SALT and other nuclear arms treaties specified that verification was to be by "national technical means of verification" did not create a *new* right for countries to verify in that way; the innovation was in mutual recognition that the ability to verify was in the strategic interest of both parties. In effect, the parties agreed that strategic stability required not only self-restraint but transparency. This would not have been possible without a minimal level of trust. But as President Reagan often emphasized, the requirement was to "trust but verify," reflecting the melding of cooperation with the independent ability to confirm compliance.[28]

Implications for Policy Makers

This foregoing analysis points to the central (and familiar) dilemma for U.S. policy. Any measure that affects U.S. freedom of action in space imposes a cost. This includes not just measures to restrict certain behaviors, but verification measures that make U.S. space operations more visible to potentially unfriendly or disruptive observers. The question is whether this short-term cost is offset by longer-term benefits to the United States of a more stable and predictable space environment. There has always been a contradiction between the desire of the U.S. (and other major actors) for freedom of action in space, and a common interest in a well-

[27] In brief, DARPA tethered ten eight-foot diameter red balloons at random spots on public land throughout the contiguous 48 states and issued an open challenge to find them, offering a $20,000 prize. The winning team from MIT offered $1,000 to anyone who could refer them to someone with information about the balloons, and $1000 to the person with that information. The challenge quickly went viral on the web, and all ten balloons were found in under nine hours. Details can be found at https://networkchallenge.darpa.mil/ProjectReport.pdf

[28] Similarly, an element of *cooperative* verification intruded into what was supposed to be a regime of multilateral verification by force majeure, i.e. the post-defeat inspection of Iraq for weapons of mass destruction. What was supposed to be a regime of anywhere-anytime surprise inspection became instead a process of negotiated access because the defeated party continued to control the facilities to be inspected.

regulated domain. This contradiction is not limited to space policy.[29] Until recently, that contradiction was overcome – for many U.S. theorists - by the prospect of space control, i.e. the notion that the U.S. would use its dominant position to *impose* order on the cosmos by enlisting willing collaborators on the one hand, and using superior force against outliers on the other.[30] The model often cited is Mahan and the control of sea lines of communication; the underlying assumption is that space, as all other domains of human competition, will inevitably be a theater of conflict.[31] Space control remains an article of faith for many, but it has become a residual element in the Obama space policy. The dominant theme for the new Administration is the necessity of cooperation. In a congested and contested environment, a cooperative approach assumes a measure of trust. But as President Reagan pointed out in another context, trust is not sufficient in itself. There is a vital role as well for verification, i.e. our ability to assure that U.S. impulse to collaborative efforts in space, especially those involve U.S. self-restraint, will not be exploited by others to gain strategic advantage.

Improvements in U.S. space situational awareness will enhance the timeliness and certainty of verification. But these improvements are less likely to come in future from unilateral U.S. sources, if only because of constraints on spending. This is what some have identified as the "SSA challenge." In a world of limited resources, the emphasis will have to be on improvements in SSA by other means, and in particular by exploiting the possibilities of the other three forms of verification, i.e. multilateral, cooperative and 'open' verification. There is some reason to think that U.S. military services recognize this reality, and also the associated dilemma: that taking full advantage of information exchanges, reciprocal measures to increase transparency (cooperative verification) and the potential of the internet-empowered observer community means becoming ourselves more transparent. Where to draw the line?

To a degree, reality may make the choice for us. Some measures, particularly expanded exchanges of information, are already taking hold among commercial operators. There is pressure from the commercial community for expanded information exchanges with governments, combined with a willingness to facilitate improvements in SSA, by, hosting (albeit not funding) SSA payloads. As well, there are autonomous developments – facilitated by greater U.S. openness – which have potential both to aid detection of non-compliance and make such acts politically more consequential. These include what we identify as "open" verification, i.e. harnessing the power of the private observer community and the connectivity of the internet to monitor activities in space. Internet communities are good at finding things and identifying

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[29] The Chief negotiator of the INF agreement with the Soviets commented with regard to the debate over INF limitations: "It was, and remains, difficult to find common ground between those who believe that, in general, the national security of the United States would be strengthened if no limits were placed on the weapons it could have, even if that would mean there would be no limits on the same type of Soviet (or some other adversaries) weapons, and those who believe the national security of the United States would be strengthened if limits were placed on the Soviet (or some other adversaries) weapon systems, even if it would mean limits on the same type of U.S. system." Maynard Glitman, *The Last Battle of the Cold War*, (New York: Palgrave McMillan, 2006), p. 229.

[30] See, for example, Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age*, and Steven Lambakis, *On the Edge of the Earth: The Future of American Space Power*, (Lexington: University Press of Kentucky, 2001).

[31] No one thinks conflict in space is inevitable this week or even this year. In that sort of timeframe, all would agree that conflict or its absence depends on decisions of policy makers. Inevitable conflict always takes place in what might be called "ideological time," i.e. a time remote enough in the future that particular circumstances are necessarily unknown to us, and ideological preconceptions can therefore be liberated from the sobering influence of facts.

anomalies; they may also be credible in a way that national actors are not. The effectiveness of such programs depends on: 1) the existence of agreed, specific and observable norms of behavior, and 2) the amount and nature of information governments are willing to make available.

Increasing the openness of space operations and the availability of SSA information inevitably involves inequity for the United States. Because we can see more and see further, others stand to gain more in the short run than we do. A political judgment will be needed as to whether the long term gain in stability and predictability outweighs this short term, relative disadvantage. One thing is certain; some operations will always be kept from public view, not just by the United States but by all major space faring nations.

On the other hand, this aspect of the emerging situation – the trend, both intentional and autonomous – toward greater transparency also plays to U.S. strengths. What we call "open" verification is a new category, enabled by the greater availability of information on the one hand and internet connectivity on the other. In this "emerging networked world," as Anne-Marie Slaughter has argued, ". . . the state with the most connections will be the central player, able to set the global agenda."[32] This raises the possibility of a system of public-private verification possibility of a system drawing on public and government resources which has both potentially positive and negative aspects, but may be – in our interconnected world – an inevitable next step. The advantage the United States has in connectivity, transparency, trust and in situational awareness makes it the nation best positioned to be the central player in space. It also makes possible extra-national capabilities for space awareness and verification that could not have been imagined in the Cold War.

CONCLUSIONS AND RECOMMENDATIONS

The central conclusion of this analysis is that verification is not an obstacle to arms control or other agreements that include reciprocal restrictions on the freedom of action in space of the U.S. and other major players. This is not to say that all potentially disruptive activities in space are verifiable or proper subjects for arms control agreements; but means are available to increase predictability and stability in space by reciprocal constraints on disruptive actions, including certain maneuvers, operations in certain orbits and/or the testing of dedicated or other ASAT systems whether space based or surface based, that are observable and in regard to which compliance can be verified. A well-constructed verification regime will incorporate a necessary element of unilateral capability along with measures to make verification more certain and politically effective by making use of the inherent strengths (and limiting the potential costs) of international consensus, multilateral inspection regimes, and the credibility of public oversight of potentially non-compliant activity.

As to those variables we have identified as affecting the scope and intrusiveness of verification measures, the transparency of the domain is much greater than it was even five years

[32]Anne-Marie Slaughter, "America's Edge," *Foreign Affairs*, January/February 2009. Although she doesn't deal specifically with space, Slaughter argues that "connectivity is power" in all realms of human endeavor. Slaughter manages to synthesize the sort of national dominance exemplified in space by the "space control" model, with the cooperative paradigm inherent in a world of connectivity. All will be connected; but the United States will be more connected than others.

ago, the criticality of small changes has diminished (as the number of satellites engaged in national security activities has multiplied many fold) and the trust between actors – though far from perfect – is nonetheless greater than it was in the Cold War.

Verification does not ensure against cheating, and neither norms nor treaties may apply in a wartime environment. But a well-constructed verification regime can make evidence of violation timely and less ambiguous, providing a stronger case for collective efforts to respond before a crisis becomes a conflict. An adversary seeking to exploit mutual constraint to seek unilateral advantage would have to mount a significant program over a protracted period of time that would leave signatures in a variety of domains. A broad spectrum of verification methods, from independent national capabilities, to multilateral or cooperative regimes, and even open approaches using private observers, will increase the probability of detection and give greater credibility and legitimacy to the analysis of disputed activity.

We conclude that the ability of the *least* competent *major* actor to verify compliance will define the outer boundaries of what is possible in arms control.[33] Our conclusion is based on the assessment that if meaningful strategic consequences are possible as the result of non-compliance, no strategic actor will rely for information from any source it does not control. For that reason, the *most* competent player is unlikely to be faced with international consensus for constraints that exceed its verification capabilities. The requirement independently to verify is less true of second tier space powers, who have limited independent space surveillance capability.

We predict the emergence of "trust groups" clustered around major countries that *do* have such capability. It follows that a possible locus for competition in space (which may already be taking place) is the competition among major actors to expand their trust groups, and therefore build international support for the interpretation of events in space that reflects and serves their individual interests. In this competition, the nation with the most comprehensive, credible and available information – and the greatest willingness to share it – will have a decisive advantage. At the moment, and for the foreseeable future, that country is the United States. The United States, as the predominant player, also has the most at stake in regimes that limit freedom of action, and therefore the greatest interest in ensuring that, if such restrictions are put in play, they can be adequately verified, incorporated in binding agreements rather than amorphous systems of 'norms', and that non-compliance will be visible to a wide international community. Sharing information and opening space to greater public scrutiny is relevant to enforcement of restrictions on activities in space, since these may well be invisible to many international actors whose cooperation is necessary to make sanctions or other collective actions to punish non-compliance more effective. On the other hand, if public transparency does have such an inhibiting impact, that affect is likely to be greater in open societies than in those where both information and public opinion are tightly controlled.

Fortunately, the emphasis on verification plays to U.S. strengths.[34] The Chinese/Russian draft treaty prohibiting the stationing of weapons in space (PPWT) is precise on what should be

[33] By "*least* competent *major* actor" we mean the state with the most limited capability that is nevertheless critical to enforcement or implementation.

[34] This is, in essence, an extension to space of Slaughter's argument that "In the twenty-first century, the United States' exceptional capacity for connection, rather than splendid isolation or hegemonic domination, will renew is power and restore its global purpose." (Slaughter, *ibid*.)

limited, but vague on verification. The Chinese in particular have presented this as a concession to U.S. sensitivities about its activities in space; but it may also reflect a relative weakness of capability and reluctance by the authors of the PPWT to make their own space programs more transparent. The U.S. is in a far different position regarding both openness and capability. It can therefore ensure its interests and capitalize on its strengths by taking precisely the opposite tack, i.e. by making verification the first rather than the last focus of international discussions on binding constraints in space. Since satellites themselves will play an increasing role in space situational awareness, non-interference with satellites will be both the objective for any new agreement as well as the standard by which compliance is measured.

Verification is not synonymous with enforcement. Indeed, verification without enforcement – as has been the case with the Outer Space Treaty – arguably weakens rather than strengthens the incentive for restraint. There is a tendency in any negotiation to use vague or ambiguous language to achieve consensus. Ambiguous norms provide the appearance of regulation without imposing specific constraints, and thereby may satisfy both those who favor greater structure in space and those who insist on freedom of action. But that ambiguity will be multiplied several times in the resulting verification regime, increasing uncertainty, suspicion, disagreement, and generally conducing to disorder rather than order. Precision should therefore not be sacrificed to consensus in either the terms of agreements or the description of how compliance will be verified. Indeed, precision of language may be more important for establishing verifiable constraints on activities in space than the form such agreements take, i.e. whether voluntary norms or treaty language. Unfortunately, the trend seems to be precisely in the opposite direction, i.e. to transform the relatively precise obligations of the Outer Space Treaty into vaguely worded, highly qualified and voluntary undertakings. This is true of the various schemes of "norms" for behavior in space. In short, verification is only potentially stabilizing if it establishes compliance with specific and observable rules (whether established by "hard" or "soft" law), and parties are willing to call others to account. Otherwise, such schemes may serve only to verify that no real agreed order exists.

We conclude that verification is a natural area for U.S. leadership and presents an opportunity to achieve objectives formerly couched in terms of being able physically to dominate space. The U.S. does have – and will likely maintain – information dominance. This presents policymakers with two options for continued protection of U.S. space assets. The first is to maintain a "closed system," keeping national security systems out of public catalogs and relying on its own capabilities to verify the activities of states that do the same. The disadvantages with this approach are twofold. It fosters suspicion about U.S. actions and intentions that cannot be publicly dispelled and hampers its ability to hold others accountable for disruptive activity since to do so would reveal the extent or limits of U.S. surveillance capability. A clever and dedicated adversary will be apt to push the limits of tolerance for disruptive actions, confident that leaders in Washington will choose to remain silent.

The alternative course of action would be to capitalize on the principle of non-interference with systems involved in verifying compliance with any agreement. This includes placement of sensors on a variety of space platforms, whether hosted on commercial systems or integrated into government vehicles (civil and military alike). It applies as well to those observation and analysis systems based on the ground involved in such work. There are two potential advantages: first, detection capabilities are improved through means that can be used

publicly to hold disruptive actors accountable to international scrutiny while protecting sources or methods. A proliferation of government, commercial, multilateral and public observation mechanisms makes it more difficult for a disruptive actor to escape public exposure.[35] Second, by entangling an ever-increasing number of satellites in the verification regime the principle of non-interference is broadened to include a greater number of satellites. Non-interference is, in the end, a primary goal of any peacetime protection efforts and may be achieved without formal negotiation of any new agreements or arms control, building on existing traditions as discussed above. Entanglement of government and commercial systems, both domestic and foreign, can also contribute to deterrence by complicating an adversary's decision-making calculus.[36]

Shifting the focus to verification will help define the range of constraint and/or arms control measures that follow and will provide a basis for hope of their achieving broad international consensus and impact. More importantly, it will allow the U.S. to reassert leadership in an area of its relative strength, help fend off proposals by others designed solely for tactical diplomatic advantage, and set a practical agenda likely to have broad international appeal. This would be an appropriate initiative to take up in the Committee on Disarmament or any other international venue where the security and sustainability of the space domain is an issue.

[35] Public scrutiny of space activities has increased significantly in its specificity in recent years, as exemplified by analysis of Chinese orbital rendezvous maneuvers concerning the *Shi Jian 12* and *Shi Jian 06F* satellites. See Brian Weeden, "Dancing in the Dark: The Orbital Rendezvous of SJ-12 and SJ-06F," *The Space Review*, 30 August 2010, found at www.thespacereview.com/article/1689/1.

[36] For a discussion of entanglement as a component of deterrence see the Eisenhower Center's Space Deterrence Study, p. 20, found at web.mac.com/rharrison5/Eisenhower_Center_for_Space_and_Defense_Studies/Space_Deterrence.html.