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Executive Summary

The United States has created a military structure that is heavily satellite-dependent, without making corresponding improvements in the survivability of its space systems. The result is a classic opportunity for asymmetric, preemptive attack. The central question of this study is how to structure a strategy of deterrence to persuade potentially hostile actors that the costs of attack will nevertheless outweigh the benefits.

There is little to be gained from attacks in space unless they translate into strategic or tactical advantage within the atmosphere. Space and terrestrial deterrence are therefore inextricably linked. If space deterrence is not credible – i.e. if an aggressor perceives that he can critically disable U.S. air, ground and sea forces by a preemptive attack in space – terrestrial deterrence is weakened. If, on the other hand, he perceives that a preemptive attack in space will *not* yield a decisive tactical or strategic advantage, both space and terrestrial deterrence are strengthened.

Although the body of strategic analysis that structured Cold War deterrence provides a foundation as well for a study of deterrence in space, factors unique to space make the conclusions reached in that earlier era suggestive rather than determinative. Among those unique factors are some that make the task of deterrence in space less difficult than nuclear deterrence, others that complicate it. For example, Cold War deterrence assumed a rough equality of capability and risk between the superpowers. The same assumption cannot be made in space. The U.S. is uniquely capable there, but also uniquely vulnerable. The threat of retaliation was the centerpiece of Cold War deterrence. It is more problematic in space because, among other things, of difficulty of attribution of attack. There was scope in the Cold War for exploitation of various defensive strategies, including hardening, mobility and eventually ballistic missile defense. Defensive options also exist in space, but are more limited and may compromise capability. On the other hand, a failure of deterrence in space, although it would have profound military consequences, is not an existential threat to the United States. There is no space analogue to the Cold War policy of mutual assured destruction.

The most effective space deterrence posture is therefore one that draws on the strengths of several forms of deterrence while avoiding the weakness (in the space environment) of each in isolation. Thus, a space deterrence posture is stronger which confronts an adversary with the early imposition of unacceptable political and economic costs, presents a credible threat of certain retaliation, and ultimately persuades him that he will be denied the benefit of attack. A deterrence posture is stronger when

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it forces an adversary to compete across a range of capabilities – air, sea, land, undersea, cyber and space – than when it allows him a decisive advantage by competing successfully in area of operations, i.e. space. Politically, a deterrence posture is stronger if it is credible to adversaries and enhances consensus building among allies. It is stronger if, in crisis, it satisfies the requirements of the military leadership for decisiveness, and the demand of political leaders for flexibility.

Deterrence will seldom be optimized in all these variables. Trade-offs – the balance of risk we use as our title – will be necessary. For example, decision makers may be willing to accept stronger international norms in space, and the resulting restrictions on U.S. freedom of action, if the alternative is an anti-satellite (ASAT) arms race in space**.** International norms, including arms control, are inherently difficult to verify in space, and perhaps impossible to verify in the case of ground-based electromagnetic weapons of the sort most likely to be used in future to negate U.S. space capability. Moreover, the prudent assumption would be that an adversary will attempt to negate space services just at those times and on those fields of battle where they are most necessary. Accordingly, a robust strategy of deterrence by denial will require a credible U.S. strategy to "fight through" any attempt to deny space services to its forces. This means multiplying the sources of those services both in space and within the atmosphere, and considering in advance what to do if the screen goes blank.

Even the strongest deterrence strategy is not a guarantee against attack. Still, a deterrence posture based on strengthened military capabilities and broadened international engagement should provide a greater measure of security and stability in space, even as the entry of new space-faring powers like the PRC, and the reemergence as a possible military competitor of the Russian Federation, raise the specter of space as a "contested" environment. A layered deterrence framework offers the prospect of responding to changes in the dynamic space security environment including a perceived "vulnerability gap," the growing number of space powers, and the potentially contested nature of space.

We have set a time horizon of twenty years, about the span necessary to develop and deploy two generations of satellites, i.e. sufficient time for the full range of potential threats to develop, and for the United States to respond with changes to the design and deployment of potential offensive and/or defensive counter measures. Our intent is not to create consensus, but to spark debate. Finally, this study is not a threat analysis. Threat is assumed here for purposes of argument. Whether in fact our satellite capabilities face a threat sufficient to justify adoption of the measures recommended here is the subject for a different study, and decision for national security decision makers.

Section I: Introduction and Terms of Reference

Deterrence in general is a process by which decision makers of a hostile entity are persuaded that the costs of attacking a U.S. asset or interest will outweigh the benefits. They may be persuaded by the likely effects of an attack on other national interests, the certainty of the threat of retaliation, or by uncertainty of ultimate success.[1]

[1] Deterrence requires that an adversary accept the inevitability of a string of consequences arising from his initial attack – i.e. that he envision (in the same way we do) the likely situation at D+1, D+2 and so on, with D as the circumstance just before the initial attack. Rationally, we realize that the situation at D arises from a host of variables, some known, some unknown, some within our control and some not. We arbitrarily designate a subset of these variables as determinative

Space deterrence is defined here as a policy or process that deters direct attacks on U.S. satellites in orbit with the goal of permanently disabling them or temporarily disrupting their operation. We recognize that the functioning of satellites can also be disrupted by cyber attacks or attacks on ground stations. Deterrence of cyber attacks directed at space assets is an element of cyber deterrence generally and therefore beyond the scope of this paper. Deterring attacks on ground stations by either hostile states or terrorist organizations is more properly dealt with in a study of conventional deterrence. It poses the same challenges and should be considered in the same context as attacks on other communication nodes, electrical grids, water systems and other elements of the terrestrial infrastructure.

Nuclear deterrence theory evolved in the Cold War with the help of game theory, which claims to apply to any situation in which there are two or more competitive players.[2] We will argue that *some* of the concepts developed to strengthen deterrence in the Cold War are applicable as well to a "contested" space environment. On the other hand, space as a strategic area of operations is unique. Analogies to Cold War nuclear standoff are therefore suggestive, but not conclusive. Our task here has been to identify in what ways space is unique and what particular challenges it presents for U.S. deterrence strategy.

The question of deterrence arises now because the overarching conception of the U.S. position in space has evolved from "space control" in the Clinton Administration, to "unhindered freedom of action in the Administration of President Bush to "contested space" now.[3] Precise definitions of

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and assume that manipulation of these few will allow us to manipulate the overall system to serve our interest. We assume that our adversary sees the same variables as determinative, since deterrence depends on his perception, not ours. If deterrence succeeds, the policy is judged effective, though the absence of attack may be coincidental. If deterrence fails, the situation at D+1 (the next decision point for policy makers) is invariably different than the situation we envisioned in advance. The number of variables affected as we move from D to D+1, and the magnitude of the impact, cannot be predicted. That truism is reflected in time honored military bromide: the plan of battle never survives the first exchange of fire. The incalculability expands infinitely at the imaginary D+2, and so on. Games and simulations are designed to bridge the gap between imagination and reality by testing the conception of future events against realistic scenarios played out either by computers or – more usefully – by human beings. But simulations are a limited tool for at least three reasons: the players realize that there are no real world consequences to their acts; bias may be introduced by the game designer or sponsor, and no player can accurately reflect the possible adversary except as he is conceived by 'our side'. The question therefore arises: how do we make realistic projections about the consequences of the failure of deterrence, as we have to if we are to persuade a possible attacker that those consequences will be negative for him? The first answer is that incalculability is itself a deterrent. If a potential attacker cannot make a reasonable assessment of the likelihood of success of an attack, he will be less likely to launch one. But a more accurate answer may be this: that the point is not that the predicted sequence of events is *realistic*, but that it is *persuasive* – initially within our bureaucracy and then with possible adversaries. Ronald Reagan's projection of a ballistic missile shield was not realistic, but it was persuasive, so much so that it caused the Soviets to reassess their advantage in the strategic balance with the United States.

[2] The most recent of this process, updating it to the present is "Deterrence: From the Cold War to the Long War, RAND Project Air Force 2008, available at http://www.rand.org/pubs/monographs/2008/RAND_MG636.pdf Our title is a variation on Albert Wohlstetter's seminal RAND study "The Delicate Balance of Terror" of 1958 adapted, in our case, to a circumstance in which much – but not as much – is at stake if deterrence fails.

[3] "Contested" space is not a phrase that appears in the Bush Space Policy Document, but is used to characterize our current situation by AFSPACE commander Kehler, among others. The Clinton Space Policy document is summarized at

what constitutes 'contested space' – i.e. who is contesting space, how they are contesting it and what precisely is being contested – have not been universally agreed. But we can safely assume that whatever contested space is, it is something less than either control or dominance, and therefore describes a situation in which others will have the capability to destroy or disrupt U.S. satellites in orbit, and will have to be deterred from using that capability.

The *Deterrence Operations Joint Operating Concept* (DOJOC)[4] study of 2006 concludes that the goal of deterrence strategy must be to exercise "decisive influence" on the decision making processes of a potential attacker. [5] In fact, deterrence by nature can never be as absolute as the phrase "decisive influence" implies. Deterrence depends on the decisions of actors who are outside our direct control and whose perceptions of costs and benefits may differ from ours. They may underestimate our capability or our resolve; they may react emotionally or unpredictably. Their decision process probably will be opaque to us and perhaps to them as well. In sum, no deterrence policy can reduce the risk of attack to zero, and no national strategic policy should rely exclusively on deterrence for national defense. Still, deterrence is an element of any national security strategy, and it is relevant to consider what actions are likely to make deterrence more robust and what actions may weaken it.

It might be thought that adequacy of deterrence is established by the absence of attack. But some would argue that the absence of attack means only that adversaries perceive no present need for it, not that they are inhibited by our policy. Perceptions of this sort are a function of an individual's reading of history, view of conflict, experience of the world, bureaucratic responsibility and/or conclusions about human nature, among other things. The same can be said of the various schools of thought about the likelihood of conflict in space; Hays (following Lupton) describes four such schools,[6] Mueller seven[7] – ranging from inevitable conflict to space as sanctuary.

Theories multiply in the absence of experience. The United States has never fought a battle or even a skirmish in space. It has never faced an opponent with more than limited offensive capability against its satellites. In that circumstance, a divergence of points of view about the nature of any eventual conflict – and appropriate measures to avoid it - is inevitable. We conclude that no consensus is likely on the adequacy of space deterrence, and no study of this sort should be aimed at creating one. The present study avoids that danger in favor of an entirely different goal: a concept of space deterrence useful to decision makers that takes into account the constraints which surround them, in particular restraints on available resources.

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http://history.nasa.gov/appf2.pdf and the Bush Space Policy document is at http://www.ostp.gov/html/US%20National%20Space%20Policy.pdf

4 See www.dtic.mil/futurejointwarfare/concepts/do_joc_v20.doc

5 Decisive influence is the sort of term that emerges from the dynamics of bureaucratic consensus building. It sounds more robust than mere "influence" but not so infeasible as "control" Still, control is what is implies, i.e. that we can intervene – directly and indirectly - with decisive effect.

6 Hays, Peter L. United States Military Space *Into the Twenty-First Century*: INSS Occasional Paper, 42, Air University Press, September, 2002, pp. 11-12.

7 As cited in Moltz, James Clay, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests,* Stanford Security Studies, 2008, pp. 23-24.

Section II: Methodology, Terminology, and Premises

This study is based on open source material. While it is prudent to assume that space is technologically dynamic, what programs may exist in the United States or elsewhere with the potential to change the existing strategic situation in space is necessarily unknown to us. Even the most basic of our assumptions – that space is, on balance, offense dominant – is subject to change because of technological innovation. However, a deterrence strategy that is effective when offense is dominant will be even more so if the balance swings more toward defense.[9] We therefore take the worst case as our starting point.

We began our research with the notion that game theory might give a structure to consideration of space deterrence. The advantage of game theory is that it purports to be "scientific" – i.e., to provide an objective standard for judgment amid the thicket of ideological preconceptions that otherwise dominate discussions of space security. As the study progressed, our confidence in game theory as a useful tool waned. Game theory presumes rational actors and the DOJOC study assumes that "truly irrational actors are extremely rare." However, the history of strategic policy is replete with examples of nominally rational actors behaving irrationally – because of flawed intelligence, ideological preconceptions, leadership dynamics, time pressure, bureaucratic interest, personal rivalry, lack of experience and poor judgment, among other reasons.[10] We know these elements of irrationality are true of ourselves, and can reasonably impute them to others.[11]

What remains of game theory in this document is therefore the barest essentials: that a contest in which the offense has the advantage will tend to be less stable and more

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[9]Robert Jervis' seminal study of the Offense-Defense balance serves as our guide, "Cooperation Under the Security Dilemma" *World Politics,* Vol. 30, No. 2 (January 1978), pp. 186-214. The classic security dilemma, outlined by Rousseau and others, holds that an increase in one state's security decreases the security of others, since a state's intentions about the use of that security apparatus can never be known if the capabilities are inherently defensive of offensive. Jervis clarifies the security dilemma for us by highlighting two crucial variables, whether defensive weapons can be easily distinguished from offensive ones and which of the two has an advantage on the battlefield. In Jervis' language, "offense has the advantage when it is easier to destroy the other's army and take its territory than it is to defend one's own. When defense has the advantage, it is easier to protect and to hold than it is to move forward, destroy, and take. If effective defenses can be erected quickly, an attacker may be able to keep territory." Jervis ultimate argues that the security dilemma is most problematic when offensive and defensive postures are indistinguishable and when offense has the advantage.

[10]This notion also ignores the 'crazy man' theory of deterrence, i.e. convincing an opponent that your possible reaction is terrifying precisely because it is not predictably rational (Schelling and others). Kissinger employed a variant of this approach without notable success in his dealings with the North Vietnamese.

[11] Thomas Schelling's *The Strategy of Conflict.* Harvard University Press, 1960, makes the classic case for allowing the "weak" rational actor assumption, particularly on pgs. 16-18. He argues that it is better to think about rational individuals as those having the ability to conduct strategic interactions, that is, those with the ability who try to get something they want with the knowledge that another actor is trying to acquire the same thing. As Milton Friedman argues, assumptions of rationality should be assessed on the benefits and clarity they produced in their analyses, not on how emotionally stable an actor might be. "The Methodology of Positive Economics." *Essays in Positive Economics* University of Chicago, 1953.

prone to escalation, than a contest in which defense predominates; that adversaries will seek to exploit an opponent's vulnerabilities rather than attack his strengths; that successful deterrence depends on convincing a potential attacker that the costs of attack will outweigh the benefits.[12] These are the dictates not only of game theory but of common sense, and at least as venerable as the writings of Sun Tzu and Thucydides.

Nomenclature can and does bias consideration of space security, which is often characterized by imprecision of language, the confusion of metaphor for reality and the use of political mobilizing slogans in place of analysis. Much dispute has raged, for example, around the question of space militarization and/or weaponization - terms that have become politically-charged code words for contending points of view about the future of space.[13] Some argue that space is already militarized, and that the only issue now is how the U.S. should deploy its space military capability to best advantage. Others contend that although space has been used for intelligence and other military purposes, there remains a political barrier to weaponization that the U.S. should not be the first to cross. Our study will not end this controversy – or even refer to it beyond this short description. Instead we will concentrate exclusively on those acts or policies which can strengthen or weaken deterrence without regard to how they may be characterized, attempting to discover whether they are 1) feasible, 2) affordable, 3) in the strategic interest of the United States, and 4) sustainable and effective in the presence of foreseeable adversary counter measures.

As mentioned above, we assume in this document that offense is dominant in space. We note as well, however, that this dominance is theoretical rather than actual because the weapons that might establish it, although technologically feasible, are not – as far as we can determine – presently deployed. The assumption of offense dominance rests on the notion that it is easier and cheaper to add a unit of offense in space than it is to add a unit of defense.[14] Later in this study we discuss the problems with defense, especially of large satellites that form the backbone of U.S. space capability. Other modes of deployment are emerging which could perform many of the same functions as existing satellites but be inherently resilient to attack. New forms of offense may also emerge. In short, within the twenty-year timeframe of this study, the offense-defense equation may change.

[12] These "game theoretic" properties are well established in the contemporary rational choice literature. See Robert Powell's "Uncertainty, Shifting Power, and Appeasement," *American Political Science Review* 90, no. 4 (December 1996), pp. 749-64, Christopher Achen and Duncan Snidal's "Rational Deterrence Theory and Comparative Case Studies," *World Politics* 41 (September 1989), pp. 143-169, James Fearon's "Selection Effects and Deterrence." *International Interactions* 28, 1 (January-March 2000): 5-29 and Barry Nalebuff's "Rational Deterrence In An Imperfect World." *World Politics* 43, April 1991, pp. 313-335.

[13] For the view that space is already weaponized, see Everett Carl Dolman, "Space Power and U.S. Hegemony: Maintaining a liberal Order in the 21st Century" available at http://www.gwu.edu/~spi/spaceforum/Dolmanpaper%5B1%5D.pdf
Teresa Hitchens gives an opposing view "U.S. Policy: Time to Stop and Think" http://www.hartford-hwp.com/archives/27b/049.html, but she also thinks inevitable that "weapons will inevitably go into space".

[14] The "Nitze criteria" for cost-effective missile defense establishes the notion of a defense-dominant environment as one in which defense measures must be "cheap enough to add additional defensive capability so that the other side has no incentive to add additional offensive capability to overcome the defense." We assume that that criterion cannot be satisfied in space, i.e. that it is cheaper, technologically more feasible and easier to add a unit of offense to overcome any incremental improvement in defense. See: "On the Road to a more Stable Peace"
Department of Public Affairs, Department of State, *Current Policy No. 657*, 20 February 1985.

Insofar as it changes in the direction of defense, deterrence becomes a less important subject; so we assume for purposes of this study that offense will retain its predominance.

Some will object that our emphasis on services to the war fighter within the atmosphere ignores the potential for conflict in space over the raw materials that may exist on the moon and various other celestial bodies. Such conflicts are very unlikely in the timeframe of this study. Even looking out fifty or one-hundred years, the notion that raw materials might be mined economically in space for use on the surface – and that nations would fight, for example, over the best sectors of space or the moon to exploit for this purpose–is open to serious doubt.[15] Exploiting raw materials in space for *use* in space may be a more economically viable option; but it is not a near or even medium term prospect, and no business case has been made to attract the billions in investment capital it would require. What is and will increasingly be in short supply in space are orbital position and bandwidth – both now allocated by international agreement. The allocation is imperfect and subject to much dispute; such dispute will probably increase as more nations jockey for position in space. On the other hand, neither orbital position nor bandwidth lends itself to control by *force majeure*. Some commentators believe that the U.S. potentially has, or could develop, the power to allocate these scarcities according to its own interests, but no U.S. administration has taken that view, and none is likely to do so.[16]

Our study assumes that the list of potential actors with both the motive and the capability of contesting with the United States in space is small, and unlikely to expand greatly over the next twenty years. More importantly for space deterrence, those potential adversaries are nation states with things of value that can be held at risk. Terrorists might exploit weaknesses in cyber defense to launch attacks that include space assets, but that threat is defined by the prospects for cyber terrorism generally. A terrorist *state* with space capability might attempt attacks on U.S. assets, particularly in connection with terrestrial hostilities. Some see emerging Iranian space capability as an example of this threat. It cannot be discounted. But terrorist states are still *states* with things of value to hold at risk, and therefore subject to deterrence by a variety of means. The central problem of the war on terror – that the adversary is irrational, fanatical and undeterred by any threat - is therefore unlikely to arise as a problem hampering space deterrence.

Finally, our analysis is based on the assumption of limited budget resources. If we assume substantial increases in budgets for military space, the United States can mount programs to deal with whatever threats the imagination can conjure. Whether such programs would succeed, of course, is a different matter; but all things could be attempted. In the period like that immediately ahead, on the other hand, policy makers will have to distinguish between the probable and the possible treats, and emphasize cost effectiveness and comparative advantage. In

[15] Exploiting resources in space for use in space could only be describe as economic when compared to the cost of launching such resources to space from the surface. No one has devised a convincing business case for either model. In general, economic theories about wealth creation in space ignore principles of comparative advantage and opportunity costs, underestimate the capital required, and overestimate the return to be expected.

[16] This argument is made, for example, by Everett Dolman, "Space Power and U.S. Hegemony: Maintaining a Liberal World Order in the 21st Century."

the words of Lord Rutherford: “We have no money, so we must think.”

Section III: Deterrence and Space

Space deterrence differs from Cold War nuclear deterrence in several ways. Among these are some distinctions that make the task of space deterrence less difficult and some that complicate it.

Cold War Deterrence

From the time in the late 1960’s when the Soviet Union achieved rough parity with the United States in nuclear arms, deterrence from the point of view of US policy makers shifted from a reliance on retaliation alone, to an interplay of retaliation and denial.

The key concern of policy makers was the possibility of a preemptive nuclear first strike that would destroy U.S. nuclear retaliatory capability. The U.S response to this threat took the form of a series of measures to ensure the survivability of the nuclear deterrent, including hardening of ICBM silos, 24-hour airborne alerts by bomber forces, and increased reliance on less vulnerable systems like mobile launchers (for intermediate range missiles) and submarine launched ballistic missiles. The concept of the deterrence “triad” of land-based, air and sea-based nuclear weapons arises from this period as do the key doctrines that came to define Cold War nuclear and conventional strategy: ensured second-strike capability, flexible response, escalation dominance, defense in depth, rapid reinforcement, and survivable C3I. All were elements to support a strategy of deterrence by denial, designed to convince our Cold War adversary that there was no permanent advantage to be gained at any level of conflict, whether conventional or nuclear.

Deterrence by entanglement – economic interdependence for example - played little role in this era. The autarkic impulse of Soviet leadership and the containment policies of the U.S. and its allies worked together to isolate the Soviet Union and the Warsaw Pact countries economically from the world economy, making deterrence by entanglement minimal.

Deterrence by international norms, including arms control, was more important, albeit not always positive from the point of view of the U.S. The Soviets pursued a consistent strategy of promoting international norms and multilateral arms control agreements designed to restrict U.S. options, including repeated initiatives to ban nuclear first strike as well as general and complete disarmament proposals. These were the subject of much diplomatic maneuvering, but had little practical effect. Later in the Cold War, bilateral and substantive arms control agreements came to play a key role.

The likelihood that the nuclear arms race would not result in a decisive advantage for either side began to be apparent in the 1960s. Accordingly, the United States initiated a parallel process designed to reach an equilibrium point in U.S. and Soviet conventional and nuclear arms, beginning with the Partial Test Ban Treaty (PTBT) in the Kennedy Administration. The search for equilibrium led to a series of arms control negotiations: limitation (SALT) and then reduction (START) of overall strategic arsenals, mutual (the United States added “balanced”) conventional reductions in Europe (MBFR), and elimination in Europe of intermediate range nuclear forces (INF). The Reagan Administration energetically pursued the notion of equilibrium at much lower levels of nuclear arms, a goal symbolized by Reagan’s decision that what had been nuclear limitation negotiations (SALT) should be redesignated nuclear reduction negotiations (START).

As space operations became more important to overall military capability, both the Soviets and the United States developed and deployed kinetic kill ASAT systems. Both unilaterally abandoned those systems, which did not play an important role in the overall military balance between the two countries. A number of technologies which might have brought additional offensive space capability – neutron beam weapons, orbiting rail guns – were not pursued. Indeed, even at the height of the Cold War each side refrained from interference with the other's space capability, a tacit agreement that was formalized in later nuclear arms control treaties in provisions banning interference with national technical means of verification (NTM).[17]

Moltz argues that these developments were by no means inevitable, but dependent on individuals and circumstance.[18] Still, it is possible to conclude that each side saw more value in maintaining its own capability than in destroying the capability of the other side. This was true as well of the Soviets, in spite of the existence in those years of relative superiority of U.S. military space. In Moltz' words, both sides desired "stability more than superiority."[19]

Cold War deterrence was successful. The equilibrium that emerged, although certainly imperfect, has proven durable, at least by the standards of great power competition. Even with the tensions of U.S. anti-missile deployments to Eastern Europe, and Russian threats to abrogate the INF treaty, the U.S. continues to reduce its arsenal of deployed nuclear warheads. No one now imagines a second nuclear arms race anything like the first. Other nuclear powers, like the Chinese, seem content with limited arsenals.

Unique Challenges of the Space Environment

Cold War deterrence – both within the atmosphere and in space - was ultimately based on symmetry of capability and of risk. The two sides each had the capability to destroy the other; neither could entirely ensure itself against that danger. This balance was most graphically represented in the doctrine of "mutual assured destruction" and the "balance of terror" - key elements of nuclear deterrence that helped stabilize the nuclear standoff (and fuel the search for an equilibrium point) but have no direct analogue in space.

On the contrary, space deterrence is seen to present particular issues because the U.S. is now *uniquely* dependent on space assets for its military capability and therefore potentially subject to asymmetric attacks in space. This is the so-called "vulnerability gap". Since no potential adversary would have as much at stake as the United States in a generalized offensive war in space, the task of deterrence is seemingly more difficult – some would say, impossible. This problem has been recognized at least since studies in the 1970s, but the emergence of net centric war and the Revolution in Military Affairs have increased dependence and therefore at least in theory incentive for hostile attack.[20]

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[17] Non-interference with "national technical means" became codified in the Strategic Arms Limitation Treaty (Article V). The Anti-Ballistic Missile Treaty (Article XII) specified the role of NTM for verification and precluded parties from interfering with or undertaking measures that would conceal or otherwise impede verification via NTM.

[18] Moltz, p. 50.

[19] *Ibid*. p. 56.

[20] The 1975 Schlichter Report and the 1976 Buchsbaum Panel both cited the growing dependence of U.S. forces on satellites vulnerable to Soviet attack. Both pointed to the dangers of an ASAT arms race. The Buchsbaum

Space deterrence may also be seen as problematic because two potential deterrence strategies – deterrence by threat of retaliation and by denial (including defense) - present theoretical difficulties in space. This is particularly true if space is seen as a area of operations in itself with a separate military balance independent of the balance within the atmosphere. Finally, space deterrence is seen as problematic because of gaps in our situational awareness, in particular our ability to distinguish between intentional and unintentional interference, i.e. between a hostile action (perhaps disguised) and the consequences of operating in a harsh and electromagnetically active environment.

In short, we identify four central issues that must be addressed by any coherent doctrine of space deterrence:

- The "vulnerability gap" in space
- The difficulty of defending space assets
- The credibility of retaliation in an asymmetric environment
- The weaknesses of space situational awareness (SSA) and attribution of attack

Vulnerability Gap

That a vulnerability gap exists is not disputed. The United States has created a military structure which is heavily satellite-dependent, without making corresponding improvements in the survivability of those satellites in a hostile environment. The result is a classic opportunity for asymmetric, preemptive attack. Because of the vulnerability gap, an adversary might assume that even if the origin of an attack in space were known and the U.S. retaliated in kind by destroying (even disproportionately) the enemy's space assets, he would nonetheless gain by the exchange since overall U.S. military capability – more dependent than his on space - would be disproportionately degraded.

Some believe that this gap will narrow of itself as the militaries of potential adversaries modernized and become more dependent on satellites.[21] It is just as likely, in our judgment, that other space-faring nations will see our example as one to avoid rather than emulate. They may be alert to the distinction between reliance and over-reliance on space, and less certain of the value added space provides in the sort of wars they are likely to fight. They may take advantage of emerging technologies to deploy space assets in inherently more defensible modes – rather than committing to vulnerable satellites that will still be operating two decades and more from now. Our reliance on space is fueled in part by our desire for global reach. Our most likely competitors are – at least for the moment – geographically less ambitious and therefore less in need of space assets to enable far distant military campaigns. Nor can we rely on them to follow our example of net centric war. Who else, for example, is likely to devote assets to creating a global communication grid? Even if potential adversaries mirror our military space strategies, they are unlikely to become as dependent on space as we are, and the vulnerability gap is therefore unlikely to narrow significantly. Nor are we likely to

Panel did not see U.S. assets as a viable deterrent but did conclude they might have potential use as a bargaining chip in negotiations with the Soviets on ASAT arms control. For a review, see http://www.au.af.mil/au/awc/awcgate/au-18/au18003e.htm

[21] Bruce W. MacDonald describes the potential narrowing of the vulnerability gap in: "China, Space Weapons and U.S. Security," Council of Foreign Relations Special Report Number 38, p. 4.

achieve the sort of "space control" that would give us assured superiority in every circumstance.

As well, it is usually a mistake to adopt strategies that depend for their success on the cooperation of potential adversaries. Those who will potentially contest with us in space have no interest in reducing our vulnerability there, or increasing their own. Mirror imaging of military capability is known in PRC strategic circles, for example, as falling into the "Soviet trap."[22] The problems posed by the vulnerability gap for U.S. space and strategic policy are real. But they can only be addressed by our actions and policies, and not by relying on the actions of others.

The effect of the vulnerability gap on the effectiveness of deterrence may not, however, be as great as this analysis would indicate. Classic nuclear deterrence theory demands that we hold at risk things of value to an opponent. We have assumed for forty years that value equates to utility, and since we depend more on satellites for our military reach, the value we attribute to them is correspondingly higher. But foreign actors may value satellites far above their immediate utility – as potential economic growth multipliers, symbols of national progress, as tools of political control, or as tokens of status given the military in return for military obedience. This may be true in particular of the PRC, but cannot be discounted in the case of other emerging space-faring nations. In short, although our military vulnerability in space is greater, the value gap may not be so great. The threat of retaliation in kind, even in a situation where the U.S. is asymmetrically vulnerable in terms of capability at stake, may therefore play a substantial deterrent role.

Difficulties of Defense in Space

The categories of direct, offensive threats to satellites have been very well understood for at least four decades. These divide, generally speaking, into physical threats – impact (kinetic kill) or proximity explosion – and electro-magnetic threats, EMP, laser, high power microwaves, neutron beam. Both types of attack can in theory be delivered by either terrestrially-based or space-based weapons. The options for defense of satellites have also been understood: hardening, maneuver and various guardian or self-defense satellite schemes. Given limitations on mass, satellites designers are faced with trade-offs between capability, service life, and defense. Generally speaking, they have made the choice of maximizing capability. This is true of the large satellites that form the backbone of U.S. strategic space and of the next generation of satellites, including GPS- III. [23]

Given the state of satellite technology when these design decisions were made, they appear in retrospect to have been made with good reason. Capability was maximized. The operating environment remained relatively benign, at least as regards hostile attack.
Even if designers had assumed a more hostile environment, it is not certain they would have altered fundamentally the tradeoff between capability and defense. Some space

[22] Paul J. Bolt and Adam K. Gray, "China's National Security Strategy," paper presented at the December 2007 Air Force Institute for National Security Studies Conference, Colorado Springs, Colorado.

[23] It may be that the cost and development time of prospective space systems has raised fundamental questions about the comparative advantage of space, even for core functions like communications. For example, General Cartwright told the Space Power Caucus in July 2008 that, given the cost of TSAT, perhaps DoD should "invest in airborne comm first" (Reported in the CAG's "Legislative Update," July 2008).

capabilities, especially reconnaissance and communication, required large structures in fixed orbits which are inherently easier to target and therefore more difficult to defend. Some defensive measures repay their cost, but with diminishing returns. For example, a satellite can be hardened against EMP and equipped to counter laser dazzling. It can be given some maneuver capability. But it cannot be hardened to defend against KE attack; maneuver is limited by on board fuel supplies (which are also needed for station keeping and against the contingency of maneuver to avoid space debris). Finally, defense against jamming and laser attack may require, in effect, shutting down operations temporarily – which is all a potential adversary may require.

Other measures such as equipping satellites with on board homing missiles against KE attack, or providing them with the capability of moving into parking orbits out of ASAT range, have been considered but not pursued, presumably because of prohibitive costs and technical obstacles. In theory it is also conceivable that large satellites might be provided with small guardian satellites designed to intercept KE attack. That technology does not currently exist. Moreover, KE attacks are only one – and arguably not the most likely – method an adversary might use, especially if the goal is to disable rather than to destroy a satellite.

Stealth would be an ideal alternative for maintaining the benefits of large strategic satellites. It would also be ideal to strengthen deterrence by greatly complicating an adversary's attack options. Discussions of such programs or capabilities are generally not part of the public discourse.

Another approach for dealing with the inherent difficulties of satellite defense is "operationally responsive space" (ORS). Like other space strategic concepts, ORS has taken on several meanings. The one most discussed, however, is the Air Force proposal to launch on short (30-day) notice satellites to replace those destroyed by hostile action. The advent of entrepreneurial companies promising "cheap launch" has given some impetus to this idea. But cheap launch has not been demonstrated, and even if it could be, an ORS program would likely require considerable investment. Moreover, a prudent attacker preempting against U.S. satellites would enhance chances of success by retaining second and third strike capability with far less expenditure of resources than we would require to replace the assets he destroys. Although the U.S. would retain the option of attacking the ground installations supporting this second or third wave, counter measures – viz. launcher mobility – are well within the capability of major space-faring nations. Ground-based laser or pulse weapons could be dispersed and disguised, or based in unwitting third countries. The satellites replacing those destroyed would presumably be lighter, deployed in LEO where they would be less resistant to attack and only available after some delay. That might be a conceivable option in the era of large and protracted conventional war (if the problem of survivability of the satellites could be resolved). But technology has made sudden attacks to gain territory or for tactical advantage more likely, and against this sort of attack, a month-long loss of initiative could well be fatal.

Finally, the notion of operationally responsive space is another example of how nomenclature can bias analysis. What U.S. commanders are interested in is not "operational responsiveness space" but operational responsiveness itself, however achieved. Space may very well not be the most cost effective way of achieving that goal.

The next generation of GPS satellites will begin deploying in 2014. Both GPS and other systems currently in production are expected to have a service life of several decades, which means that U.S. strategic defenses will depend on large, single point of failure systems at least until 2040, and potentially well beyond. These systems cannot be retrofitted in orbit to increase their self-defense capabilities – even if practical measures were available to do so. Moreover, the cost of completing programs already approved as centerpieces of U.S. strategic space are such as to make the simultaneous development of alternative technologies problematic, at least without devoting considerable, additional resources to military space. There are circumstances in which this sort of budget commitment might be made; but that is hardly a desirable alternative from the point of view of the United States. Once the next generation of systems is on line, U.S. ground, sea and air forces will become even more dependent on space assets, and therefore more vulnerable to interruption of the information they provide.

Meanwhile, advances in technology may offer an inherently more defensible means of deploying capability in space. Many argue that mini-satellites hold the promise of basing mode which is much more difficult for a possible adversary to target.[24] Constellations of these satellites might provide some or even most of the same functions of the existing satellite constellation. They could be designed to degrade incrementally, in essence reconfiguring to account for losses of some of their element to hostile action. Finally (and again, in theory), mini-satellites would be cheaper to develop than existing, large multi-function satellites. More redundancy would therefore be possible within existing budgets. All these characteristics of mini-satellite constellations would enhance deterrence. Indeed, adoption of this technology by all major space-faring nations might create the defense dominant atmosphere in space which is not only favorable for deterrence but for a stable and predictable space environment.

There are, however, reasons for skepticism, not least that no one has so far succeeded in deploying constellations of mini-satellites. To quote a noted strategic analyst, "It's possible to attribute any qualities you want to a system you have yet to develop."[25] Thus, constellations of mini-satellites are said to have the potential of replacing not only command and control and electronic surveillance functions, but even reconnaissance missions that now require large structures to accommodate very long focal point cameras. It is also possible to conceive of mini-satellites employed as co-orbiting hunter killers. None of these visions has been proven.

Perhaps the most formidable obstacles, however, are political and cultural. It is difficult to imagine the national leadership adopting a strategy of relying on unproven technology for key strategic capabilities, especially given the sunk costs already devoted to the next generation of satellites. Even if this decision were made by the new administration, the existing (and more vulnerable) satellite infrastructure would continue to provide the foundation of U.S. space capability for many years to come. As well, the advent of mini-satellites will tend to level the playing field, and de-value the U.S. industrial base. That industrial base is built to

[24] Will Marshall, "Reducing the Vulnerability of Space Assets: A Multitiered Microsatellite Constellation Architecture," *Astropolitics*, Vol. 6, No. 2, May 2008, pp. 154-199.

[25] Walt Slocum, referring to the potential CEP of the MX missile warheads to the author at a time (1983) when the MX had not yet been tested.

create large, complex, very capable satellites. No one can match us in that capability. But it is of less comparative value in an era of mini-satellites, which – as a consequence – have little attraction for our large, aerospace companies. It is no coincidence that the locus of mini-satellite development has in the universities, or that the trend toward cheap, low technology launchers has been led by startups in the private sector.

Prompt Global Strike (PGS) has been offered as an option to strengthen deterrence by convincing adversaries that the United States is capable of destroying threatening capability anywhere in the world by means (e.g. conventionally armed SLBMs) against which there is no defense. This option might be thought of as active or preemptive defense, and could be useful as deterrent against an enemy's direct assent KE weapons, or against a second or third wave attack by any other fixed, surface-based systems.

There are objections to PGS, at least in theory. For example, PGS assumes availability of exact and extremely reliable intelligence of the quality that has been notably absent in recent conflicts. It employs a delivery means that, once launched, cannot be recalled – even if the intelligence changes or the adversary wishes to capitulate. Our resort to conventionally armed SLBMs as a tool of military conflict could and probably would be matched by the Russian Federation, and potentially by the PRC as well. A target of sufficient value to justify launch of a nuclear-capable intercontinental ballistic missile (even if conventionally armed) would presumably be of such urgency that destruction would have to be assured, requiring launch of more than one missile, and perhaps a volley. Finally, our obligations under the START treaty would require us to notify the Russians before an SLBM launch; they have no reciprocal treaty obligation to keep that information confidential. Such an interchange might destabilize the U.S.-Russian strategic nuclear relationship that remains the most important single factor in U.S. national security. Nevertheless, the existence of PGS as demonstrated capability would have a deterrent effect on potential adversaries, or at least those few who themselves possessed no practical means to retaliate.

We conclude that defense, like the vulnerability gap, will continue to present challenges for a policy of space deterrence. All practical should be done to bolster the defense of satellites. But the vulnerability of key space assets will not be overcome within our twenty-year timeframe.

Attribution of Attack

An abiding issue for space deterrence is the difficulty in attributing attack, and distinguishing between intentional interference and the consequences of operating in an electro-magnetically active and physically harsh environment. If a satellite ceases to operate, or operate effectively, the fact will be immediately apparent, but the cause may remain unknown. The problem of attribution is not entirely unique to space; it exists as well in other theaters of military operation, particularly the War on Terror and cyber warfare. The contestants in the Cold War often used surrogates and "spoofing" to disguise the real origins of conventional attacks. Still, attribution in space poses particular problems.

In general, we will only become aware of an attack in space because of its effects. Direct ascent KE weapons, such as the one tested by the PRC in 2007, are an exception to this rule; the origin of the attack of such weapons would be detected. But for a variety of other attacks – either from space based interceptors or, more likely, ground based dazzling or jamming – origin may be difficult to determine, and the identity of the attacker even more so. For example, a hostile entity might mount a jamming or dazzling attack from a third country, as the Iranians apparently did from Cuba in 2003. The culprits in that case were eventually determined, but only after a lapse of some months. It is conceivable, though not likely, that a similar operation could be conducted from neutral countries or even countries allied with the United States without the knowledge of the government. It is also possible that we might attribute the failure of a space system in a crisis to the action of an adversary, when in fact, it results from the natural effects of the space environment itself, such as severe space weather.[26]

The most difficult scenario arises if a key satellite simply ceases to function. In that case, we may not know – or be able to discover – the cause of the malfunction.

These difficulties, however, may be more apparent than real. The likelihood of a random attack unconnected to some strategic or tactical purpose within the atmosphere is remote. The greater likelihood is that attacks will take place in the context of the failure of deterrence within the atmosphere, and therefore as a result of, or in preparation for, terrestrial hostilities. In context, the source of the attack will be difficult for an adversary to disguise. Moreover, the redundancy in crucial satellite systems like MILSTAR and GPS means that gaining military advantage would necessarily involve a coordinated attack on a number of satellites; an adversary could hardly expect such an attack to be mistaken for anything else, or the origin of the attack to remain long secret. The number of countries that might be expected to have both motive and capability to launch such an attack is small, and not likely to grow appreciably in the twenty-year timeframe of this study. Finally, experience in the Cold War and the war on terror indicates that we will often discover the origin of attack not from detecting the attacker at the time, nor from direct evidence available at the point of attack, but from intelligence sources with access to the information either directly from the attacking country or through third parties – not, that is, exclusively from ELINT, but also from HUMINT sources. Such detection might even occur before the fact.

The question from the point of view of deterrence theory is: will a potential adversary *believe* that the origin of his attack on U.S. space assets can be disguised? Will he make the key decision based on this assumption? If so, deterrence is weakened. But – for the reasons listed above – a prudent adversary would have to assume that the origin of such an attack could *not* be disguised, especially if the attack were connected with hostilities on the surface or took place in the context of tensions between the attacker and the U.S. He would have to have a plan not just for the initial attack, but for a strategy if the origin of the attack were discovered; and if *that* plan were not credible, deterrence would be strengthened. In short, he would have to act *as if* the attack would be discovered. His assessment would be affected by his perception of U.S. SSA capabilities, as well as by his assessment of the competence of U.S. intelligence. He might underestimate our actual capability. But just as there is no substitute in deterrence theory for the perception that our leadership is competent, so there is no substitute for a reputation for competent, all pervasive and all-seeing U.S. intelligence capability.

[26] "Severe Space Weather," *Science@NASA,* 21 January 2009, p. 1. http://science.nasa.gov/ headlines/y2009/ 21jan_severespaceweather.htm?list209021

We recognize that these same considerations may not apply to harassing, transitory jamming or dazzling interference, exemplified by the Iran attempt to disrupt a U.S. satellite from a source in Cuba. On the contrary, more of these are likely. If the concern is a disabling attack on significant U.S. space capability, however, we believe an adversary would have to judge the likelihood of attribution as high, and the affect of disguise as an effective tactic correspondingly low.

In short, there is no evidence available in open sources pointing to the conclusion that an adversary could destroy a significant portion of the U.S. strategic space capability by clandestine means; although incidental attempts to degrade U.S. assets might be difficult to distinguish from intentional interference in individual cases, no systematic attack could be disguised or would likely be mistaken for anything else. Nor could an attacker reasonably expect to remain undetected. It is also possible a natural occurrence like severe space weather might be interpreted in time of crisis as a hostile attack. A bolt from the blue attack, launched with weapons developed and deployed in secret and unrelated to a terrestrial conflict may be conceivable, but is not a practical possibility in our judgment. Improvements in SSA are crucial to the certainty of attribution, as are an improved ability to recognize anomalies in our space constellation and to use that knowledge to alert satellite operators and national security decision makers. That aspect of the attribution issue is dealt with below.

Resolve, Red Lines, Trigger Events, and Deterrence Guarantees

Will an opponent perceive that national leaders lack the resolve to retaliate for an attack in space that is invisible to public opinion and perhaps leaves essential civilian services intact? It is a notable feature of our political system that those *out* of power tend to doubt that those *in* power have sufficient resolve, especially if they belong to a different party. Military leaders can have these same doubts about their civilian superiors, and – in some cases – civilians about the military. In our country, these doubts are very public and will be known to a potential adversary, who may therefore judge retaliation unlikely - not for lack of capability, but for lack of will.

Doubts have consequences for policy. Perception of lack of resolve – or the fear that others may perceive such a deficiency – is one motivation, for example, behind a policy of "red lines" or "trigger events", i.e., declarations that certain, specified acts by an opponent which will automatically trigger U.S. response.[27] These policies have two goals, one domestic and one international. On the domestic side they are intended to build bureaucratic consensus by reassuring doubters that under certain circumstances, retaliation is automatic. Internationally, they are meant to persuade potential adversaries that they cannot exploit internal weaknesses within the U.S. political or national strategic communities to gain advantage, particularly by incremental attacks.

There are a number of objections to red lines. To have any significance they must be drawn around some things but exclude others. Secretary of State Acheson unintentionally sent a message to both the North Korean and Chinese leadership in 1950 by defining our

[27] This aspect of trigger events is parodied in the movie "Dr. Strangelove" by the "doomsday device," rigged to destroy the world automatically if the Soviet Union is under nuclear attack. The strength of the doomsday device as a deterrent is that it removes all doubts about "resolve" by taking man (in the fictional case, the Soviet First Secretary, who might decide *not* to retaliate) out of the loop. This example also points up the importance of making red lines or trigger events public if they are to have value as deterrents.

"sphere of interest" in Asia to exclude the Koreas. Red lines" may also be less red than they seem, i.e., the fact that leaders feel impelled to proclaim red lines may be taken as a sign of ambiguity rather than resolve. In the Cold War, red lines tended to proliferate precisely in those areas where retaliation might otherwise be thought uncertain – both by our adversaries, and to some degree, by ourselves. There was no need in those years to proclaim red lines around the sovereign territory of the United States, for example. In Europe and Asia, on the other hand, they tended to proliferate.

Another objection to "red lines" as external trigger events is that they tend to be seen (and used) as limits on the flexibility of the commander in chief, i.e., as ways to bolster a potentially wavering national command authority during times of crisis. But effective national security leaders will insist on flexibility in those circumstances whatever trigger events have been announced or red lines drawn in advance. Kennedy's drawing and then redrawing of "red lines" to give Soviet leaders a chance to reconsider in the Cuban missile crisis is perhaps the best case in point.

In space, red lines may take the form – among others - of deterrence guarantees for the commercial constellation. The question arises because of the increased use of the commercial network for military communication. All the objections to red lines apply equally to this question, with the added problem of credibility, since many commercial satellites are owned either by international conglomerates or by countries that will probably be neutral in any future space conflict. Would the U.S. risk escalation in a space conflict to retaliate for attacks on non-sovereign assets? Would it wish to forego the option of itself retaliating against commercial satellites used by adversary nations for military communication? Would the red line of "deterrence guarantee" extend to some of the constellation, or to all – and if to all, how credible could it be?

There may be some limited role in crisis for the use of declaratory policy like red lines. For example, the U.S. effectively extended a deterrence guarantee to third country tankers in the Persian Gulf during the crisis there in 1987. Those tankers were temporarily "flagged," and declared to be U.S. sovereign assets. Such a temporary tactic may also be useful in space; at least it should not be ruled out.

In sum, red lines and trigger events as elements of doctrine are not a solution to the problem of perceived strategic resolve, and may have several negative consequences. They are therefore of limited use. But the problem of "resolve" (insofar as it exists except as a tool of political debate) is not one that can be solved by doctrine, bureaucratic organization or declarations. If a possible adversary perceives lack of resolve, deterrence is weakened. But the solution is to elect competent leaders, who will not project indecision in crises, an issue that is well outside the confines of this study.

Section IV: Responding to the Challenges of Space Deterrence

Four Layers of Space Deterrence

Given the unique nature of the space environment and the fundamental differences between space systems and nuclear weapons, we conclude that a layered approach to deterrence is most appropriate in this context. Just as the uniqueness of the space environment poses four distinct challenges for a strategy of space deterrence (see page 10 above), so we believe that effective space deterrence requires a "layered" approach with four essential elements:

- International norms
- Entanglement
- Retaliation
- Denial

Deterrence by International Norms

International norms are understood here to include all treaty and customary law as well as arms control treaties, test bans, formal and informal weapons moratoria, confidence building measures and "rules of the road". The question is whether these mechanisms - either singly or in combination - have deterrent effect, and whether they are legitimately (and even necessary) elements of a U.S. deterrence policy.

No international agreement is likely to deter a determined attacker in space any more than on the surface. Arms control agreements that have curtailed possible aggressive actions in space – notably the provisions of the strategic and intermediate range nuclear arms limitation agreement, which ban interference with national technical means (NTM) – have incorporated rather than created a mutually acceptable status quo. Finally, it may be the case that agreements regulating the behavior of nations in space have only been effective insofar as any one of those nations have lacked the capability and/or interest in violating them. The same could be said, of course, of any political agreement between sovereign entities.

The history of multilateral accords specifically regarding space is one of successive international agreements, albeit of diminishing scope.[28] The Outer Space Treaty is the most sweeping; among other things, it bans the stationing of nuclear (but not conventional) weapons in orbit and military activity on the lunar surface, stating that the moon and other celestial bodies must be used for "peaceful purposes." In agreeing to these limitations, U.S. policy makers decided nuclear weapons had limited utility in space, and that verification was therefore not essential. The other provisions of the treaty were similarly unverifiable, but there is no evidence that any have been violated, or that nuclear weapons have been deployed (or are likely to be deployed) outside the atmosphere.

Meanwhile, states were organizing internationally under the International Telecommunications Union (ITU) to allocate bandwidth for communication satellites, and the United States undertook its own regulations in that regard administered by the FCC.

The latest U.S. policy document (2006) tacitly accepts the benefits of existing legal regimes in space, while asserting that no additional regulations are necessary. It asserts a U.S. right to freedom of action in space, presumably unhindered even by existing international agreement (a shift from the Clinton space policy of 1996). Arguably, this right is no more than all sovereign nations insist on; but its assertion was generally greeted with accusations of U.S. unilateralism and aspirations to "space control." Regarding

[28] The Outer Space Treaty (1967), the Rescue and Return Agreement (1968), the Liability Convention (1972) and the Registration Convention (1975). Space activities are also affected by provisions of the 1963 Limited Test Ban Treaty which prohibits nuclear explosion in outer space, the 1980 Environmental Modification Convention which prohibits techniques which produce "long-lasting, severe or widespread environmental changes in Earth's atmosphere or in outer space" is also binding on the Russian Federation prohibiting interference with national technical means of verification. See Waldrop, *Ibid*. p. 13.

arms control, whereas the space policy of the Clinton Administration had left open the possibility of arms control agreements that were "equitable, effectively verifiable, and enhanced the security of the United States and its allies," the Bush Administration policy emphasized the negative, ruling out any new legal regimes or "other restrictions." It did not, on the other hand, *explicitly* rule out arms control, as long as such regimes did not impair the rights of the U.S. to conduct research, development, testing, and operations or other activities in space.[29]

Formal agreements affecting interference with satellites have been effective – indeed, more effective in the case of "national technical means" than strictly required by the language of the treaties that mention them. Both the Russians and the United States have extended the "non-interference" ban to the entire military space constellation of the other. This is certainly in part because neither side wished to designate which of its satellites was involved in the functions covered under the NTM provisions; but it has undeniably brought a level of stability and predictability to the strategic balance between the U.S. and Russians in space.

Verifiable testing bans can also be effective, as the Partial Test Ban Treaty has shown. An adversary is unlikely to launch a preemptive attack with weapons he has never tested under realistic conditions. Such tests in space – particularly of KE vehicles – would be seen. There are those who argue that a single test might be disguised and would be sufficient. That is not likely, in our view. Since the U.S. has renounced the option of KE ASAT weapons, and given the growth in international concern about space debris in recent months, a ban on KE ASAT test may be a very productive approach by the United States to future arms control in space.

Informal international norms can also be effective. For example, the PRC reportedly followed its KE test with informal assurances in Europe and the United States that the test would not be repeated. Reports have meanwhile leaked to the press of two previous PRC tests of the same system that had failed. The U.S. apparently had observed those failure as well as preparations for the eventual successful test. The U.S. did not intervene diplomatically to stop any of the tests; it did not publicly protest the successful test, although several other countries did, and the U.S. made representations only about the resulting debris field. In this case, the U.S. was abiding by its own strictures about freedom of action in space. To have protested the Chinese attack would have been to acknowledge the existence of some informal norm of behavior which bound *all* space-faring nations, something which the United States has specifically denied. Still, the political result of the Chinese test tended to confirm the existence of such informal norms sufficient to persuade the Chinese not to pursue this sort of testing. The U.S., too, must react to such informal norms, one reason perhaps that the Bush Administration, probably more receptive than its predecessors to the notion of stationing weapons in space, did not pursue that option. Indeed, the 2006 space policy document, although characterized by some on the Left as more aggressive than its Clinton Administration predecessor, was arguably in some ways more cautious.

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[29] The Bush space policy document reportedly went through thirty-four drafts, a good indicator of a brokered result. That would account for language which, on the one hand, does not explicitly rule out arms control (thus satisfying some bureaucratic interests), but on the other hand makes arms control practically impossible (thus satisfying others). It would also account for the inconsistency of insisting on a sovereign right to freedom of action, while also asserting a right to deny such freedom to other sovereign nations.

Finally, arms control negotiations can facilitate communication and provide information about what is really of value to an opponent. For example, we learned in the process of strategic arms negotiations with the Soviet Union that we had overestimated the value they attached to large, MIRV'd ICBMs, and underestimated the value they ascribed to preventing the U.S. from deploying an effective anti-ballistic missile system. That knowledge informed the U.S. approach to both strategic policy and arms control over the following two decades.

In short, arms control and other international norms can be an aid to deterrence, and can help in discerning a potential adversary's intent and the relative value he ascribes to his space and other strategic assets.[30] Arms control agreements which verifiably limit testing can strengthen deterrence by decreasing an adversary's confidence in his chances of success, enhance warning of a change in the strategic environment, and help dampen an arms race in areas otherwise of no interest to the United States (such as KE vehicles). Verification of agreements in space remains an obstacle. As far as we can determine from open sources, for at least the last decade the government has not sponsored active efforts to determine how technological advances might be leveraged to enhance verification of space arms control agreements.

[30] General Kehler, speaking at the 2008 National Space Symposium, acknowledged the potential benefit of such an approach when he stated that "a diplomatic mission to sway a would-be space attacker could outweigh the use of offensive counterspace options," *Inside the Air Force,* April 2008. The history of cooperative measures in the Cold War has been analyzed in greater detail by Jervis (1976), Axelrod (1984), and Moltz (2008).

Deterrence by Entanglement

Deterrence by entanglement is the notion that state actors will be deterred from attacking others because of economic interdependence. The notion has a checkered history. Norman Angell speculated in 1913 that interdependence of trade in Europe made another European War impractical.[31] In fact, two wars followed in the next four decades.

Still, the *degree* of globalized interdependence that characterizes the modern world is without precedent. It is also different in *kind*. In the first decades of the 18th Century, interdependence was based on trade in tangible goods, and governments still controlled both trade and investment flows. Governments could decide to forego certain economic advantages, including those arising from trade, in the service of national ambitions. In our new millennium, wealth has increasingly lost its relationship to tangible goods, and governments no longer control the flow of foreign investment, which can now occur instantly because of the independent decisions of multiple international actors who have concern only for maximizing profits and minimizing losses. Seven trillion dollars of "wealth" was destroyed in the United States in a period of two weeks in September/October of 2008 – and many trillions more in the rest of the world – without a shot being fired or, indeed, any tangible wealth being affected in any way. Governments might have wished to deter investors from the decisions that led to this widespread and virtual destruction of wealth, but lacked the means to do so. They were at the mercy of something that can be summarized by the phrase "investor confidence."

[31] Norman Angell, *The Great Illusion*, New York and London, 1913.

Judgments of the market now extend to all globalized economies, regardless of ideology or political system; the only defense is to take an economy “off the grid” – a solution employed by the regime in Burma, for example, but no longer available to leaders in the United States, China, India or – indeed – any other country which might be considered a future adversary of the United States in space. This new international economic interdependence is perhaps best exemplified by the relationship of the U.S. and the PRC which has led to a U.S. trade deficit created by purchase of PRC consumer goods financed by PRC purchase of U.S. Treasury bonds.[32] Deterrence by entanglement, therefore, is not only now a function of interdependence, as it was thought to be a century ago. Although we are “entangled” economically with the Chinese, perhaps even to the point of deterring hostile Chinese acts against U.S. interests in their geographic sphere of influence, both China and the United States are entangled in an international financial system which neither country can control, and the judgments of which are final.

Satellites, of course, are one communication node in that financial system. Any generalized breakdown in that system which could not easily be repaired – for example, the destruction of all satellite communication by nuclear detonations in space – would threaten “wealth” on a massive scale. It might be argued that repercussions would be less severe on China than the United States, because much of the Chinese economy is not globalized. The argument is not persuasive. The impact of a generalized destruction of space assets would have a considerable impact on Chinese business and political elites, i.e. those whose decisions matter. The impact on growth areas of the Chinese economy would be particularly serious. Reconstruction of the financial system without space assets – or with sufficient terrestrial backup to restore confidence in reliable financial transactions – would be a formidable and time-consuming task. Even an attack on a significant proportion of the commercial satellite infrastructure would have huge consequences for the wealth of globalized economies. It is difficult to envision the sort of gain in foreign or security policy terms that would offset this potential economic loss.

Entanglement extends beyond financial transactions to all the various applications of GPS satellite data. The U.S. ended encoding of GPS data in 2000. Since then, our most precise GPS signal has been available globally. That signal is now built into electric and transportation grids worldwide - among a vast number of other systems and devices, creating a degree of technological entanglement (and potential economic loss) that could only be truly appreciated if the GPS signal were suddenly to disappear.[33]

The example of GPS demonstrates entanglement when civilian applications of a system originally built for a military purpose proliferate globally. In such cases, the effects of any attempts to deny the original military function would not be confined to one country in a crisis, but would unavoidably draw in other states who have become reliant upon space over time. The reverse situation also obtains. Communications systems originally built for civilian, commercial purposes now carry a variety of necessary military traffic, including data from unmanned air systems

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[32] James Fallows, “The $1.4 Trillion Question,” *The Atlantic,* January/February 2008.

[33] The degree of interdependence on the GPS signal by 2001 is described, inter alia, in The Rumsfeld Report. See “Report of the Commission to Assess United States National Security Space Management and Organization Pursuant to Public Law 106-65, p. 23.

such as the Predator.[34] Hostile action to disrupt military communications over commercial systems would likely draw into the crisis numerous other governments whose own military or civilian traffic is carried by the same satellite as one of the warring factions. Because the use of civilian commercial transponders is market-based and constantly shifting, an aggressor's planning would be complicated by the inability effectively to predict which other friendly, neutral, or potentially adversarial states would be affected at any given moment by interference with a particular commercial satellite.[35] The prospect of an expanding global market for satellite services means the unintended economic consequences of any attack on commercial – and even some key military satellites – will likely expand over time. This entangling web of mutual dependence and shared consequence will act as a deterrent on the policy makers of all globalized economies.

We are entangled with others in space physically as well as an economically, a fact highlighted by the recent conjunction of a Iridium and Cosmos satellite over Siberia which created a still expanding cloud of space debris. Other near misses in both LEO and GEO during the first months of 2009 further underlined the space debris issue, which was one of the reasons the U.S. backed away from KE counter satellite technology – and why the Chinese KE test of January 2007 was viewed with such alarm. No one knows how frequent conjunctions will be in the future. That will depend, in part, on improvements in space situational awareness and in the systems by which information is shared between operators. All agree that each conjunction increases the chances of more, and the eventual possibility of a cascade of conjunctions that will make low earth orbit - and the more popular orbits in GEO - more dangerous, increasing the costs of operating there and bringing further into question the comparative advantage space offers commercial operators. Any large ASAT exchange in space would scatter debris precisely in those orbits most useful for ISR and communication of the combatants, and would raise the danger of making space unavailable for military and commercial users alike for as long as the resulting debris remained in orbit.

As noted above, however, sovereign governments have the power, at least in the short term, to ignore or sacrifice their economic interests – and those of succeeding generations - to immediate strategic gains. Deterrence by entanglement is therefore one, but certainly not the only, component of a deterrence strategy.

Deterrence by Retaliation

Perhaps the most disputed question and the most intractable dilemma of space deterrence is whether it requires a space-for-space retaliatory option to be credible. In other words, will an adversary believe that it can attack vital U.S. space assets with impunity if the U.S. lacks the option of retaliating in space?

The analogue from Cold War deterrence theory is the notion of escalation dominance. The theory held that deterrence could best be maintained if the Soviets perceived that the U.S. was superior at every stage of potential

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[34] Don Branum, "Coalition Force Reaper Unit Deploys to Joint Base Balad," *Air Force Print News Today,* 21 November 2008, www.af.mil/news/story_print.asp?id=12312565.

[35] Then Colonel, now Lieutenant General Frank Klotz wrote in 1999 "The health and safety of some civilian satellites may become just as important to the outcome of an armed conflict as those of dedicated military satellites." See *Space Commerce, and National Security*, Council on Foreign Relations, 1999, p. 10.

escalation: thus, the U.S. could counter conventional aggression on allies with conventional force, theater nuclear with theater nuclear force, strategic attack with strategic forces. Seeing 1) U.S. willingness to escalate, and 2) the impossibility of achieving advantage through escalation itself, the Soviets would decide that attack would achieve no permanent advantage. But this depended on credible forces being deployed at each rung of the escalatory ladder.

Is the same thing true in space? The answer is partly political rather than theoretical. If a potential adversary deployed space-based ASATs, it can safely be assumed that the U.S. would have no political choice but to follow their lead. Aside from the expense, the resulting arms race would not be in the interests of the United States as predominant and most vulnerable actor .[36] A space arms race would also have negative consequences for the commercial space industry, which depends on a stable and predictable space environment to justify large investments that space commercial infrastructure requires. But none of these arguments would likely prevail in a situation where a potential adversary threatened to achieve an asymmetric advantage. As well, the existence of such weapons in orbit unmatched by American capability would have a chilling effect on U.S. policy makers, and might limit their choices in situations of crisis.

Some would argue that this space arms race is already in progress, although confined for the moment to laboratories and "dual use" systems assumed to have some counter space capability. A future race in space is inevitable from this point of view; the U.S. should assume that others are working on orbiting ASAT weapons and begin work itself rather than allowing an asymmetric threat to develop in space.

On the other hand, no country currently deploys an ASAT system in space; the only system which might be so described – the Soviet co-orbiting KE ASAT system – has not been tested in twenty-five years. Whether any future space-based ASAT systems are in development cannot be determined from unclassified sources. That the U.S. would have failed to detect "dual use" or "sleeper" satellites in orbit is possible in theory; in practice it has not been a claim made by responsible military commanders who would seem to have little motive to keep secret the existence of such a threat. In short, we conclude that there is a threshold that has not been crossed between our current strategic situation in space and events (some within our control and some not) that would trigger a space-based ASAT arms race. Others may have evidence to prove that conclusion wrong. If so, it will be included in the responses to our study we intend to publish when comments on it become available.

There is another potential technological space competition that is visible in the open literature and, in our judgment, will set the tone for the future, i.e., devices intended to incapacitate satellites temporarily by degrading, denying or disrupting their operations or their signals.[37] Ground-based systems have a number of advantages in that role. The barriers to entry – in both capital and technology - are lower. The availability of energy is comparatively unlimited, unlike space based systems where on-board energy

[36] The expense is literally unknowable. Even the cost of existing programs is calculable only within wide orders of magnitude. We can assume, however, that the cost of ASAT arms race in space would be very considerable indeed.

[37] See also: Elizabeth S. Waldrop, "Weaponization of Outer Space: U.S. National Policy" in *Annals of Air and Space Law*, Vol. XX1X, p. 10.

supplies are a limiting factor in capability. The effects produced by ground based interference may be decisive in conflict, but are transitory, do not create space debris, perhaps delay attribution, and provide (or so it may seem to an attacker) less of a trigger for retaliation. Jamming and dazzling devices already exist; the United States cannot prevent their future evolution and proliferation. The U.S. has its own program of "tactical denial" as a key element of space strategic policy. It is prudent to assume that Russia, the PRC and potentially other space-faring nations have similar programs. Accordingly, outcome of future hostilities on the surface between the United States and a technologically sophisticated space-faring opponent may be decided by which side is more able to negate the satellite assets of the other, and to preserve relatively more of its own capability. This tactic is not without technological hurdles of its own. For example, the problem of "frequency overlay" makes it difficult to jam the satellites of possible adversaries without also jamming the signals from allied satellites and potentially even one's own. Still, in this area, as in others, technological superiority will be important. If adversaries are convinced that U.S. "fight through" disruptions in space while disrupting the space services of adversaries, deterrence will be enhanced.

Some argue that robust space deterrence requires a deployed ASAT capability in space, so that attacks in space can be answered in kind. Such a capability faces political and budgetary obstacles. Congress has been consistently cool to the idea on grounds of cost and the conviction that an offensive ASAT arms race in space would not be in U.S. interest. Others do not face similar obstacles.

There are, however, potential mitigating factors. First, an adversary could not be certain that retaliation would be limited to space. Although the threat of escalation is often portrayed as inhibiting rather than empowering U.S. decision makers, that threat would also have to be taken seriously by an adversary. U.S. declaratory policy has always emphasized that retaliation for attacks on vital assets will be of a magnitude and by means of our choosing.[38] No rational adversary could rule out a disproportionate response or so-called "horizontal escalation" (for example in the cyber domain), especially if his conclusion was the same as ours: that limiting ourselves to space-for-space retaliation would leave the U.S. at a disadvantage. He would also have to take into account the possibility of a less than rational response to his action, perhaps leading to an even more rapid escalation.

The Cold War analogy is brinksmanship, the willingness to escalate unpredictably when vital strategic interests are threatened.

The second mitigating factor is that even in the absence of dedicated ASAT systems, a potential attacker is not likely to perceive the U.S. *lacks* capability to retaliate against the space assets of an adversary. Many nations perceive existing U.S. ballistic missile defense systems as having a dual-use nature, including potential anti-satellite capability. The U.S. reportedly has an active and acknowledged program of "negation" designed to deny an adversary the use of his space assets as force multipliers in the case of hostilities within the atmosphere. We may safely assume that other nations are pursuing similar programs. In our judgment, the most likely scenario for future space conflict is a "war of negation," i.e. an attempt by each side to preserve the product of its space assets while denying those space services to the opponent. To win such a contest requires technological superiority,

[38] See Joshua M. Epstein, "Horizontal Escalation," *International Security,* Vol. 8, No. 3, Winter 1983/84, pp. 19-31.

which the U.S. should make every effort to maintain and which, in this area as in others, is a vital element in maintaining space deterrence.

We conclude that the threat of retaliation can remain a credible element of our overall space deterrence. The attribution of attack is not an insuperable obstacle, and that questions of resolve will ultimately depend on the perceptions of a potential attacker in the circumstances existing when his decision to attack is being considered. A credible threat of retaliation may require willingness to escalate into other domains. It could include fielding ASAT systems if such systems are deployed by others, but the resulting arms race would not be in the interests of the United States. The U.S. should not be the first to deploy such systems and the U.S. use the full extent of its influence internationally to avoid that outcome. Ultimately, a threat of retaliation is never more credible than the leader and the government that issues it. No declaratory policy can compensate for an irresolute commander in chief, one who is misinformed or badly served by his subordinates. An opponent will tend to judge the likelihood of retaliation not according to proclamations made months or years earlier, but according to the situation pertaining at the time – as Hitler did in Europe and Saddam did in the Middle East. What a President does in the run up to and conduct of a crisis will have far more to do with an adversaries decisions than libraries full of ultimatums and guarantees. Subordinates who doubt the resolution of a commander will try to limit his or her flexibility to respond other than in ways the subordinates think appropriate. A wise commander in chief, on the other hand, will strive to maintain flexibility, to approach a particular conflict in the context of wider responsibilities, to take account of factors which were unforeseen when the doctrine or battle plan was devised – in short, to balance one risk off against others. No bureaucratic arrangement, declaratory doctrine or weapon capability will compensate when such leadership is not present.

Deterrence by Denial

Deterrence by denial is a policy which convinces an adversary undeterred by norms, economic costs, or the threat of retaliation that in the end he cannot achieve the purposes intended by launching an attack. During the Cold War, the advent of long-range nuclear missiles and Soviet conventional superiority in Europe combined to make denial problematic as a centerpiece of doctrine. A host of Cold War doctrines – flexible response, defense in depth, rapid reinforcement, assured second-strike capability – were developed to make deterrence by denial more credible. The advent of the "triad" of submarine launched ballistic missiles, hardened land-based ICBMs and strategic bombers on airborne alert could also be portrayed as elements of a denial strategy. President Reagan's SDI initiative in 1983 brought deterrence by denial to the forefront in the nuclear standoff, at the same time moving the emphasis away from the balance of terror.

The nub of the political debate in the United States in these years was whether these were steps to enhance deterrence or preparations for war fighting. In fact, they were both by necessity. No policy of deterrence by denial could be credible without the perception that the U.S. could absorb an initial attack (whether conventional or nuclear) and still fight and win the resulting war, delivering unacceptable damage to the enemy.

Accordingly, no strategy of space deterrence by denial can be credible unless a potential adversary perceives that the U.S. military capability within the atmosphere will not be crippled by attacks in space, i.e. that the U.S.

will retain superior war fighting capability even after an initial attack. If to this perception is added the conviction that his own space or other capability will also be degraded or destroyed in the process, deterrence is that much stronger.

Section V: Recommendations

This study argues that deterrence in space cannot be oriented around a single concept or created by measures limited to space alone. Instead space deterrence must be considered as a series of successive layers, some of which involve space assets and some of which require better exploitation of existing assets in the atmosphere. Together, a layered deterrence framework will be more responsive to changes in the dynamic security environment and provide policy makers with a variety of choices in responding to hostile action.

We believe a layered space deterrence framework can be created and strengthened by the following eight steps:

1. Improve Space Situational Awareness

Deterrence depends upon accurate information, especially in discriminating between intentional and unintentional/natural interference, in assessing the operation of rules of the road, in verification of any future arms control agreements, and in enhanced warning – all elements of an effective deterrence posture. Aside from its role in deterrence, improved SSA is necessary to allow more efficient use of orbital space, for space traffic management and for tracking and mitigation of space debris. The U.S. recognized the importance of SSA by assigning responsibility for this issue to Strategic Command in the Unified Command Plan. This will promote a joint approach to the issue, with the Air Force and sister services providing the capabilities required.

Beyond this, however, the United States should:

- Invest in better sensors, more satellites, and improved ground equipment, and communication/synergize existing data to create a more effective database and make better use of the information we have.
- Undertake a thoroughgoing review of data in the public domain to determine the scope of information that can be exchanged with other spacefaring states without compromising security interests.
- Reach agreements with commercial operators to upgrade future satellites to include SSA sensors, either integral to satellite design or as hosted payloads.
- Seek agreement with coalition of allies and other spacefaring states on the scope of information exchange with commercial operators.
- Establish a clearing house for exchange of SSA information in the form of a limited access "blog" or website on which both governments and private operators can post whatever information they choose; as confidence in such a system builds, better and more complete information will appear, inaccurate information can be identified/isolated, and a broader database will be created.
- Encourage rather than discourage like-minded spacefaring states to improve their SSA capabilities.

2. Internal Red Lines – Space Alerts

Internal red lines – thresholds of interference that activate system wide alert and trigger notification to the national command authority – are not just useful in themselves but an element of deterrence. They would be equivalent in space to the DEFCON system which has proved effective both in its intended function – to increase the military alert level – and also as a diplomatic signal to a potential attacker not only that forces are on alert, but that the attention of those within our government with the power to order retaliation is engaged. This system would also force military space operators to create a system to identify a trigger level of anomalies/degradations that should be brought to the attention of the NCA whether or not the source of problem can be immediately identified. Adversaries may try to spoof this system (as all such systems), but two can play that game.

3. Defense

Insofar as defense of satellites can be enhanced, both deterrence and security are strengthened. But the concept of defense should be extended to defending our capability, rather than just the satellites. Historically, defense of satellites – chiefly by hardening and maneuver – is expensive, compromises capability for a given mass, and quickly runs into diminishing returns.

4. Deploy Space Assets in Inherently More Defensible Modes

Vulnerability can be lessened – and deterrence enhanced – by moving to constellations of smallsats that are more difficult both to detect and to attack. Smallsat technology is evolving rapidly, although it is unproven as a substitute for key elements in our national security space constellation. In addition, there are some intelligence and reconnaissance functions smallsats may not be able to replace and – realistically – the existing space infrastructure will continue to rely on large, single point of failure systems at least through the 20-year timeframe of this study. Still, the U.S. cannot afford to lag in smallsat development, and they may be a near-term solution to maintaining essential space services in a hostile space environment.

5. Operational Responsiveness in place of Operationally Responsive Space

Our analysis leads us to conclude that the notion of "operationally responsive space" is impractical on the one hand, and too limiting as an operational concept on the other hand. A prudent attacker will retain capability against a second-wave or third-wave of space deployments. Even the most optimistic assumptions assume a gap of 30 days before some capability could be restored, which in modern war may be more than enough for an attacker to achieve decisive advantage. Our goal, on the contrary, should be to maintain operationally responsive services to the warfighter from a host of different sources, using existing technology within the atmosphere and on the surface.

For example:

- Exploit existing and new air breathing and lighter than air platforms, both manned and unmanned. The ability to surge air breathing and lighter than air platforms to restore capability lost from attacks on satellites is crucial to a policy of deterrence by denial and also to warfighting if deterrence fails.
- Expanding capability of fiber optic and airborne communication within theater could provide an alternative to space at acceptable cost and using known technology. Existence of such an option would complicate attempts to compromise U.S. capability and force an attacker to compete successfully in yet another arena – thus, strengthening deterrence.

6. Expand Military Use of the Commercial Constellation

The commercial constellation is a central factor in "deterrence by entanglement," and also a means to complicate targeting options for any potential adversary. Military communication is already carried on commercial satellites and that usage expands in time of active hostilities. The U.S. cannot replace the space capabilities that the commercial sector provides (e.g., up to 80% of all communications bandwidth). The practice of buying transponder time on the spot market enhances deterrence with the space equivalent of multi-aim point basing. The U.S. should encourage the expansion of the commercial network by guaranteeing multi-year buys, in return for satellite operators agreeing to harden future satellites against EMP and other hazards, and equipping them to protect classified communication and with sensors to aid SSA. It may also be useful to overbuy transponder time, especially in times of crises. We do not recommend extending a general deterrence guarantee to the commercial sector. If the inherent deterrent of mutual dependence does not discourage a potential attack, it is unlikely that a U.S. guarantee would do so; a deterrence guarantee would make these satellites legitimate military targets; and a deterrence guarantee for non-U.S. assets would tend to not be credible, would decrease U.S. flexibility in crisis, and might be actively opposed by commercial, multi-national satellite operators.

7. Become Potentially Less Dependent on Space

Deterrence cannot be effective if an adversary believes he can gain decisive advantage on the battlefield by destroying or interrupting services from the U.S. space constellation. If he believes, on the other hand, that the U.S. will retain a decisive conventional and nuclear advantage even with interruption of space services, deterrence will be enhanced. Accordingly, the U.S. should inaugurate a multi-service effort to train and equip to fight without space. The recent "day without space" points the way. This may be initially an issue of consciousness-raising for field officers; what to do if the "screen goes blank."

8. Seize the Political Initiative

The U.S. should be the leader in building consensus for measures to create a stable and predictable environment in space; no other power can take the lead, none has more to gain. The U.S. has been the leader in space debris mitigation, but has yielded the initiative to others on "rules of the road" and on space arms control, insisting instead on a "freedom of action," which is in any case largely illusory given the thicket of regulatory regimes to which the U.S. is party.

Accordingly, the U.S. should:

- Sponsor an international regime on rules of the road in the UN Committee on Disarmament.
- Propose a verifiable ban on KE ASAT testing in space.
- Formalize consultations with the Europeans on space within the North Atlantic Treaty Organization (NATO).
- Actively pursue a series of discussions on space with the PRC.

Conclusions

The present U.S. space deterrence posture is problematic. We have increased our space capability, but increased as well the potential benefit to an attacker of destroying or disabling that capability. We have improved bilateral cooperation with some allies; but we have not rallied international support for the fundamental principles of our space policy. Our efforts to slow the transfer of space technology to potential adversaries have not prevented the emergence of counter space capabilities elsewhere, and may have weakened our own space technological base. We have moved tentatively toward deploying more and cheaper satellites, but our core effort remains concentrated on a few, large, very expensive and difficult to defend systems – that will still be the backbone of our space constellation for decades to come. In defense of our freedom of action in space, we have worked to discredit legal or political impediments to the testing of ASAT weapons by others, without overcoming the theoretical, political or budgetary obstacles to testing such systems ourselves.

Although, as we have argued here, deterrence in never assured, the optimal approach for the U.S. in space is a "layered" approach, which combines the strengths of a number of deterrence strategies, avoids the weaknesses of each in isolation (especially in space), and deterrence, which combines the strengths of mutually reinforcing deterrence strategies while ensuring – as perhaps the key element in any space deterrence posture – that the U.S. can "fight through" even if deterrence fails, i.e. that our terrestrial forces will not be paralyzed even if the screen goes blank.

This outcome cannot be achieved by assuming that space capabilities can only be replaced with space capabilities. It cannot be achieved if an adversary assumes that retaliation for attacks on space capabilities will be limited to space. It cannot be achieved if our forward planning does not account for interruption of space capability just at those times –on those fields of battle - where it is most necessary. And it cannot be achieved if the United States isolates itself technologically and politically, allowing others to establish the political agenda for space.

New forms of deployment with more emphasis on defense may eventually solve the vulnerability problem and with it, the problem of deterrence. President Reagan's vision of a defensive arms race may be applicable to space as well, but that won't happen in the medium term. In sum, the Roman consul Flavius Vegetius Renatus is remembered for the phrase: if you would have peace, prepare for war. Our conclusions can be summarized in a similar phrase: if you would have peace in space, prepare for war without it.

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