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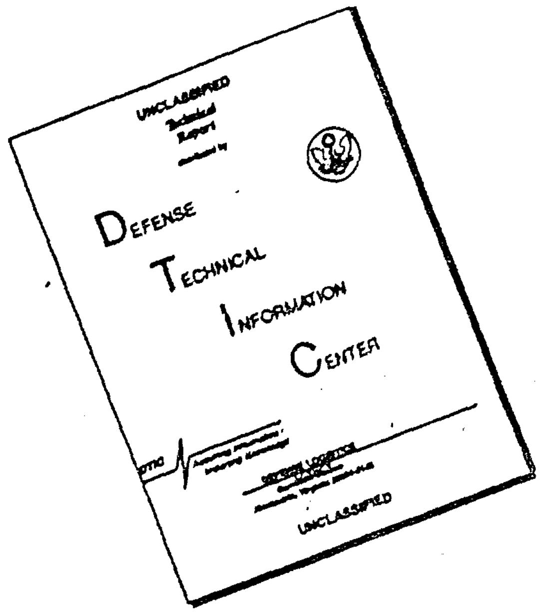

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Defending Against a Space Blockade

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DEFENDING AGAINST A SPACE BLOCKADE

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ABSTRACT

Although great attention has been paid to space weapons in relation to the Strategic Defense Initiative (SDI), there seems to be little recognition that platforms performing an SDI role could establish a space blockade. The United States must recognize the feasibility of such a blockade and take steps to offset it. Possible steps include depending on arms control pacts to keep weapons out of space, developing terrestrial systems for use in breaking a blockade, or putting weapons in space before an adversary can establish a blockade.

Problems in verifying the nature of orbiting vehicles reduce the reliability of arms control. Advantages space weapons will have over surface-based systems argue against dependence on restorative measures undertaken from the ground. Thus, putting weapons in space is an option that should be explored.

There are, of course, arguments against this option. Perhaps the most cogent is that using space for military ends may be destabilizing. Merely placing US weapons in low orbit, even if they were deployed solely for SDI, would threaten rivals because of the possibility of a US blockade. Moreover, such platforms would be vulnerable if another power put weapons in orbit. However, a mix of low-orbit SDI forces and high-orbit reserve forces should be less vulnerable and less threatening. Such a defense could be improved by creating a high-orbit keep-out zone for each space power.

DEFENDING AGAINST A SPACE BLOCKADE

THE UNITED STATES is presently analyzing the potential of space-based boost-phase intercept weapons for defense against nuclear ballistic missile attack. Framed by the widespread fear of nuclear war, the Strategic Defense Initiative (SDI) focuses on intercepting and destroying large numbers of missiles, especially during the powered stage of flight. This emphasis on full strategic defense capability against mass attack overshadows the implications of such weapons at levels of conflict much lower than all-out nuclear war. A major implication is the possibility that the first nation* to deploy boost-phase intercept weapons could use them to exclude all other nations from space.[1] By maintaining such a space blockade, a nation might be able to control space indefinitely.[2] Although a space blockade might not be able to defeat massive numbers of nuclear ballistic missiles, such an attack would continue to be deterred by the threat of response in kind, and less massive deployments, bearing nuclear or nonnuclear payloads, could be intercepted and destroyed. Such payloads could include another nation's boost-phase intercept capability as well as intelligence platforms, weather satellites, and communications stations.

Blockading space is, of course, an option that a nation could decide not to exercise, but developing a blockade capability is not something a nation building a defense against ballistic missiles can select or reject. Developing a blockade capability is an inevitable by-product of SDI research and development. Having even a fractionally effective SDI system in space would give a nation a significant blockade capability. That capability would be attainable much sooner than an all-out strategic shield. Moreover, it is far more feasible technologically and would be much less expensive.

Any nation achieving an enduring space blockade would not only reserve to itself the opportunity for deploying a space-based strategic defense shield but would also gain significant advantages in conventional terrestrial military operations. These advantages would stem directly from a monopoly of space-based intelligence, communications, navigation, weather, mapping, and other military support platforms. Such advantages combined with the potential for precluding launch of an adversary's advanced research vehicles and for gaining decisive political leverage may have more to do with the Soviet position on arms limitation and SDI than do the more publicized consequences of effective strategic nuclear defense.

The Soviets have stated that American ideas about knocking down massive numbers of simultaneously launched intercontinental ballistic missiles (ICBMs) will not work.[3] They have said little or nothing about the potential effectiveness of a space

*Since the Soviet Union is the United States' primary space rival, that nation is used often in this article as the example, but many of the author's arguments would apply to any rival who develops similar capabilities.

blockade against less massive deployments. Soviet fear that the United States may gain this capability could be the primary reason the Soviets are urging the United States to abandon plans to place weapons in space.

Whether or not the Soviets fear a potential US space blockade, the United States should fear the consequences of Soviet development of a blockade capability. Direct confrontations between the United States and the Soviet Union have in fact occurred, and they *all* were blockades (two blockades of Berlin and one of Cuba). In each case, even though its adversary had nuclear weapons, the blockading nation tried to stem the buildup of military or political power of its primary adversary near the blockading nation's territory. The Soviets might view potential American space weapon deployments as constituting a similar buildup in military and political power near the borders of the Soviet Union. If the Soviets acted to head off such a buildup through a space blockade, history could repeat a familiar pattern.

Of course, Americans cannot know for certain whether the Soviets will develop a space blockade capability or whether they would use such a capability once they achieved it. The only sure way of finding out would be to do nothing and see what happens. Conducting such an experiment would be tantamount to withdrawing US forces from Western Europe to determine whether they are really needed there. Americans have not been willing to conduct that experiment in Western Europe. Once Americans become aware of what is at risk in space, it would seem they would be even less willing to try such an experiment there. Space domination would afford an adversary the opportunity to place weapons within a few hundred miles of any point in the United States or the world. If space were to be unilaterally occupied (occupied in its military sense) by an enemy of the United States, and if such a situation could not be rectified, the high-water mark of American influence would be history. (For example, even if the Soviet Union permitted US space deployments it had certified weapon-free, American military power would be severely constrained.)

The purpose of this paper is to point out the implications once *any* nation orbits boost-phase intercept weapons and to underline the consequences if the United States is second. The reasons for this concern are the possibilities that Soviet objectives include expansion of its military space power[4] and that the Soviet Union is currently developing weapons capable of boost-phase attack.[5]

What military and political dilemmas could a space blockade cause? Is the simple solution "don't be second" enough to avoid a space blockade? Could all these problems be precluded by banning weapons from space? These questions raise issues that *should* now be as thoroughly analyzed as space-based ballistic missile interdiction has been. This article is meant to be a first and admittedly incomplete start for such analysis.

There appear to be two ways a space blockade could occur: as a result of single occupancy (where only one side has weapons based in space) or as a result of a surprise attack in space that converted co-occupancy to single occupancy. The following discussion is mainly concerned with US alternatives in such circumstances although much of the discussion would be germane to any nation facing similar problems.

Blockade after Single Occupancy

Once an enemy unilaterally occupied space and implemented a blockade, a US president would have only *two* options: to tolerate a blockade or to react to it. Neither option appears attractive.

Tolerating a Blockade

If a president chose to tolerate a blockade, he or she would be ceding to the adversary all the benefits of space-based platforms. As noted, these would include all the force enhancement capabilities presently based in space (plus those that might be developed in the future). The immediate consequence of this predicament is plainly stated by Gen Robert T. Herres, vice-chairman of the Joint Chiefs of Staff. "It is clear that the use of space can provide a decisive edge. Modern military forces cannot expect success if they are denied that edge while operating against forces who enjoy the support provided by space-based systems."[6]

In the long term, tolerating a blockade would hamper US ability to plan reactively.[7] US military planners would have to try to tailor forces to evolving threats without benefit of satellite intelligence on the types and deployment of adversarial forces. Given the closed nature of the societies of some potential US adversaries, only limited capabilities to replace such intelligence would exist. In addition, a decision to tolerate a space blockade would allow an adversary to deploy a strategic defense at leisure.

Reacting to a Blockade

Assuming a president had the public backing necessary to respond to a space blockade, US options would again seem to fall into two categories—military or nonmilitary responses.[8] Nonmilitary responses (political, economic, etc.) do not seem to constitute credible options because they are unlikely to be strong enough to offset the advantages accruing to a blockader. One would be hard pressed to produce a historical example in which nonmilitary responses not backed by the threat of military force have broken a blockade.

Thus, a president trying to restore American space access would seem to have little choice but to use (or threaten to use) military force. Unfortunately, the prospects for force in this situation seem less than favorable, whether a president were to opt to attack a blockade directly or indirectly.

To directly attack a space blockade following an adversary's unilateral occupation of space, the United States would appear to have recourse only to such weapons as ground-launched antisatellites (ASATs), air-launched ASATs, and ground-based directed-energy weapons (DEWs). Each of these weapon systems would have specific deficiencies when used in an attempt to break a space blockade.

A mass attack by ground-launched ASAT rockets would face attrition during boost phase.[9] Depending on boost-phase intercept efficiency, the attrition ground-based ASATs would suffer might be quite severe. This could make breaking a space blockade very expensive—perhaps many times more expensive than it would be for the blockader to deploy reinforcements. In this way the much-touted "cost-effectiveness at the margin"[10] could operate in the blockader's favor.[11]

Air-launched ASATs would endure a shorter period of boost-phase vulnerability because they would be launched above most of the atmosphere. However, the number of ASAT missiles that could be simultaneously launched would be limited by the number of aircraft modified for this purpose. In addition, as ASAT-carrying aircraft neared launch altitude they could be vulnerable to the weapons used to attack the missiles.[12] An attack on ASAT-launching aircraft would widen a limited space war to the air medium and cause human casualties, injecting further emotional and potentially escalatory elements into a conflict that crisis management initiatives would be operating to constrain. In such a case, it might be arguable as to which side was widening the conflict to the air medium. As a result, the United States might face an unfortunate choice between accepting at least some of the onus for widening the conflict or of limiting the types of weapons it could use.

Ground-based DEWs (ground-based lasers, for example) would avoid the problems of boost phase because DEWs act instantaneously. However, among other problems, even a DEW must be able to locate its target, and space is a very big place.[13] Even if DEWs "knew" the approximate locations of weapon platforms supporting a space blockade, such platforms would probably be designed with stealth elements so that they would have low-observable designs with respect to earth-based radars.[14] Thus, a ground-based DEW could have great difficulty in precisely targeting space-based weapons. The best way to make a DEW effective would seem to be use of "artillery-spotter" satellites that could precisely identify target locations. Such satellites might be able to spot blockading space platforms more easily than ground installations both because they could approach closer and because they could view these platforms from different and thus more observable angles. The problem is, unless a nation put such satellites in place before a blockade was instituted, it would be difficult or even impossible to get them into space.

If the United States concluded that because of the problems just discussed it could not effectively carry out a direct attack against a blockade, its only remaining option would be to widen the conflict by indirectly attacking the blockade. It could try to destroy terrestrial targets critical to operating the blockade or try to destroy targets the blockading nation valued so highly that it would relent. Presumably the United States would adopt limited objectives in following either of these plans since it would not wish the widening war to escalate to nuclear war with its risk of annihilation.[15] Unfortunately, neither of these plans would be free of dangerous escalatory risks.

Consider, for example, the risk involved in attempting to carry out the first plan by destroying launch facilities. Such an attack (launched against an adversary's sovereign territory) would obviously entail the risk of nuclear escalation, particularly if penetration of the blockader's frontiers were detected. Such penetration might well be interpreted as a nuclear attack. Even if attack without warning could be achieved (perhaps by using conventionally armed stealth cruise missiles or some other such weapon) there would be an incalculable risk that the enemy might misinterpret the conventional nature of the attack and launch a nuclear retaliation. Moreover, in the case of the Soviet Union, targets of military value are hardened against attack (or designed to be mobile and hidden) as a matter of course.[16] Thus, conventional attacks might be less than successful.

Consider now the problems inherent in trying to carry out the second plan by trying to destroy the blockading nation's will. Assume, for the sake of argument, that the blockader is the Soviet Union and that such a conflict could be conducted without escalating to nuclear war (that risk, of course, would exist and would be an excellent counterargument against this plan). In this scenario, the United States would select, threaten, and, if necessary, begin to destroy (using conventional weapons) targets so valuable to the Soviet Union that it would give up its space blockade rather than risk further destruction. However, the Soviets could counter US conventional attacks with a response in kind (especially in view of Soviet development of "quiet" submarines, which could be armed with "stealthy" cruise missiles). In fact, Soviet planners would be presented with a far richer target selection than their American counterparts. Beyond this imbalance, the United States has a far more extensive and independent news media than the Soviet Union and thus could expect far more external coverage of damage from an exchange of conventional attacks. The United States would therefore appear to be the more sensitive in a conventional exchange—it would suffer more. Given all of the above, there seems little reason to believe the United States would win the contest of wills that would surely result from following this plan.

In short, all the possible reactions to a space blockade following single occupancy of space present unfavorable consequences. Toleration of a blockade would likely lead to permanent power loss, nonmilitary responses historically have been ineffective, and military responses would carry severe risks of nuclear escalation or of unfavorable results even if nuclear war were avoided. Thus, being the second nation to carry SDI-type weapons into space could leave the United States in a classic dilemma in which all options are unsatisfactory. An obvious solution would seem to be to avoid the dilemma—that is, avoid being second by (if not occupying space unilaterally) co-occupying space. However, there are also problems with this answer.

Low-Orbit Co-Occupancy of Space

If one agrees that the domination of space through a blockade is an advantage neither superpower can afford to cede to the other, it may appear that the solution with the least threatening consequences for both sides is co-occupancy. *However, two problems* work against the adoption of this solution, especially from the US point of view.

The first problem is that neither side can ensure its adversary's cooperation, particularly when deploying systems each side considers threatening. For example, even if co-occupancy were agreed upon, the United States would have no way of ensuring that its deployments of space weapons would be conducted in chronological concert with those of the Soviet Union. The Soviets would have many opportunities for complaints and requests for delay that could be based on fabrications. If the United States slowed its program based on such complaints, it might awaken to find it had been or was being left behind. In short, there appears to be no way to ensure a tie in putting weapons into space.

The second problem is that low-orbit co-occupancy, even if achieved, could be turned (by a surprise preemptive attack) into single occupancy. The preempted nation would then suffer all the consequences already discussed.

To be within range of ground-launched vehicles, the boost-phase intercept weapons of both sides must orbit at relatively low altitude (approximately 500 to 2,500 miles above the earth). This low-orbit requirement is established by the projected lethal range of directed-energy weapons, at least within presently anticipated technological constraints. Also, the intercept weapons must spread out along their orbits to fill all the gaps, or weak areas, as the platforms revolve around the earth. Without continuous coverage of the opponent's ground missile sites by a procession of intercept weapons, ICBMs could be launched through the gaps in the missile defense. With a large number of intercept weapons providing continuous coverage of ground positions within roughly a 2,000-mile thick orbital band around the earth, two forces would, even in peacetime, infiltrate and envelop each other, seriously diminishing their ability to defend themselves. Their proximity and perceived vulnerability would set a hair trigger on surprise, preemptive action.[17, 18] Such attacks could be made with either direct fire from satellite weapons or accomplished with space mines.

Readers may object that national space forces could be segregated in "keep-out" zones so that infiltration and envelopment would be avoided. Other considerations aside, the effective ranges of projected boost-phase intercept weapons, the requirement for continuous coverage of launch sites, and the relatively limited volume of low-orbit space mean that some portion of two or more SDI-type space forces would be intermixed and within range of each other at various times. Moreover, this proximity problem would worsen as the number of platforms in low orbit increased. Keep-out zones are discussed in greater detail later in relation to higher orbits where they could be more useful.

The problems of co-occupancy thus seem to array themselves in twin paradoxes. First, the superpowers' adversarial roles dictate that neither side can afford to be second in taking weapons into space, but these roles are antithetical to the cooperation necessary to ensure co-deployment. Second, if co-occupancy were somehow achieved, intermixed low-orbit weapons would create massive incentives to shoot first. Thus, strategic defensive systems deployed to low-orbit space from purely defensive intentions would likely create conditions even less stable than the status quo.

Banning Space-Based Arms

Readers might now ask, "Why not avoid all of the difficulties discussed so far by the use of agreements banning weapons from space?"[19] Such an approach is unlikely to work. Beyond the problems that present themselves when concluding *any* arms control treaty and the problem of ensuring adversarial cooperation[20] just discussed, there are special difficulties associated with detecting banned equipment in space[21] and with taking restorative measures if a treaty violation were detected.[22] The difficulties associated with attempting to verify compliance[23] through detecting banned equipment can best be discussed by looking at the periods when such detection could occur: before or after launch.

Detection before Launch

Detection of banned equipment before it was launched could be attempted in at least two ways. The first of these would be by using satellite-gathered intelligence to differentiate legal from banned payloads. However, there are many methods for degrading satellite-gathered intelligence capabilities. For example, the Soviet Union has built gigantic buildings "only somewhat smaller than the great pyramids" that would block a satellite assessment of Soviet space arms production.[24]

A second way to try to detect banned equipment while still on the ground would be through in-country inspection of payloads, and there seem to be two methods for accomplishing such inspections. One method would be to inspect assembled payloads just before launch. However, only a cursory degree of inspection can be conducted just prior to launch without taking the payload apart. For satellites constructed in totally dust-free environments, almost any inspection would cause contamination and larger satellites would likely contain factory-sealed parts. To use the second on-the-ground method of verifying what was on a satellite, one would need to have the satellite's plans and to follow the satellite through production. Aside from the obvious problems with these methods, both would subject a space power's most secret technologies to the close scrutiny of its primary space competitor. Thus, to the degree the United States is still superior to the Soviet Union in space technology, a prelaunch inspection program effective enough to ensure against the weaponization of space would not be in US interests.[25] It would increase the flow of American technology to the Soviet Union just when American security programs are struggling to stem this flow. In any case, neither inspection method would ensure against covert production followed by withdrawal from an inspection accord. These problems appear to demonstrate the need for a capability to detect possible treaty violations *in space*.

Detection in Space

Unfortunately, depending on detection of weapons in space to verify an arms ban does not seem to offer a reliable solution. The first reason arms detection in space would be difficult is the great volume of space. For example, it would be very expensive to launch inspection satellites to cover all low-orbit space (the space within shooting range of boosting ICBMs). Even low-orbit space is vast compared with the amount of territory occupied by the United States or the Soviet Union. If tasked to scan low-orbit space, national technical means of verification would have to cover an area many times the size they currently examine.

Second, a weapons detection instrument would be attempting to find objects that were in violation of a treaty, so such objects probably would be disguised. The airless, weightless nature of space would aid in engineering "add-on" facades for purposes of deception. Lightweight materials could be employed; or, if necessary, facades could be enhanced. For example, radiation shields could make distinctions of nuclear weapons from permitted nuclear-powered generators difficult.[26] Even telemetry transmissions could be made to closely replicate those of an unarmed satellite.

Third, if an instrument in space is to differentiate between such objects as nuclear bombs and nuclear reactors (and especially if shields were used), the detection instruments would probably have to be brought relatively near a satellite. But a satellite could be endangered by such an approach;[27] the inspection satellite might leave behind a space mine (a remotely controlled bomb).[28] Nations might thus be unwilling to allow close-up inspections of their satellites.

Fourth, there seems little reason to suppose that the space weapons of an adversary must necessarily be nuclear (the United States is emphasizing research on nonnuclear space weapons). What characteristics could be used as criteria for deciding something was a nonnuclear weapon? Could an instrument "sniff" conventional explosives through the vacuum of space? Even if such a criterion can be found, the fact remains that any satellite with a booster, fuel, a guidance sensor, and a guidance computer could be used to ram another satellite.[29]

Fifth, even assuming that a detector could be built and that one's space competitors would allow it to get close enough to do its job, would such equipment need more than an instant to take its "readings"? If so, the detector would have to match orbits with a satellite it was to inspect. To reuse the detector, it would have to boost and deboost repeatedly to match orbits with other satellites. The fuel necessary for such maneuvering would be, to borrow a phrase, astronomical.

Sixth, the number of satellites necessary for treaty verification might be fairly high. Moreover, the more satellites one side used for verification, the more the other side would need to verify the verification satellites.

Seventh, assuming a detector found a violation, then what? The adversary would surely deny the violation. Given that the weapon was disguised, detection of a violation would depend on data that varied little from that gathered from permitted satellites. Experts would be required to interpret such data, and they might find it difficult to prove that the data constituted a "smoking gun," especially in the face of denials, accusations that the interpretations were politically motivated, alternative interpretations by other experts, and declarations that small-scale violations were inconsequential. Additional ambiguity might arise if tests of space weapons were called something else by adversarial authorities.[30]

In short, it is unlikely that violations of a space weapons ban could be detected with reasonable certainty. However, to complete this analysis, the author is willing to assume such weapons could be detected. The question then becomes whether weapons (or tests of weapons) could be detected in time for the United States to take restorative measures.[31] The author sees no reason to believe that such a margin for error would exist, especially if a US space weapons production and deployment program had to be put together from scratch after a treaty violation was detected. For example, James Oberg, an expert on the Soviet space program has expressed anxiety with regard to the payload capability of the new 2,000-ton Soviet *Energia* booster. "A *few* [emphasis added] payloads like this would allow the Soviets to set up an orbiting battle station system and to deny space to any payloads that did not meet with their approval."[32, 33]

From the preceding discussion, it would appear that there is reasonable doubt as to the effectiveness of an arms ban in defending American interests in space. Some of the problems that present themselves might not be solvable; consequently, the deployment of weapons to space might be unpreventable. Thus, it seems reasonable to consider another approach that might offer a more stable situation.

Enhancing Survivability of Space Forces

The United States does not need to wait for the problems discussed earlier in this article to occur or to depend on a space arms accord, to build inspection equipment, and to hope for the best. Americans do not have to either accept the consequences of single occupancy by an adversary or live with the hazards of co-occupancy in low orbit. There is another approach to defending US interests in space. This alternative is to ensure the survivability of US space forces even under conditions of co-occupancy, through a combination of low- and high-orbit platforms. Once the United States had this mix of platforms in high and low orbits, co-occupancy would be much less threatening. The mix would improve mutual stability between the United States and its competitors in space. Low-orbit platforms would provide the boost-phase intercept capability required. High-orbit platforms would serve a dual role. Some of the high-orbit platforms would provide an antisatellite defense capability. Others would serve as a *reserve force* of boost-phase intercept weapons that could be called down into low orbit to replace damaged or destroyed platforms. This strategy of combined low- and high-orbit platforms provides space survivability through methods the United States can control (that is, without depending on an adversary's good faith). It avoids the problems of arms verification in space. It also ensures the survivability of US space weapon forces (in the aggregate) without relying entirely upon difficult, continually evolving technologies to shield low-orbit systems and allows space-based forces to take measures in concert for their mutual defense.

Problems of Low-Orbit Shield Technology

Most proponents of strategic defense who have responded to the vulnerability issue have expounded upon the ability of such technological devices as shields to achieve survivability.[34] They have focused upon the strategic defense purpose of SDI-type weapons and have made a related assumption that all such defensive systems should be placed in low orbit (that is, within range to destroy boosting ballistic missiles). However, there are both general and specific disadvantages to an approach that depends only on devices to achieve survivability.

Generally, since there is no "cover" and no place to "dig in" in space, no inherent advantage accrues to the defense in a battle between space forces. This means that if US space platforms are to survive preemptive attack, US space shield technology would have to stay one step ahead of Soviet technological capabilities for attacking shielded satellites. Since it would be difficult to assess exactly what Soviet attack capabilities would be, US space capabilities would, at great expense, have to continually anticipate, both in research and deployment, potential Soviet advancements.

Specifically, many space system vulnerabilities would plague a solely technological approach to survivability in space.[35] For example, as low orbits became more densely populated, space weapon platforms would face potential attack from many directions, creating a requirement for omni-directional shields. If an attack hit any part of a satellite (including its shield), the satellite would move due to impact and jetting effects. These hits would help illuminate the satellite to targeting sensors and thus aid an attacker in continuing the attack. The vibrations and motions caused by the attack would hinder retaliation by the attacked platform's own finely tuned targeting mechanisms, as would the requirement to shutter sensors. Louvers for heat radiation, if closed to protect the satellite's sensitive components from the heat of the attack, could hinder vital cooling systems.[36] Antennas and sensors as well as mirrors for ground-originated directed energy could be vulnerable at the attack's onset. Even if each of these problems could be overcome, they are only samples of what must be solved in following a purely technological approach. One could attempt to offset these types of problems by deploying many platforms to achieve redundancy, but this would be no solution if the adversary has equivalent numbers of weapons.

It would be wrong to declare these problems unsolvable: Americans have met many complex challenges with technological solutions. But such solutions appear to be very expensive and in this case such an approach might mean trying to build invulnerable weapons. So far, at least, such weapons have proved illusory.

Deployment Strategy

If a nation were unconstrained by a strategy that assumed the need to deploy all its space weapons in low orbit for prompt use against ICBMs, a portion of those weapons could be made more survivable by placing them in higher orbits. This portion would have increased survivability because it would be more difficult to find and attack. Such a reserve force would, in effect, have a *primary mission* of survival. The balance of weapons could be placed in low orbit, where, at a minimum, they could be useful against accidental or third-nation ballistic missile attacks. There appears to be a point where the percentage of forces that are preserved from attack (those in high orbits) would be great enough that an adversary could not decisively preempt an opponent.

Merely using high orbit to enhance survivability of a portion of space forces would not provide a permanent solution to the vulnerability problem. There is a finite amount of orbital space, even in higher orbits, and this space eventually could be slowly but systematically searched by an adversary's detection satellites (for example, in highly elliptical, precessing orbits).[37] Thus, the advantage to be gained by hiding in higher orbits could not by itself be permanent.

An idea that more directly addresses this problem is the concept of exclusionary or keep-out zones in high orbit. If zones could be established that were significantly larger in radius than the range of space weapons and their targeting systems, attackers would have to identify their belligerency by moving into a keep-out zone well before they could begin to fire. This fact might well encourage an aggressor to give up the idea of direct attack entirely.

In addition, keep-out zones would also address the previously mentioned problem of space mines.[38] If deployment of these small, remotely controlled bombs were to be allowed near a critical number of space assets, it might bring an offensively minded nation to believe that an attack in space could be instantaneously successful. If each nation's platforms were instead separated from those of others in designated high-orbit keep-out zones, mine-laying vehicles would have to betray their intentions (before commencing mining operations) by moving into the zones. Thus, each side would have time to react to mining operations and the chances of gains from offensive actions would be reduced.

Practically speaking, and in view of the fact that directed-energy weapons might be able to fire at and hit targets thousands of miles distant, effective keep-out zones might have to be huge. A hypothetical example would be a zone along an orbit 50,000 miles above the equator. This zone, if the effective range of laser weapons were 3,000 miles, might extend 5,000 miles from the baseline orbit.[39] Thus, attackers would have to traverse 2,000 miles of potentially hostile space before being able to attack. This would give the defense time to react.[40]

An objection to this approach is that it would require modifications to present international space law before such expansive armed zones could be created to separate potential belligerents. However, since it would be in the interest of each side to have time to preserve its forces, each would have incentives to negotiate the necessary formal agreements. (Soviet writers have already called for the establishment of exclusionary zones in space.)[41]

Moreover, in the past decade, legal groundwork has been laid for the establishment of keep-out zones. The "Blau-Goure Doctrine" bases the legality of such zones on the right of self-defense as a principle of national policy and international law.[42] More recent legal analysis of keep-out zones makes a case for their legality in relation to existing space accords (such as the Outer Space Treaty) and their utility in building space stability.[43] The reasonability of such zones (and thus their legality) would seem to depend primarily on whether they would interfere with navigation and whether their use would be nonaggressive.[44]

To keep such zones from interfering with navigation, they could be located as much as 100,000 miles above the earth. In addition, each nation could be limited to only one such zone. Thus, the United States, the Soviet Union, and a hypothetical third space power could maintain keep-out zones centered on equatorial orbits at 100,000, 90,000, and 80,000 miles altitude. Location of zones so far from earth would certainly allow room for space missions to circumnavigate (although clearance could be requested through) these areas and thus they would provide no barrier to space travel.

A high-low deployment mix with the high-orbit portion of the space force placed in a keep-out zone would thus offer the United States several advantages. The survivability of US space forces would be improved through increased ability to survive the transition from peace to war and would provide a number of options to restore US power should war come.

Restorative Measures

Perhaps the greatest benefit of having a reserve force in a high-orbit keep-out zone would be that such a force could take effective restorative measures against a space attack. Adversarial understanding of this fact might serve to deter such an attack in the first place, but, if it did not, the United States would have the maximum number of options in responding to an attempt to impose a space blockade. All the discussed options (toleration, military and nonmilitary responses, and direct and indirect attacks) would still exist; a warfighting capability in space would enhance their utility. For example, if a president decided to respond to a blockade through nonmilitary action, that action would be backed by a credible in-kind military response available for use as a second step in pressuring opponents.

Of course, to serve in this role or to break a blockade by direct attack, tactics and strategy for the reserve force must be developed. Though answers in those areas must evolve through analysis, the following scenario illustrates a potential approach.

To break a blockade, platforms in a high-orbit keep-out zone would boost (or deboost) to change their orbits and counterattack into low orbits. The most efficient way to accomplish this would be to change the counterattacking force's orbit from circular to highly elliptical. This would bring the counterattacking force down into the low-orbit area where (using stealth or an approach "out of the sun") it could attack blockading forces.

The attack would be most effective if it were concentrated against that portion of the cordon then covering US launch areas. If such an attack did not destroy this portion of the blockade, it might still weaken or distract the blockading forces enough to get a high percentage of launching US forces safely into space.[45]

Blockading forces, in defending themselves passively (by shielding sensors) or actively (by turning their weapons on the attackers), would lose some (hopefully most) of their ability to intercept boosting weapons. US weapons successfully running the blockade would then be in a position to compete with enemy forces on much more even terms.

An important plus in this restorative scenario is that only a fraction of a blockader's space forces could be within shooting range of any given launch area at one time. This factor means that high-orbit reserve forces much smaller than the adversary's total low-orbit forces could be effective at breaking a blockade.

A further plus in the restorative scenario could be generated by properly coordinating all US forces in the attack. For example, the blockade could be attacked in the neighborhood of mountaintop ground-based lasers to allow ground-, air-, and space-based forces to work in concert.

Note that nothing in this scenario addresses what would be going on in terrestrial theaters. There is no way to prove that a space conflict could be limited to space, but having a reserve force would increase that possibility. Without such a force, the United States would have to run much greater risks of widening and escalating the conflict to break a space blockade. If the conflict should widen and escalate, the

United States would certainly be in a more tenable position with space control than without it. In short, any future that includes the weaponization of space (which the author believes cannot be prevented) would be safer for the United States if opponents were to believe that their use of such weapons would elicit an equivalent response.

Conclusions

The superpowers' space weapons research programs have until now been viewed almost entirely in the context of their possible effects on full-scale, unlimited nuclear war. Given the deep-seated fear of nuclear war, this orientation has been understandable. It is in the area of more limited, nonnuclear warfare, however, that space weapons will have their most immediate effect on the force-influence of nations.

This paper has suggested a deployment of space weapons (co-occupancy with a high-low force mix and with keep-out zones) that could promote international stability and peace and avoid undesirable futures. However, for the reasons discussed, the United States cannot guarantee simultaneous deployment to achieve that stability. In reality, the United States is limited to one of two choices—to deploy or not to deploy weapons to space.

If the United States chooses not to deploy weapons to space, it risks the undesirable consequences of a blockade previously mentioned. That risk would probably increase with the passage of time as other nations approach the capability of placing intercept weapons in space.

If the United States chooses to deploy weapons to space, one of three conditions will result. The United States might be first to deploy such weapons; it might deploy at the same time as another nation; or it might find that it had no option but to try to deploy second because another nation had deployed first. If the United States were to deploy first, it would have a further choice of whether to blockade other nations or to allow them to deploy weapons to space. If the United States allowed others to deploy second, or if there were a dead heat in weapon deployments, the United States would face the vulnerability problems already discussed unless it used the high-low survivability plan outlined in this paper. If another nation deployed first, the United States would face the same risks it would run if it decided not to deploy weapons to space at all.

The questions are: What is the safest course of action for the United States within the possibilities outlined and what is the best outcome? From the US point of view, the safest course of action would be to proceed with actions culminating in deployment. From another nation's point of view, its safest course of action would be to follow the same plan. In the interests of mutual stability (from a position incorporating the interests of all sides), the best outcome would be co-occupancy and a high-low mix of weapons assigned to keep-out zones because this situation is less threatening for all concerned. Since coordinated, simultaneous deployment may be impossible to achieve, the best outcome (from the US point of view) would be achieving US deployment first. Deploying first would probably have a disconcerting effect on relations between the United States and the Soviet Union, but the United States would have it within its power to restore harmony by building stability. If in deploying first, the United States placed intercept weapons in both high and low orbits, it would send a signal that should be reasonably clear—the United States is deploying for stability in a future of space co-occupancy. Such a message could be reinforced by negotiations assigning keep-out zones to the space forces of both sides. Subsequently, the United States could allow co-occupancy, thereby improving and reinforcing mutual stability.

The path outlined in the previous paragraph may seem somewhat unsatisfactory because it entails pursuing an independent course of action rather than a cooperative solution. One can appreciate, however, that not all the problems discussed have easy answers, all the elements of which are completely satisfactory. There are undoubtedly other viewpoints that should be considered in this issue, but rejecting the proposed course of action entails a corresponding responsibility to justify a different course of action within the context of potential consequences.

Alternative analyses are, in fact, needed so that the strength of the American system, full and open discussion, can operate to produce the best possible policy options and strategies. Americans have expended great effort in examining the potential effects of space weapons upon nuclear conflict. Now, an equivalent effort must be made to help this nation set the safest course through potential space blockades.

NOTES

1. Senator Malcolm Wallop is quoted raising this issue in "Accelerated Laser Weapon Effort Urged." *Aviation Week & Space Technology*, 4 August 1980, 52. The issue was revisited by Dino A. Lorenzini and Charles L. Fox in "2001: A US Space Force," *Naval War College Review*, March–April 1981, 51. Thomas H. Krebs, "BMD: Soviet Countermeasure Strategies," *Defense Science 2003+*, August/September 1983, 73, mentions the possibility the Soviet Union might control all access to space by being first to deploy a ballistic missile defense to space. Gen Daniel Graham, *High Frontier* (New York: Pinnacle Books, 1983), 63, notes that an SDI strategy would also "secure the availability of the vast resources of space . . . providing for its defense against attempts to deny [its] use." Jeff Hecht, *Beam Weapons: The Next Arms Race* (New York: Plenum Press, 1984), 348, mentions the problem. Robert Bowman, *Star Wars: A Defense Insider's Case Against the Strategic Defense Initiative* (New York: St. Martin's Press, 1986), 115, writes, "[To] seize military control of space, destroy all opposing satellites, and prevent a potential adversary from launching anything else into space . . . *is the primary mission of an early Star Wars system*" [emphasis in original]. *The National Security Strategy of the United States* (The White House, January 1987), 4, lists "to assure unimpeded US access to the oceans and to space" as a "major objective in support of US interests."

2. The author uses this term to identify the condition when one nation is comprehensively interdicting another nation's deployments to space.

3. Dmitry Mikheyev, *The Soviet Perspective on the Strategic Defense Initiative* (Cambridge, Mass.: Institute for Policy Analysis, Inc., 1987), xi, 27, 32.

4. Department of Defense, *Soviet Military Power 1987* (Washington, D.C.: Government Printing Office, 1987), 45-61. See also Viktor Olenev, "The Threat From Above: The U.S.S.R. and the Militarization of Space," *Détente*, Winter 1986, 2–7. A further important source to examine is Jacob Kipp et al., *Soviet Views on Military Operations in Space* (College Station, Tex.: Center for Strategy Technology, Texas A&M University, July 1986).

5. Peter Samuel, "Soviets Making Major SDI Gains, Experts Say," *New York City Tribune*, 2 October 1986, 1. See also Sue McMillin, "U.S. Must Plan for Space Wars, General Says," *Colorado Springs Gazette-Telegraph*, 8 July 1987, 1; "Pentagon Warns of Soviet Space Buildup," *Aviation Week & Space Technology*, 12 October 1987, 28; and Nicholas L. Johnson, *Soviet Military Strategy In Space* (London: Jane's, 1987), 191: "To Moscow the prospect of war in space . . . is a logical eventuality for which serious preparations must be made."

6. Gen Robert T. Herres, "The Military's Use of Space-Based Systems," *Signal*, March 1986, 48.

7. Robert Salkeld, *War and Space* (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1970), 154–55: "The national space program has been primarily a reactive one to outside events." The irony is that a continuation of such a reactive strategy in space (building space weapons only after Soviet space weapons are detected) could result in the curtailment of terrestrial abilities to react strategically.

8. A president might find it difficult to gain public backing for either toleration or military response. If he or she could not marshal support for either of these options, by default US actions would be limited to ineffective measures and would thus tolerate a space blockade.

9. A rocket's vulnerability in boost phase is, of course, more than the ease with which it can be located because of its exhaust. Boost stresses pull at the structure; see Angelo Codevilla, "How Eminent Physicists Have Lent Their Names to a Politicized Report on Strategic Defense," *Commentary*, September 1987, 22: "Tests have shown that when those missiles are under the heat and pressure of boost phase, they will stand less than one-sixth of [the laser heat they could otherwise tolerate] before they disintegrate."

10. Gary L. Guertner and Donald M. Snow, *The Last Frontier: An Analysis of the Strategic Defense Initiative* (Lexington, Ky.: Lexington Books, 1986), 44. See also page 51 for "cost-exchange ratio" discussion. See also Robert Jastrow, *How To Make Nuclear Weapons Obsolete* (Boston: Little, Brown and Company, 1985), 128–30.

11. American forces would thus attempt to use mass to support a frontal assault, attacking directly the enemy force's strength. This is precisely what good military strategems are designed to avoid.

12. Bowman, appendix E, 145, quotes SDI Director Lt Gen James A. Abrahamson: "Some of the postulated [BMD] laser systems could potentially be very effective against cruise missile-carrying aircraft literally anywhere in the flight of the attacking aircraft to the cruise missile release line. . . . Some postulated laser systems deployed in space may be useful in this regard." Cruise missile-carrying aircraft would be larger than F-15s, but the ASAT-launching F-15s climb higher and thus are protected by less atmosphere than cruise missile-carrying aircraft. Donald Latham, "Space-Based Support of Military Operations," *Armed Forces Journal International*, November 1987, 43, proposes defense against air-breathing threats as one leg of a "triad of strategic defense.

13. Hecht, 254–55.

14. In terms of low-observable design, space appears to be the ultimate medium for stealth technology. Relatively few requirements are levied on the craft to maneuver through space (as opposed to the sea or the air) so that stealth can be the primary exterior design criterion. For more on stealth and satellites, see William J. Broad, "U.S. Designs Spy Satellites To Be More Secret Than Ever," *New York Times*, 3 November 1987, C-1.

15. Morton Halperin analyzes the nature of limited war in *Limited War in the Nuclear Age* (New York: John Wiley and Sons, Inc., 1963). It would be fair to note that some scholars appear to assert the impossibility of limited war in space. For example, Thomas H. Krebs, "Ballistic Missile Defense: Soviet Countermeasures," *Defense Science 2003+*, August/September 1983, 70: "Prudent Soviet military planners would have to assume, however, that any attack on our BMD system would be recognized as an immediate precursor to an attack on our nuclear forces, and that the vast majority of US strategic nuclear forces would be launched before Soviet warheads arrive. An attack on all or part of the BMD system . . . is not a likely strategy for the Soviets." Certainly if the United States is willing to escalate to all-out nuclear war the moment a conflict breaks out in space (which would not have to include destruction of ICBM attack-warning satellites), or if the Soviet Union believed this, as Krebs's language suggests, then limited war in space is impossible. But this would be a dangerous all-or-nothing policy. One might infer from a closer reading of Krebs's text that he might have wished to use the word "could" instead of "would."

16. Caspar W. Weinberger, "The Soviet Space Challenge and National Security," *Space Support of US National Security: Conference Report* (Washington, D.C.: US Global Strategy Council, 24 November 1987), 12: "Given the orientation of the Soviet space program, it would be foolish not to assume that the Soviets have a covert mobile space launch capability, complementing the highly redundant fixed facilities."

17. Gen Waldmar Erfurth emphasizes the role of surprise at the beginning of a war in *Surprise*, translated by Stefan T. Possony and Daniel Vilvroy (Harrisburg, Pa.: Military Service Publishing Company, 1943), 45–61. Possony and Vilvroy also provide a thoughtful and thorough introduction. Richard E. Simpkin, *Race to the Swift: Thoughts on Twenty-First Century Warfare* (New York: Brassey's Defense Publishers, 1985), 179, discusses technology's potential to increase the scope for surprise.

18. Bowman, 102: "'Star Wars' . . . would create a new front line of totally vulnerable forces." A parallel in the vulnerability of forces due to proximity can be seen in the scrapping of US plans to forward-base its nuclear-armed strategic aircraft to Europe in the event of heightened tensions. This decision was at least in part a reflection of lessons learned from the attack upon Pearl Harbor. See Fred Kaplan, *The Wizards of Armageddon* (New York: Simon and Schuster, 1983), 92-93.

19. An argument for antisatellite arms control is found in Paul B. Stares, *Space and National Security* (Washington, D.C.: Brookings Institution, 1987). (The bulk of this book is a useful history of space arms evolution.) A contrary argument is made by Colin S. Gray, "Space and Arms Control: A Skeptical View," *America Plans for Space* (Washington, D.C.: National Defense University Press, 1984), 133–56. The case for current US ASAT needs is made by Gen John L. Piotrowski, "The U.S. Antisatellite Requirement: Myths and Facts, *Armed Forces Journal International*, September 1987, 64–68. One of the better nontechnical explanations of why space is highly unlikely to remain free of weapons is by Charles A. Lindberg, "Man's New Environment," in *The Impact of Airpower*, ed. Eugene M. Emme (Princeton, N.J.: D. Van Nostrand, 1959), 145–52, although the author is referring to the history of air power.

20. Mikheyev, 69–70.

21. William J. Durch, "Verification of Limitations on Anti-Satellite Weapons," *Verification and Arms Control* (Cambridge, Mass.: Ballinger Publishing Company, 1984). Further discussion of the problems of verification is available in *Anti-Satellite Weapons, Countermeasures, and Arms Control* (Washington, D.C.: Office of Technology Assessment, 1985).

22. Fred Charles Ikle, "After Detection—What?" *Foreign Affairs*, January 1961, 208–14.

23. James T. Hackett, "Verification: The Impossible Dream," *Wall Street Journal*, 27 May 1987, 30.

24. "Photos show Soviets embarked on 'Star Wars' preparations," *San Diego Union*, 26 October 1986, 21.

25. Warren Strobel, "U.S. Holds Military Advantage in Space, But Will It Continue?" *Washington Times*, 10 September 1987, 1. See also Peter Samuel, "Soviets Making Major SDI Gains, Experts Say," *New York City Tribune*, 2 October 1986, 1.

26. The prospect of the deployment of nuclear weapons to space is raised in Robert Salkeld, *War and Space* (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1970), 152. Soviet writers have outlined this idea as a prospective Soviet reaction to a US space-based strategic defense. For example, Yevgeni Velikhov, Roald Sagdeev, and Andrei Kokoshin, eds., *The Dilemma of Security* (Moscow: Mir Publishers, 1986), 75–77.

27. Malcolm Russell, "Soviet Legal Views on Military Space Activities," in *National Interests*

and the Military Use of Space, ed. William J. Durch (Cambridge, Mass.: Ballinger Publishing Company Inc., 1984), 215–16: "The Soviet Union contends that notions of state sovereignty bar the 'inspection' or close approach of a space vehicle without the consent of the parent country."

28. Albert L. Weeks, "Top Soviet Scientist Says Moscow Will Use Anti-SDI 'Space Mines,'" *New York City Tribune*, 28 August 1986, 1.

29. Albert Wohlstetter and Brian Chow, "Arms Control that Could Work," *Wall Street Journal*, 17 July 1985, 28.

30. A possible example of this situation is the Soviet deployment of a laser and a particle beam accelerator for firing at the surface of Phobos (a moon of Mars). Paul Nitze, chief US arms control adviser, has stated that it would be difficult to prove that the power, brightness, and tracking and aiming characteristics of these devices were insufficient to constitute components of a weapon system. However, his assessment appears to have caused little alarm in the United States. Thus, detection of a violation could go unheeded for an extensive period. Robert C. Toth, "Soviet Beam Devices to Aim at Mars Moon," *Los Angeles Times*, 2 April 1987, 28.

31. Confidence that detection of testing can provide adequate warning of the deployment of a strategic defense is expressed by the Union of Concerned Scientists, "Anti-Satellite Weapons: Arms Control or Arms Race?" (Cambridge, Mass.: 30 June 1983), 33–38. However, page 37 of this pamphlet implies that the less complicated a system is, the less it needs to be tested. The question of how much testing an adversary would need before imposing a blockade (especially given potential crisis circumstances) must be addressed in future studies.

32. Martin Sieff, "Russia's New Rocket Could Tilt Space Power Balance to Soviets," *Washington Times*, 18 May 1987, 6. See also Peter Almond, "Pentagon Warns of New Soviet Space Arms Buildup," *Washington Times*, 16 November 1987, 1.

33. One has to ask whether a space arms accord would limit either the size or number of a nation's space platforms. For example, if an agreement limited the number but not the size, would it not be possible to use huge platforms to conceal large numbers of space weapons? Not only might such weapons be better protected from detection on such "holding" platforms, it would seem they could be redeployed to form a world-encompassing cordon relatively quickly in comparison with a direct deployment from the ground.

34. Shields are the prime survivability measure mentioned in Robert Jastrow, *How To Make Nuclear Weapons Obsolete* (Boston: Little, Brown and Company, 1985). On pages 63–64, Jastrow relates what appears to be supreme confidence in the efficacy of this approach.

35. George F. Jelen, "Space System Vulnerabilities and Countermeasures," in *National Interests and the Military Use of Space*, ed. William J. Durch (Cambridge, Mass.: Ballinger Publishing Company Inc., 1984), 89–112.

36. Curtis Peebles, *Battle For Space* (New York: Beaufort Books, Inc., 1983), 135.

37. If deployed into large, nonsynchronous elliptical orbits, search satellites could continually search new circular orbits without having to burn fuel.

38. Albert L. Weeks, "Top Soviet Scientist Says Moscow Will Use Anti-SDI 'Space Mines,'" *New York City Tribune*, 28 August 1986, 1.

39. Hecht, 90-91, outlines an example using a hypothetical laser range of 5,000 kilometers (km) or 3,000 miles and shows a laser spot size table ranging to 4,000 km.

40. Wohlstetter and Chow, 28. Angelo Codevilla, "Strategic Defense Now," *Global Affairs*, Summer 1986, 30–31, examines supporting arguments for space exclusionary zones.

41. F. Kenneth Schwetje, "Protecting Space Assets: A Legal Analysis of Keep-Out Zones," *Journal of Space Law* 15, no. 2 (1987): 131–46.

42. Ibid., 8–10.

43. Ibid., 12–14.

44. The mobility advantage of high versus low orbit platforms is discussed further in G. Harry Stine, *Confrontation In Space* (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1981). Pages 55–58 outline the doctrine of the gravity well. Stine credits Dr Robert S. Richardson with the authorship of this doctrine in his April 1943 article "Space Fix" in *Astounding Science Fiction*.

45. See Karl von Clausewitz, *On War* (Washington, D.C.: Infantry Journal Press, 1950), 428–31, for information on the cordon.

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