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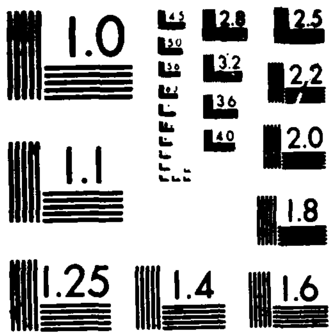


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# ANTI-SATELLITE WEAPONS, ARMS CONTROL OPTIONS, AND THE MILITARY USE OF SPACE

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# FOREWORD

This report has benefitted greatly from the input of a number of people, especially those who served as consultants to this project and, previously, as members of the Space Working Group of the Center for Science and International Affairs (CSIA), John F. Kennedy School of Government, Harvard University. The consulting group met several times during fall 1983, providing well-informed and helpful advice, and consultants' working papers on technology, legal issues, arms control approaches and associated measures contributed greatly to the structure and substance of the report.

However, the analyses and conclusions contained in this report reflect the views of the author and should not be construed necessarily to reflect the views of the consultants or advisers to the project.

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## EXECUTIVE SUMMARY

This report addresses primarily anti-satellite (ASAT) weaponry, its utility, and approaches to its control. It addresses issues related to strategic defense only as they pertain directly to the use of space, the security of space assets, ASAT arms control and the Anti-Ballistic Missile (ABM) Treaty.

Neither the building of space-directed weapons nor their limitation should be automatic. It is not clear, *a priori*, that either approach on its own is in the best interests of the United States. Rather, the political and military implications of space-directed weapons need to be examined in the context of likely scenarios for their use to obtain some sense of the net security costs and benefits of such weapons for the United States. The implications of various approaches to ASAT arms control, including issues of negotiability and verification, also need to be addressed carefully. This report makes an effort to meet these objectives.

### THINKING ABOUT SPACE

There are emotional as well as operational underpinnings to the recent upsurge of interest in the military use of space. Some see in space an arena in which to show resolve, signal intent and engage in symbolic conflict with little or no risk of terrestrial spillover. Others see space as a separate ecology to be saved from military depredation. Space is a sanctuary for military action, in the one view, and from military action, in the other.

Space cannot be a sanctuary, in either sense; it is not a separate, or separable, theater of operations. All current military space systems support terrestrial operations; in a war originating on earth these systems are likely to be the targets of electronic countermeasures and direct attack weapons. Superpower conflict originating in space, on the other hand, is no more likely to remain confined there than such a conflict is likely to be limited to one region, or one level, on earth.

The basing of weapons in space is advocated by some for the purpose of holding the "high ground." This particular "ground" is, however, transparent to most forms of radiation -- which has made it valuable for military support missions of various kinds. But that very transparency makes objects orbiting in space difficult to hide from enemy sensors and potentially vulnerable to attack by a variety of means. Weapons based in space would present particularly high-value targets for ground- and

space-based ASAT weapons. Concurrent deployments of space-based weapons by the United States and the Soviet Union would be more likely than deployment by one power only; those systems would be targetted, among other places, on one another. If dominance of the "high ground" means the ability to defend against and defeat the other side's space weapons, then such weapons must be able to react autonomously to indications of attack (since a laser beam, for example, could propagate from one satellite to another with essentially zero warning to the ground), making the whole system prone to react to false attack warning. Alternatively, dominance of the high ground means being able to prevent deployment of opposing weapon systems, that is, an ability to control all access to and use of space. Such a control regime would be costly to implement and would run counter to current precepts of international law as it now applies to outer space.

Demilitarizing outer space is sometimes advocated, with reference made to Antarctica and the treaty which prohibits military activities and nuclear explosions on that continent. But the analogy is inappropriate. Antarctica has low utility for most military activities. Any such activity based there could be carried out more cost-effectively if based somewhere else; the reverse is often true for space and for many military missions that are satellite-supported.

Space policy is inevitably affected by these and other images held and analogies used by those responsible for policy formulation. Romanticized images and inapt analogies can lead to inappropriate, even counterproductive policies, with potential implications for war and peace in coming decades as the use of space for both military and non-military purposes continues to evolve.

DIMENSIONS OF THE ISSUE

Spacecraft functions may be disrupted by a number of means, some not normally thought of as ASAT weapons, ranging from electronic countermeasures through deliberate nuclear attack. Which of these is a threat that might be usefully addressed by arms control negotiations? Four criteria for evaluating such threats are suggested: is the weapon effective (and what is likely to follow it)? does it threaten capabilities or values that are important and difficult or costly to replace? is there a plausible scenario for its use? can effective countermeasures to it be deployed relatively cheaply?

Applying these criteria, it is apparent that of the categories of threats addressed (interference, direct attack, ground segment attack, collateral nuclear damage, and deliberate nuclear attack) only direct attack weapons (kinetic and beam weapons) are suitable subjects for negotiations aimed at limiting ASAT capabilities. The problem of wartime interference may best be dealt with through electronic countermeasures; ground segment attack would be casus belli, moreover an ASAT agreement could do little to lessen that segment's vulnerability to attack; collateral nuclear damage might be mitigated by spacecraft hardening, but negotiating its avoidance would be difficult; and the systems likely to be used in a deliberate nuclear attack are the proper subjects of other negotiations. Nuclear attacks on satellites are also highly implausible outside the context of general nuclear war; and in that context an ASAT agreement is likely to be of little effect.

One final dimension of the ASAT issue should be highlighted. There is considerable interaction between ASAT and ABM. Development and testing of certain types of weapons for antisatellite purposes (for example, multiple-warhead interceptors or directed energy weapons) could undermine the ABM Treaty or better position the weapon developer to break out of that treaty's strictures. On the other hand, ABM interceptors permitted by the ABM Treaty could, if designed and tested with non-nuclear kill mechanisms, establish an irreducible minimum ASAT capability with respect to near-earth orbit and orbital inclinations greater than 40-50 degrees, the latitude range of current ABM deployment areas (though this ASAT "floor" could be lowered by limits on the testing of any weapon against space objects.) Finally, ASAT capabilities would follow automatically from deployment of space-based ballistic missile defenses, which deployment would also stimulate a secondary offense-defense competition aimed at negating and protecting, respectively, the orbiting weapon stations.

## SCENARIOS

The report examines three types of conflict scenarios and the potential role of antisatellite weapons in each, the better to evaluate the political/military costs and benefits of ASAT arms control measures. The scenarios are: limited superpower engagement in a Third World conflict; a NATO region crisis or conflict; and nuclear war.

ASAT's task in the first scenario might be to sever communications links to central command authorities (a task beyond the range capability of current ASATs) or to counter real-time surveillance, especially radar ocean reconnaissance satellites (RORSATs). It would be difficult, however, for direct attack ASATs to be timely without being highly escalatory, because a RORSAT could transmit targetting/location data well before US and Soviet forces were otherwise engaged. Electronic countermeasures (ECM) could, on the other hand, be both tmely and non-escalatory in application; and if the RORSAT can be spoofed, leaving it in orbit could work to the benefit of US forces.

In the NATO region the Western allies deploy an array of capabilities under theater operational command that reduce current dependence on space for theater wartime support. Whether Western forces become more dependent on space in the future depends to a great extent on the maintenance of budgets, spare parts, training and exercises for non-space systems as new and more capable satellite networks (such as MILSTAR and NAVSTAR) reach full operational status in the late 1980s and early 1990s. If NATO becomes highly dependent on space assets for wartime support, then these assets become highly attractive targets for Soviet ASATs. Given the Soviet approach to redundancy and retention of older systems and the USSR's internal lines of communication in this scenario, it is unlikely that the USSR would equal or surpass the U.S. in its dependence on space for wartime support. Should NATO become more dependent on space, threats of reciprocal ASAT attack probably would do little to deter Soviet ASAT use.

If, on the other hand, neither side is highly dependent on space for wartime support, US possession of a direct attack ASAT capability might serve to deter Soviet attacks on US space systems. It would be difficult, however, to do that and at the same time use ASAT capabilities against such posited threats as RORSAT. In an unrestrained ASAT competition, the US is unlikely to be so far ahead in capabilities as to be able to use its ASAT yet still deter Soviet reprisal. Moreover, Soviet preference orderings with respect to ASAT use may be different from those of the United States; the USSR may well rate denial of NATO access to satellites ahead of preserving its own access.

With regard to nuclear war, ASAT is sometimes thought to support surprise attack strategies. However, use of ASAT against warning satellites could itself be considered to warn of strategic attack. Satellite blinding would not, in any case, blind all US early warning capabilities (which entail much more than satellites). The utility of ASAT weapons in future strategic scenarios, on the other hand, is likely to vary with the extent to which the superpowers shift strategic assets, including weapons, into space.

## INCENTIVES FOR ASAT AND ARMS CONTROL: NET ASSESSMENT

This section draws upon the discussion of weapons and the discussion of scenarios to assess US and Soviet incentives to deploy, and to limit, antisatellite weaponry.

It concludes that the US does not now have very great incentive to seek limits on ASAT weapons, if current threats (eg, RORSAT and the existing Soviet low-altitude interceptor) are the only incentives considered. If, however, the assessment considers the comparative difficulty of limiting ASAT capabilities now versus several years from now, and the probable level of threat likely to be posed (especially by space-based weapons) to both military and civilian uses of space, including the space station and frequent shuttle missions, then American incentives to negotiate limits on space-directed weapons are considerable. Soviet incentives for arms control in this area would derive from a concern about advancing American technology, their ability to match it and, in all likelihood, the threat posed to an apparently ambitious Soviet manned space program by future space weapons. Forestalling development of such weapons is thus likely a key Soviet incentive to negotiate.

ARMS CONTROL FOR ANTI-SATELLITE WEAPONS

Objectives for ASAT restraint measures can be cast in terms of the classic goals of arms control (reducing the cost and likelihood of war and reducing the cost of preparing for it), but they can also be cast in terms of direct military utility (for example, restraining future destructive, non-nuclear threats to US satellites, including those with command, control, communications or intelligence functions).

Arms control approaches that address all of these objectives were chosen with reference to a basic criterion of fairness which, along with acceptable levels of verification, is a prerequisite for the ratification of any arms control agreement. In strategic arms negotiations, fairness has come to mean numerically equal limits. In ASAT, it could be attained by a zero-zero agreement (no possession of direct attack ASAT weapons by either party); a zero development and testing agreement (which would rely on long disuse to degrade the current Soviet ASAT capability); or a "one each" agreement (capping ASAT development at current types, with or without a corollary test ban). Any of these approaches could be supplemented by a non-use or "rules of the road" agreement. Each of them is discussed fully in the main text and more briefly in the conclusions, below, which also address the question of standards of verification for ASAT arms control.

Cooperative measures could assist in monitoring an ASAT agreement, but only in certain respects. On site inspection measures might discourage launch site storage of ASAT weapons and thus, potentially, inhibit rapid launch of any covertly-retained ASATs in crisis. But on site inspection could not verify that all ASAT weapons had been eliminated or that none were being produced covertly. Space inspection, of the cooperative type described in the main text, could be useful in coping with the "space mines."

Any ASAT agreement would build on provisions in current space law. It would be desirable that an agreement cover all categories of space objects and not just those in which either have an interest, lest excluding some objects from coverage have the appearance of sanctioning actions otherwise prohibited. Limiting coverage to space objects operating according to certain criteria runs a different risk, that of transforming an ASAT agreement into one about activities permitted rather than activities prohibited. Such an approach could invite future problems with respect to new types of activities, new technologies, or the specific missions of particular satellites.

The USSR has proposed a space weapons limitation agreement at the UN. Its August 1983 draft treaty on the subject is, by contrast to its 1981 draft, a more serious and potentially useful document that incorporates an ASAT test ban and calls for elimination of current ASAT means. It does not restrict breadth of coverage or impose behavioral standards for space objects. On the other hand, it resurrects from the 1946 Gromyko Plan a notion of unilateral enforcement to supplement National Technical Means (see main text), and limits testing and use of "any manned spacecraft" for "military, including antisatellite, purposes." Such language would seem to prohibit use of the space shuttle for military payloads; but it would do the same for the nascent Soviet shuttle and essentially end the Salyut space station program. The draft treaty's ban on the threat or use of force in or from space parallels language found in the UN Charter (Art. 2(4) but goes beyond what would be necessary in an ASAT accord. The 1983 Soviet draft nonetheless appears to reflect considerable evolution of the Soviet approach to this subject since the last US-Soviet bilateral talks in June 1979.

## CONCLUSIONS AND OPTIONS FOR POLICY

It is the conclusion of this study that arms control measures for antisatellite weapons can support United States security interests. It must be emphasized that arms control measures are not panaceas and are no substitute for programs to enhance satellite survivability and to monitor Soviet activities with respect to space. Yet survivability measures backed up by an arms control regime will, other things being equal, afford better protection to US satellites than the same measures taken in the context of an unconstrained weapons competition. Monitoring, moreover, can afford to be no less rigorous in the unconstrained case than under an arms control regime. Missing significant and relevant activities in either case can mean the future emergence of an unanticipated threat. Yet different standards are often applied to the two cases.

In the unconstrained case, monitoring is called upon to detect and define military threats; in the case of arms control it is often asked to demonstrate compliance, that is, to prove the absence of proscribed threats. Proving a negative is a logical impossibility and to that extent monitoring is called upon to perform an impossible task. The verification process will always be based on incomplete monitoring data, as is virtually every other intelligence assessment. Core concerns, rather, should be (1) whether the agreement halts the development of threats likely to have materialized in its absence and, (2) whether significant threats to US security and/or to the integrity of the agreement can arise undetected for which timely countermeasures cannot be taken.

High standards of verification arguably address the second of these concerns, combating the "lulling" effect of arms control, the erosion of the perceived need to keep one's powder dry. It seems clear, however, that excessively high standards can generate a high false positive rate with respect to compliance questions in an effort not to miss any potential violations, however ambiguous. Such efforts may undermine policymakers' confidence in the means of monitoring, or their confidence in other parties' compliance, when such erosion is unwarranted.

The standards of verification suggested for ASAT arms control in this study seek to take into account the concerns listed above. Some approaches clearly pose difficulties for verification. In the limiting case, verification difficulty could be so severe as to leave one or both parties able to violate the terms of an agreement with relative impunity. Such agreements are clearly unwise if either party has any incentive to violate; potential incentives are not always clear and they may, in any case, change over time. In other than the limiting case, verification uncertainties must be measured against the risks posed by undetected cheating, against the costs of the unconstrained case, and against the benefits of arms control.

Any ASAT arms control approach is necessarily limited in its scope, and it is important to catalog those limitations before proceeding to a list of policy options:

1. No ASAT agreement will eliminate non-destructive means of frustrating the missions of satellites (though an agreement might serve to deter their use).
2. No ASAT agreement will eliminate the nuclear threat to space objects posed by strategic ballistic missiles (thus ASAT arms control is a means of affecting the likelihood and the course of conflict only below the nuclear threshold).
3. No ASAT agreement will remove all antisatellite capability (though it can place a ceiling on such capabilities).
4. No ASAT agreement would be meaningful in the context of ABM Treaty termination (that is, ABM capabilities, particularly those designed for exo-atmospheric interception or basing, incorporate ASAT capabilities).

With these caveats in mind, let us review several combinations of objectives and options for ASAT arms control. All of these options assume that the object of arms control is the limitation, in some fashion, of dedicated, direct attack ASAT capabilities, and all assume that negotiations would be bilateral, at least initially.

If the objective of policy is to eliminate all dedicated, direct attack ASAT capabilities, options for arms control would include, (a) a zero-possession regime coupled with a test ban, and (b) a test ban only, of indefinite duration. Option (a) entails verification of the dismantlement, or equivalent decommissioning, of the current Soviet co-planar ASAT capability, which may be difficult. An accompanying test ban and launch site inspection regime would seek to reduce Soviet confidence in covertly-retained interceptors, and to increase the amount of time required to use such interceptors, respectively. Option (a) is negotiable in principle, as dismantling and a ban on tests are both incorporated in the 1983 Soviet draft space treaty, but the USSR has not acknowledged publicly that it possesses an ASAT capability.

Option (b) would bypass the problem of dismantling and seek to produce the operational results of option (a) through decay of existing capability from lack of testing and troop training. Because it does not seek to eliminate the current Soviet ASAT system and makes no provision for testing a US system to a comparable level of proficiency, option (b) could be viewed as unbalanced. However, considering the limited reach of the current Soviet co-planar system and its spotty success record, the effective difference between a dismantling regime and a test ban could be low. Moreover, a test ban would address future capabilities, such as improved orbital or direct ascent interceptors, or beam weapons, that could pose a real threat to American satellites. Negotiability seems feasible, since the USSR has proposed a moratorium on space testing of ASATs.

A modified form of option (b) would be consistent with the research program associated with the strategic defense initiatives, namely, a 3-5 year testing moratorium in lieu of one of indefinite duration.

Options (a) and (b) would require that the United States forego testing and deployment of the F-15/MV system. Thus the US would not develop a capability to destroy by impact such targets as Soviet RORSAT/EORSAT constellations. It would retain the option to negate those constellations by non-destructive means.

If the objective of policy is to place a ceiling on ASAT capabilities with one operational system each, options would include, (c) possession of "one current type" ASAT with further testing allowed, or (d) "one current type" with a declining test quota and a test ban on all other types of ASAT means. Option (c) permits the United States to test and deploy the F-15/MV system, and conceivably to test upgraded systems. The USSR would be able to do the same with its system. This option avoids the dismantling question, but its negotiability is uncertain. If the USSR's major objective in undertaking such a negotiation is indeed to ban space weapons, then this approach may be acceptable, even though it tends to provide the United States a technological edge which it is permitted to maintain. Restraining US technology is frequently a key arms control objective for Moscow. Finally, option (c) does less for the potential impact of ASAT on crisis stability than either option (a) or option (b).

Option (d) allows the United States to develop the MV system but closes down testing after an agreed period of time and/or number of tests; and it bans outright the testing of all other types of ASATs (eg, directed energy systems). It would thus fall between the first two options and option (c) in terms of immediate impact on crisis stability: over time, both sides would tend to lose confidence in their ASAT systems. It would prohibit space-based ASAT capabilities and testing of high-altitude direct-ascent or ground-based co-orbital systems. It is likely to be somewhat more negotiable than option (c); if enacted after 1985-86, it reduces to option (b).

Any of these options could be associated with an ASAT non-use agreement, as discussed in text. A non-use agreement would extend to all satellites the type of protection now enjoyed by satellites used as national technical means of verification.

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## INTRODUCTION

This report addresses anti-satellite (ASAT) weaponry, its utility, and approaches to its control. It does not address ballistic missile defense (BMD) issues except as they pertain directly to the use of space, the security of space assets, and ASAT arms control. It is written, however, in full cognizance of the debate generated by the President's March 23, 1983 speech, the subsequent strategic defense initiative, and relevant reactions within the Congress and on the part of the Soviet Union.

In this report, the term "space" refers to cislunar space -- from just beyond the Earth's atmosphere to the orbit of the Moon. By far the majority of current and prospective military applications use the lowest ten percent of that altitude range, from geosynchronous orbit (35,900 kilometers) earthward. "Near-earth space" refers to the altitude range from about 5,000 kilometers earthward.

This report and the data upon which it draws are unclassified. Where it describes military space systems and their capabilities or their orbital parameters, those descriptions are based on material drawn from open sources with a reputation for reliability and on calculations using basic physics and orbital mechanics. There are no detailed feasibility analyses of particular weapon technologies, nor is there suggested a "space strategy" for the United States. This report does attempt to lay out the dimensions of this very complex defense policy issue, to examine their interactions, and to assess their implications for US security. It analyses several potential ASAT arms control measures, noting pros and cons of each, together with a space regime that entails no new arms control initiatives.

## THINKING ABOUT SPACE

Over the past year or two, the military use of space has attracted greater public attention than at any time in the past two decades. Current interest stems in part from the development of the American F-15/MV (miniature vehicle) air-launched ASAT, and in part from the Administration's strategic defense initiative. Some advocates of an ASAT ban, or at least a test moratorium pending negotiations, see the next few years as the last clear chance to impose verifiable limits on US and Soviet ASAT weaponry. The reason most often cited has to do with verifying deployment limits on an ASAT of the size and configuration of the F-15/MV system. Once tested and qualified for production, that kind of small, mobile system would, it is argued, lend itself to covert deployments undetectable by

National Technical Means (NTMs). Not all potential ASAT-limiting regimes are so time-constrained, but as ASAT testing proceeds, some potential avenues for arms control will close. (The potential significance of those closures for national security will be discussed in succeeding sections.)

The strategic defense initiative, although currently within the letter of the 1972 Anti-Ballistic Missile (ABM) Treaty with the USSR, grows out of a desire on the part of the President to move toward a strategic posture based on defenses. Space-based technologies figure prominently in the strategic defense initiative, as reported in the press and in trade journals.[22-24]

There are also emotional underpinnings to the recent upsurge in interest in the military use of space. To some, space is the "final frontier"; efforts to limit space weapons are not only futile, but fundamentally misguided. Some see in space an arena in which to show resolve, signal intent, and engage in symbolic conflict, all with little or no risk of terrestrial spillover. This image of apartness is shared, but inverted, by those who see space as a separate ecology to be saved from military depredation. Space is a sanctuary for military action, on the one hand, and from military action, on the other. For reasons that should become apparent shortly, neither view is very realistic and either can lead policy in misguided directions.

A somewhat more pragmatic view sees in space a separate military theater, and advocates establishment of a major military command to oversee all US activities there. Bureaucratic politics aside, there are good reasons not to think of space in those terms. First, all current military space systems support terrestrial military operations; that will continue to be the case. Space will not be immune from the effects of combat originating on Earth. Direct attack ASATs may or may not be available and if available may or may not be used, but electronic countermeasures will surely be brought into play, since most exchanges between Earth and space assets are electromagnetic in nature. Second, conflict originating in space is unlikely to remain confined there, if one combatant power sees space as an arena for separate, symbolic conflict and the other views attacks on satellites to be highly escalatory.

Third, space is a large and highly specialized support area for terrestial military theaters. It will remain an operationally contingent area, an extension of those theaters, whether or not space-based weapons are ever deployed. Such deployments would make the continued operation of space support more problematic in times of crisis or conflict, but would not change the basic character of the space environment. It will remain an environment where a different set of rules governs the movement of objects, an environment that provides some unique operational advantages (transparency to most forms of radiation, for example) and poses some unique hazards for people and their equipment. Its very strangeness, however, leads to abundant use of analogies to describe what it is "like."

Analogies for space drawn from sea, air and land abound and they help to shape our image of it. Free access to space, for example, is often compared to free use of the high seas and their superjacent airspace. Not as frequently noted are the regimes of more restricted passage -- territorial seas, exclusive economic zones, sealanes for narrow straits, and sovereign national airspace.

The upper extent of sovereign airspace remains legally undefined. The concept dates to before World War I and is enshrined in two major international treaties (the Paris and Chicago Conventions). [14] States shoot at aircraft not authorized to be in their airspace; they do not shoot at satellites passing over that airspace. This right of free passage has evolved as a practical matter over the past 25 years, reinforced by the Outer Space Treaty and (for the superpowers) by the SALT agreement provisions that protect NTMs. Satellites with particularly low perigees (the lowest point of an orbit) fly along the edge of this arrangement that, in effect, exempts vehicles subject to the laws of orbital mechanics but not those subject to the laws of aerodynamics. With the advent of reusable space vehicles like the U.S. (and in a few years, Soviet) space shuttles, the distinction between aircraft and spacecraft begins to blur. Shuttles become aerodynamic vehicles upon reentry into the Earth's atmosphere, raising potentialy complex legal questions (see the discussion of ASAT test bans, below).

The most prominent military analogy for space is drawn from land combat -- the "high ground." The possessor of the high ground has a better view of his surroundings and a more defensible position than those below him. The implication is that the first (and often last) shots in any conflict are his to make. Space power advocates apply this terrestrial lesson to the void, asserting that the country which claims the "high ground" of space, which climbs furthest and fastest out of the Earth's gravity well with full military capabilities, will secure for itself a commanding military position.

That vision remains unfulfilled, for several reasons. First, the United States (and the Soviet Union) have been content to share the military use of space with other spacefaring powers in part because all benefit thereby (as in mutual use of photo-reconnaissance satellites to verify arms control agreements). Second, the economic cost of enforcing a regime of "space dominance" would be prohibitively high. Estimates of the cost of a full-scale space-based ABM system, for example, run as high as $500 billion, and such a system would need further protection against foreign antisatellite weapons and BMD systems (see following sections for further discussion).[36] Third, the cost in terms of crisis stability (each side's perception, in a period of tension, that there is little or no advantage to striking first) would also be steep. If "dominance" means having a system that can defeat an opponent's counterpart weapons, then the result would be a system which tended to react to false alarms (one orbiting beam weapon could strike another with essentially zero warning to the ground), raising fears of preemption in crisis. If, to minimize such fears, "dominance" is defined to mean exclusive control of access to space by one power, then the current international legal structure of free access to and use of space would be transformed, in effect, into a game of king of the hill that any number can play. The attempt to establish such a regime could be expected to meet political, and possibly military, resistance -- in the name of the UN Charter, the Outer Space Treaty and the fundamental concept of national sovereignty.

In short, there are a number of good reasons why the regime of outer space has evolved as it has over the past quarter century. Though space may be "high," it isn't "ground"; there is nothing to be seized and held; space assets are exposed and their movements predictable unless efforts with associated costs are taken to make them unpredictable. Moreover, gravity exacts severe penalties for reinforcement and resupply.

A final analogy for space is sometimes drawn to the Antarctic and the treaty that prohibits that continent from being subject to military activities or nuclear explosions (including underground explosions, for whatever purpose). The notion of space as a separate ecology is based on the Antarctic model. It can be persuasively argued, however, that the provisions of the Antarctic Treaty were made possible largely by the continent's minimal military utility, particularly for the major northern hemisphere powers. Any military activity based in Antarctica could be carried out more effectively and efficiently from some other point on the globe. The same is not true for space, at least for the support missions discussed in the next section.

How we think about space affects policy. Romantic images and inappropriate analogies can lead to inappropriate or unworkable policies. The consequences of such policies will become increasingly important as the use of space for both military and non-military purposes continues to evolve.

## DIMENSIONS OF THE ISSUE

This section reviews briefly military space applications, looks at various types of potential threats to space objects, and lists types of measures, both unilateral and negotiated, available in principle to counter them. It discusses the potential role of ASAT weapons in a range of conflict scenarios and the relationship of ASAT and ballistic missile defense, concluding with a net assessment of incentives for deployment of ASAT weapons and negotiation of ASAT arms control measures, from both the US and Soviet perspective.

Military Space Applications

Military uses of space may be divided into the following general mission categories: direct support of combat systems, control of other military forces, and weaponry. The first category includes ocean reconnaissance satellites, both active and passive (for large-area search); geodetic and navigation satellites (to chart gravity anomalies that could affect the accuracy of weapon delivery, and to update inertial navigation systems, respectively); reconnaissance and other intelligence satellites (for definitions and details of fixed targets); weather satellites (for last-minute reports of wind, rain, and cloud conditions over target areas); early warning satellites (to permit timely launch of bombers); and communications satellites (for transmittal of Emergency Action Messages and other critical war orders).

The second category, control of forces, includes communications satellites (linking theater forces with the continental United States [CONUS] and the political leadership for the forwarding of orders, command conferencing, and field report-back); reconnaissance satellites, which could, theoretically, provide near-real-time data on the movements and dispositions of an opponent's forces (depending on how and to whom data was downlinked and the time required to distill useful tactical information from the total data flow); and weather and navigation satellites (for the planning and execution of tactical military operations).

The third category includes all space-directed weapons (where "weapon" is defined as a means of rendering a space object permanently inoperative or permanently degraded in operational capability). To date, all space-directed weapons have been ground-based, including the American direct ascent nuclear ASAT system based on Johnston Island (1964-75), the Soviet co-planar ASAT, and and Soviet ground-based lasers that may have ASAT capabilities.[42] The developmental US F-15/MV would be air-based if deployed. Systems proposed by the private High Frontier group, and those reportedly discussed in the report of the Fletcher Committee, would be wholly space-based or have major space-based components.[22-24]

Current types of U.S. and Soviet military space systems in categories one and two are summarized in Table 1. This table summarizes orbital ephemerides, estimated numbers of satellites in a given constellation and, to illustrate overall launch rates, numbers of satellites launched in 1982. To maintain these constellations, the United States launches about a dozen payloads

TABLE 1: SOME ILLUSTRATIVE EPHEMERIDES FOR US AND SOVIET MILITARY SPACECRAFT

| Function | Incl. (deg) | Apogee (km) | Perigee (km) | Period (min) | Number in Constellation | Number Launched[a] |
|---|---|---|---|---|---|---|
| **UNITED STATES** | | | | | | |
| Photo Recce. | 96-97 | 260/550 | 177/280 | 89-93 | 2-3 | 3 |
| Ocean Recce. | 63 | 1,170 | 1,040 | 107 | ? | --- |
| Navigation | 90 | 1,190 | 1,075 | 105-110 | 5 | --- |
| | 63 | 20,200 | 20,200 | 12 hrs | 18[b] | --- |
| Meteorology | 99 | 870 | 810 | 102 | 2 | 1 |
| Geodesy | 110 | 5,950 | 5,840 | 225 | ? | --- |
| Electronic Intelligence | 0 | 35,900 | 35,900 | 24 hrs | ? | --- |
| Early Warning | 2 | 35,900 | 35,900 | 24 hrs | 3 | 1 |
| Communications | 2 | 35,900 | 35,900 | 24 hrs | 4,4,3[c] | 2 |
| | 63 | 39,300 | 250 | 12 hrs | 2 | --- |
| Nucl. Explosion Detection | 32 | 122,200 | 110,900 | 112 hrs | 2 | --- |
| | 63 | 20,200 | 20,200 | 12 hrs | 18[b] | --- |
| **SOVIET UNION** | | | | | | |
| Photo Recce. | 65-82 | 450 | 170 | 89-92 | 1-2 | 35 |
| Ocean Recce. | 65 | 445 | 425 | 93 | 1-2 | 5 |
| | 65 | 265 | 250 | 90 | 1-2 | 4 |
| Electronic Intelligence | 74/81 | 670 | 620 | 95-98 | 6 | 4 |
| Navigation | 83 | 1,020 | 965 | 105 | 6,4[c] | 6,2 |
| | 65 | 19,075 | 19,075 | 11+ hrs | 9-12[b] | 3 |
| Meteorology | 82 | 940 | 870 | 104 | 3 | 2 |
| | 98 | 680 | 630 | 98 | 2 | 0 |
| Geodesy | 3 | 1,430 | 1,140 | 109 | ? | --- |
| Early Warning | 63 | 40,000 | 400 | 12 hrs | 9 | 5 |
| Communications | 74 | 810 | 790 | 101 | 3 | 4 |
| | 74 | 1,565 | 1,385 | 115 | 24 | 16 |
| | 63 | 39,900 | 400 | 12 hrs | 8 | 4 |
| | .3-.8 | 35,900 | 35,900 | 24 hrs | 2 | 1 |

a/ 1982 b/ When constellation is complete.
c/ Multiple satellite classes or generations sharing orbital characteristics.
SOURCES: Johnson, Nicholas. The Soviet Year in Space, 1982 (Colorado Springs: Teledyne-Brown Engineering, 1983); Karas, Thomas. "Implications of Space Technology for Strategic Nuclear Competition." Stanley Foundation Occasional Paper No. 25 (July 1981); Stockholm International Peace Research Institute. World Armaments and Disarmament Yearbook, 1983 (New York: Taylor and Francis, Ltd., 1983); Union of Concerned Scientists, Anti-Satellite Weapons (Cambridge, Mass., 1983); U.S. Senate, Committee on Commerce, Science and Transportation. Soviet Space Programs, 1976-80. Committee print. December 1982.

per year, whereas the USSR must launch at least 70, not counting replacements for permaturely failed satellites. The high Soviet launch rate is a function of short equipment lifetimes, other reliability problems, and an operational philosophy which emphasizes redundancy.[15,18] As a result, Soviet ability to reconstitute its satellite constellations in the event of wartime losses is today greater than that of the United States. Whether this asymmetry would be important in wartime would depend on the degree to which U.S. fighting forces required access to various kinds of satellite support (see, for example, the NATO Region scenario discussion, below).

In the future, space-based systems may include large communications platforms or antenna farms at geosynchronous orbit, along with growth versions of the current Tracking and Data Relay Satellite for improved spacetrack and routine satellite-to-satellite communications (crosslinks). Space may also contain large staring mosaic arrays (derived, for example, from Teal Ruby technology) to detect and track the infrared emissions of aircraft), and sophisticated synthetic aperture radars (derived, perhaps, from SEASAT technology) for accurate detection and continuous tracking of ocean surface traffic. Further in the future, satellites using blue-green lasers may be essential for communication with submerged strategic submarines.[11]

In terms of manned applications, the USSR is likely to join the United States in operating a cargo-carrying space shuttle by the end of the decade. Soviet Salyut space stations have had military applications (reconnaissance, for example) and any follow-on Soviet station is also likely to be used at least in part for military purposes. The Soviets have had, and are projected indefinitely to place greater emphasis than the U.S. on manned military space systems.[15,28]

An American space station, set as a goal for the early 1990s in the President's 1984 State of the Union address, is not now intended for military use. If experience with shuttle development is any guide, however, space station costs will eventually come to be justified partly in terms of national security (to repair or refuel satellites retrieved by orbital transfer vehicles, for example). Both superpowers, then, probably will have deployed inhabited military targets in low earth orbit by the middle of the next decade. (Inhabited stations are limited to orbits of not more than 600 km altitude, the lower limit of the Van Allen radiation belt.[8])

The overlap of missions and assets in categories one and two is clear: many satellites both provide direct combat support and control of forces, depending on the circumstances. There is a distinct lack of overlap, however, between those categories and category three. Disruption, damage, or destruction of other spacecraft is a very different mission. Because that is the case, limitations or rules of the road may be drawn up for ASAT without materially impinging upon other space assets or missions. There are, of course, some exceptions -- kinetic ASATs "rendezvous" with their targets and so do other spacecraft. One can also posit the protection of other space assets with a deterrent ASAT threat that would be unavailable under a strict control regime. These cases will be addressed in later sections. More problematic for ASAT arms control, however, is the fact that other (non-space) technologies may be directed to perform the ASAT mission or some part of it. Not all of these technologies would be within reach of a new arms control regime for space, and not all should be thought of as candidates in any case, based on the criteria developed in the next section.

## Disrupting or Damaging Space Objects

Spacecraft functions may be disrupted by a number of technologies and techniques, some not normally thought of as ASAT, ranging from electromagnetic interference through deliberate nuclear attack. Each will be addressed in turn. First, however, it is necessary to develop criteria to aid in evaluating threats to space objects that may be usefully addressed by arms control negotiations.

### Defining Space Threats

Not every conceivable menace to space objects is a threat sufficient to warrant major investments of technical, economic or political resources. Four rules of thumb might be applied to identify important space threats.

Is the weapon effective? Ineffective weapons function primarily as resource sinks for the other side and present at best ambiguous threats. They may be ineffective due to inherent technical shortcomings, or because relatively cheap countermeasures are available. Projections of improved weapons down the road present a hypothetical threat, but one of consequence both for force planning and for arms control planning.

Does the weapon threaten capabilities or values that are important and difficult or costly to replace? If the threatened capability is replaceable in wartime, protecting it (either by investing in survivability measures or by engaging in efforts to limit the threat) may not be as useful as investing in non-space backups. An important space asset might be defined as one that provides a substantial proportion of a particular capability or function during wartime. If all US forces converted to NAVSTAR guidance, for example, NAVSTAR's continued functioning during conflict could be crucial to successful US military operations. Important values placed at risk might include a stable military balance, or crisis stability (which, once lost, could be very costly to regain).

<u>Is there a plausible scenario for use of the weapon?</u> Some systems with ASAT capabilities might be unusable short of World War III. Several currently-deployed nuclear weapon systems, for example, may have considerable capability to destroy satellites, but the prospect of their use as ASATs is remote unless the user intends to cross the nuclear threshold in other respects as well. The real day-to-day threat they pose to operational spacecraft is therefore marginal.

<u>Can countermeasures to the weapon readily be deployed?</u> If unilateral countermeasures are relatively cheap, and the defense can clearly remain ahead of the offense, then the case for an arms control approach is problematic. Communications jamming, for example, may present such a threat. If, on the other hand, countermeasures are costly and the offense is likely to retain the advantage of the last move, the case for preventive arms control measures is much stronger.

In short, a real threat that is a potential candidate for control efforts is one that works and can reach important assets; use of which is plausible in particular scenarios that are themselves not improbable; and that is difficult or expensive to counter unilaterally. In general, the defense policy community is more readily convinced of the need to counter such threats unilaterally than of the need (or wisdom) of negotiated weapon limits. Unilateral approaches impart a sense of having the problem under positive control; negotiated approaches require the other side's cooperation and engender an uneasy sense of dependence (on both sides) that is buffered by R&D programs to hedge against bad faith on the other's part. Hedging produces behavior that may skirt the bounds of bad faith, as one side or the other defines it, and may indeed cross over, hence the insistence on unilateral monitoring to verify compliance with treaty terms. Meeting specified standards of verification can be viewed as a fifth criterion for arms control approaches. Verification is discussed in some detail in the section on arms control options.

Having identified the components of a space threat, let us look at the technologies which can be construed to pose threats, to some degree, to space objects.

<u>Interference</u>

Types of electromagnetic interference include jamming of satellite uplinks or downlinks (that is, transmission of signals intended to inhibit reception of signals by the satellite or its ground stations), blinding of optical sensors (as, with laser light), as well as various kinds of spoofing (the transmission of deceptive signals to confuse a space sensor or load its command link with spurious orders). Unless used to command a satellite to vent all of its maneuvering fuel, for example, or to overload and burn out a spacecraft's sensors or receiving antennae, such measures would not permanently damage spacecraft components and would not fall under the definition of "weapon" suggested above.

Direct Attack

Direct attack by non-nuclear means is the threat most frequently addressed in discussions of ASAT. Direct attacks can be subdivided into those using remote and proximate means: beam weapons and kinetic weapons, respectively.

Beam weapons include lasers and particle beams. Ground-based laser weapons might pose a threat to spacecraft in low earth orbit whose ground tracks pass reasonably close to the weapon's location. Able to use ground-based energy sources, ground-based lasers could be scaled up to intensitites not feasible for space basing. On the other hand, they would be subject to atmospheric deflection and absorption. Deflection phenomena include molecular scattering (as the beam's photons strike air molecules), thermal blooming (beam spreading due to atmospheric heating), and atmospheric turbulence. Significant absorption occurs at all but a few wavelengths. Exceptions include bands in the infrared and visible light, though rainclouds do block laser propagation at those wavelenths. Some of these effects can be reduced by locating the laser on mountain peaks or, perhaps, by relaying the beam through orbiting mirrors with onboard pointing and tracking capability.

Space-based neutral particle beam weapons could, theoretically, be potent ASAT weapons less amenable to passive countermeasures than lasers. The technology for such weapons is, however, less well in hand than laser technology.[1, 44]

Space-based laser weapons could, in principle, take advantage of near-vacuum conditions to use shorter wavelengths (for example, ultraviolet), which permit smaller mirror diameters and thus a smaller, lighter device. The lighter and more compact the device, the higher the orbit into which it can be placed by a booster of given capacity, and the greater the fraction of near-earth space within its line-of-sight at any given time.

Beam pointing and tracking requirements for ASAT are generally less rigorous than for BMD. A laser ASAT's presumptive targets follow paths that are known (within certain confidence limits for satellites with orbital maneuvering capability) and the number of targets is small by comparison to the number presented by a full-scale strategic missile launch. Moreover, the number of time-critical targets is some relatively small fraction of the total (whereas all targets would be time-urgent for boost-phase BMD). A laser ASAT thus could afford relatively lengthy per-target dwell times, doing damage by slow warming rather than burning (delivered beam intensity only ten times that of sunlight could, over a period of minutes, heat a nominal satellite target by several hundred degrees Celsius, well beyond the ability of its thermal control systems to compensate, and well past the point of electronic failure). Thus a laser ASAT could function at lower power levels or lower tracking accuracies (since intensity required at the target is lower, the beam could be spread to cover a larger area).

Orbiting lasers would not operate in a benign environment, however. A legal regime that sanctioned space-based laser weapons would undoubtedly sanction ground-based ASAT as well. Lasers in orbit would be as vulnerable to attack as other satellites. With their high-quality optics and large fuel supplies (chemical or electrical), they might be more vulnerable -- to attacks by other lasers or to assault by ground-launched ASATs with kill mechanisms that a laser could not easily stop (clouds of pellets or fragments with high closing velocities). Either a large fraction of a space-based laser's mass could be devoted to self-defense, or it would need to be accompanied by its own retinue of active defenses.[1,44]

Kinetic ASAT weapons can be differentiated by mode of approach to the target and by type of "warhead" carried. Type of warhead affects the accuracy with which the vehicle must be guided to its target as well as its fuzing requirements. Fragmentation warheads permit greater miss distances but require fuzing accuracies that vary with the ASAT's closing velocity. Direct-impact ASATs use no separate warhead; ramming the target at high velocity requires zero-error guidance but no fuzing. The current Soviet ASAT is apparently a fragmentation weapon whereas the US has chosen direct impact for the MV.[15,25].

The mode of approach can be a trajectory from ground to target (direct ascent) or an orbital path that matches, grazes or intersects the orbit of the target. Direct ascent weapons can reach their targets in less time than orbitals, since they spend no time entering or changing orbits. An orbital system may require 90-200 minutes to intercept a target in low earth orbit and five hours or more to reach geosynchronous altitude, using a minimum energy transfer orbit (unless, of course, it is an in-place mine or a "nearsat"; see below). Cutting that transit time to one hour would require much greater final stage mass (fuel plus payload) and roughly five times the total propulsive power (as measured by total change in velocity required, or $\Delta V$). Because booster mass requirements increase exponentially with $\Delta V$, sending an interceptor quickly to very high altitude means using a very small interceptor or a very large booster. There is clearly an equivalent performance payoff in keeping a direct-ascent system small, and this is evident in the design of the F-15/MV system, with its "oversized tomato can" payload.

A co-orbital interceptor matches orbits with the target. Closing velocities are relatively low, by definition, so this approach puts the least stress on interceptor sensors. A "co-planar" approach shares the target's orbital plane, but not its orbit. It is a compromise which requires less propellant $\Delta V$ than orbit matching and less terminal $\Delta V$ (capacity for last-second orbit adjustments) than an intersecting approach. The latter, crossing the target's orbit from out-of-plane at high relative velocity, demands a very capable sensor/guidance suite and considerable terminal $\Delta V$, particularly if the target has active countermeasure capabilities.

A nominal co-orbital ASAT might be a "space mine" designed to lurk about the vicinity of its potential target, matching its maneuvers and awaiting the signal to close and self-destruct, perhaps in minutes. A co-orbital ASAT might also be launched on demand, meet its target and explode immediately.

Co-orbital capabilities (minus explosives) are useful for applications other than ASAT, most visibly in the rendezvous of manned spacecraft (as in the US Gemini, Apollo and Skylab projects, the Apollo-Soyuz Test Project, and the Soviet Salyut/ Soyuz-T/Progress program). Orbital rendezvous would also be necessary for the construction of large space structures. There would always remain an irreducible residual ASAT capability in automatic rendezvous spacecraft such as the Soviet Progress, or a future American orbital transfer vehicle, for example, whatever the limits of a future ASAT regime. Such capabilities thus could present an opportunity to circumvent ASAT limitations. On the other hand, such vehicles, with primary applications other than ASAT, would have limited flexibility in an ASAT role.

An example of a co-planar system would be the current Soviet ASAT. Its launches must be timed to coincide with the passage of the target's ground track (orbital plane) over the launch site at Tyuratam. The ASAT vehicle's orbit grazes or crosses the target's orbit after one or two revolutions, usually at a point within line of sight of Soviet tracking stations.[15] Published figures for the Soviet ASAT show no test target with an apogee higher than about 2,100 km, and no attempted intercepts above roughly 1,700 km. Orbital inclination has not varied since 1976 from 65.8-65.9$^{\circ}$. Twenty to twenty-five per cent greater altitude could be reached for equal expenditure of energy with a launch inclination of about 45$^{\circ}$, due east from Tyuratam, to make maximum use of the Earth's rotational velocity (about 0.32 km/sec at that latitude). (Failed launches at that inclination, however, would land in China.) Orbital plane changes required for intercepts at inclinations lower than 45$^{\circ}$ would reduce the maximum intercept altitude and the need to overcome the velocity of the turning Earth would similarly degrade the system's maximum altitude in polar orbits. (Changing planes, especially in low earth orbit, requires large expenditures of energy to overcome the spacecraft's high orbital velocity. Shifting from a $45^{o}$-inclined low earth orbit to a $0^{o}$ equatorial plane would require a $\Delta V$ equivalent to about 75 per cent of the vehicle's velocity, or 5-6 km/sec.)[8]

To lift the current Soviet ASAT to semi-synchronous or geosynchronous (especially equatorial) orbits would require a booster with double the payload capability of the currently used F-1-m (SS-9). This would mean using the Proton launch vehicle which requires a cryogenic oxidizer and hence takes much longer to prepare for launch. Moreover, sending the current Soviet ASAT vehicle to geosynchronous orbit would appear to be at the limit of even the Proton's capabilities.[15,35] New-generation launch vehicles with higher-energy liquid oxygen/hydrogen fuels could more easily do the job. These cryogenically-fueled, Saturn V-sized vehicles would be less likely to be used as wartime boosters, however, than would military missiles like the SS-18.[28]

Any orbital ASAT with sufficiently capable sensors and maneuvering capability could use an out-of-plane, intersecting approach to its target, immediately after launch or (if designed for long-duration missions) from on-orbit storage. The latter, "nearsats," would be proximate to their targets only in terms of energy needed for intercept and not, like space mines, physically close to their targets on a continuing basis. One example of a nearsat might be an ASAT "bus" in a four-hour elliptical orbit with an apogee of 20,200 km, the orbital altitude of the NAVSTAR constellation. If equipped with three kill vehicles, the bus could be commanded to intercept, on successive orbits, each of three in-plane NAVSTAR satellites, which trail one another in orbit at four-hour intervals. Many such configurations may be deduced from known orbital parameters.

### Ground Segment Attack

Attacks on ground operations centers or communications links could be a particularly inflammatory but very effective means of degrading an opponent's space capabilities. Most current US satellites are operated from a single ground station. Disabling that station, which may be more or less vulnerable to sabotage, special forces action, or long-range attack, can take a number of satellites out of action as effectively as direct attacks against each. Spacecraft vary in the amount of time they can keep station without updates from ground controllers. Newer designs (for example, NAVSTAR) may have increased stationkeeping autonomy, but for many applications (eg, reconnaissance) tasking must change frequently and requires instructions from the ground. The new Combined Space Operations Center will be less vulnerably located than current facilities, but it will remain easier for the USSR to disable U.S. ground facilities than for the reverse to happen, in situations short of general war.

### Collateral Nuclear Damage

Collateral damage could result from nuclear bursts not specifically intended to disrupt spacecraft operations (a high-altitude -- 400 km -- nuclear test in 1962 inadvertently damaged several satellites, including Transit IVB, TRAAC, and Ariel, all in 1,000 km orbits). Effects would include prompt radiation (X-rays and neutrons propagated directly over several hundred kilometers), explosion-pumped Van Allen belts (a phenomenon observed in the 1958 Argus high-altitude test series), electromagnetic pulse (especially against the ground segment), and propagation disruption (blackout and scintillation).[8,9]

### Deliberate Nuclear Attack

Nuclear weapons carried by ballistic missiles and mid-course ABM interceptors could be used deliberately to destroy an opponent's space assets. As they are exceedingly blunt weapons, however, an attacker using them would have to anticipate the elimination of many of its own spacecraft as well. In the nuclear age, denial of space to all parties is intrinsically easier than control of space for the benefit of one.

## Countermeasures

### Unilateral Measures

There are countermeasures of varying cost and effectiveness that may be implemented unilaterally for most of the above categories of potential threats to spacecraft. Countermeasures to electronic interference include the use of higher frequencies (to reduce the impact of nuclear effects and to provide greater bandwidth and decreased beamwidth), anti-jam techinques (for example, antenna nulling or frequency hopping) and anti-spoofing techniques (such as encryption and command authentication). Countermeasures to beam weapons might include shielding for sensors (filters or covers) or power sources less fragile than solar cells.

Direct countermeasures to a kinetic ASAT could include maneuvering the target out of its way (on the initiative of ground controllers or on-board attack warning systems), jamming or spoofing the ASAT's sensors or command links, or engaging it with armed escort satellites or one's own ASATs. Indirect measures would include dark spare satellites on-orbit, proliferated capabilities (so that destroying one or two satellites would not defeat the mission), quick reconstitution (with satellites of equal or lesser capability), or terrestrial backups. The probability of collateral nuclear damage can be reduced if satellites are designed to be hardened against EMP, X-rays and neutron flux. The probability of damage in the case of deliberate nuclear attack, however, would remain near 1.0 despite such efforts because a determined adversary could detonate his weapons at closer range; the effect of survivability measures would be to increase the number of weapons required to damage a given number of satellites.

Building countermeasures into the spacecraft itself imposes various penalties in the form of increased system cost or complexity, power requirements or weight. If countermeasures involve added shielding or maneuverability, they may impose performance tradeoffs elsewhere in the system.

Negotiated Measures

Not all potential space weapons can or should be the subject of arms control measures. ECM and nuclear capabilities are cases in point. ECM is an integral part of terrestrial military capabilities; restraints on means of non-destructive interference would be extremely difficult to craft so as not to affect ECM capabilities that are not space-directed and have applications (for example, battlefield communications jamming) beyond the writ of an ASAT negotiation. This question becomes more complicated when levels of electromagnetic radiation aimed at a space object are sufficiently high to overload and damage a receiver or sensor, but this is, again, an "attack" that can be mooted more easily at the drawing board than at the conference table. Nuclear-armed missiles capable of carrying their weapons into space also stand beyond the reach of negotiations on ASAT means. They have other primary missions; an ASAT agreement could not effectively address those systems' residual ASAT capabilities without impinging upon those primary missions. While it is generally thought desirable to limit such missile systems *per se*, that would also fall outside the purview of an ASAT negotiation.

ECM and nuclear weapon systems also fail to meet one or more of the specified threat criteria. Resistance to electronic interference and hardening against collateral nuclear damage can be accomplished unilaterally, and are prudent measures to take whether or not an arms control agreement is in prospect. A deliberate nuclear attack on space systems outside the context of a wider nuclear war is a highly improbable event that could cost the attacker much more (from resulting escalation or retaliation) than the initial attack was intrinsically worth.

Finally, attacks against ground segments would be highly provocative acts. Damaging a spacecraft might or might not be considered *casus belli*, but an assault on US or Soviet territory, or overseas tracking and relay stations, surely would be.

That leaves direct attack as a potential candidate for arms control measures. Just as direct attack ASATs can be distinguished from other categories of military space systems, so can they be distinguished clearly by principal mission from other types of weapon systems. Limiting direct attack ASAT capabilities does not impinge upon systems with other, non-space applications, with one exception, discussed separately, below: ABM systems and components. The remainder of this report considers whether this bounded category of antisatellite weapons poses a sufficient threat to national security, as defined above, to merit bilaterally-negotiated limits, and if so, what kinds of limits, with what associated problems of negotiation or verification.

## ASAT-DABM Interactions

The issues of satellite survivability and defense against ballistic missiles are conceptually distinct, yet they cannot be completely separated politically or technically, and these elements are themselves intertwined. They involve potential for circumvention of the development restrictions in the ABM Treaty, an irreducible minimum of direct attack ASAT capabilities due to residual permitted ABM capabilities, and the interaction of ASAT and space-based ABMs.

### ASAT and the ABM Treaty

The ABM Treaty (Articles I, II and III) prohibits deployment of ABM systems or components except in the places, numbers and fixed, land-based configurations specified. Treaty Article V prohibits the development, testing and deployment of ABM components "which are sea-based, air-based, space-based, or mobile land-based." These prohibitions are acknowledged by the Administration, in the Fiscal Year 1984 Arms Control Impact Statements, to be applicable to any technology, included directed energy, used in an ABM role.[31] An Agreed Statement (D) associated with the treaty, read in conjunction with the above Articles, entails that deployment of even fixed, land-based ABM systems based on new physical principles and including components "capable of substituting" for ABM radars, ABM launchers, and ABM interceptors would be subject to discussion in the SALT Standing Consultative Commission and to specific limitation by way of treaty amendment. Another Agreed Statement (E) contains a prohibition on the development, testing or deployment of ABM interceptors with multiple, independently guided warheads.[30]

There are no parallel constraints on development, testing or deployment of anti-satellite systems whether air-, sea- or space-based, directed energy or kinetic, single or multiple warhead capable. Experience in the development and testing of space-based directed energy ASATs could be quite valuable to the design and development of space-based BMD, even though ASAT systems may not need the power or pointing accuracy of their larger cousins, and cannot legally be made capable of substituting for BMD systems or components. Space-based ASATs deployed only in sufficient numbers to damage some fraction of the other side's operational satellites would probably fall far short of the capability required to defeat or substantially thin a full-scale ballistic missile attack. But the ABM Treaty clauses cited do not deal in threshold numbers or precise measures of effectiveness. A space-based system that is capable of substituting for one or more ABM components, that is, capable of being used in an ABM role "to counter strategic ballistic missiles or their elements in flight trajectory," would violate the treaty. If the system was not tested "in an ABM mode" such capability could not be proven, and the absence of such testing ought to reduce its owner's confidence in its ABM capability. Concerns about the ABM breakout potential inherent in space-based ASAT could be well-founded nonetheless.

Fixed, ground-based ABM lasers may be tested only at designated sites. In the absence of ASAT limitations, however, ASAT lasers, fixed or mobile, based on the ground or elsewhere, could be tested (though not "in an ABM mode") and sited in many places. These could generate considerable uncertainty with respect to ABM Treaty compliance.

The prohibition contained in the Agreed Statement (E) has an effect similar to that of Article V, paragraph 2 (multiple-launch and rapid reload systems), namely, to assure that technology does not, over time, multiply the capability of permitted numbers of ABM launchers and interceptors. Multiple, independently guided, non-nuclear warheads are key to cost-effective mid-course BMD -- the defense equivalent of MIRVs on offensive missiles. Multiple-warhead ASAT tests are not restricted. Research and development on multiple kill-vehicle ASAT (an approach that could make efficient use of boosters for intercepts at geosynchronous or other high altitudes) could provide valuable data for BMD applications.

There are other respects in which ASAT and mid-course BMD technologies interact. The apogee of a minimum-energy ICBM trajectory is more than 1,000 km and mid-course reentry vehicle velocities are nearly orbital. Thus much of the technology applicable to non-nuclear mid-course missile intercept is also applicable to ASAT.

ABM and the ASAT Floor

Because the ABM Treaty permits deployment of 100 ABM interceptors, and because a mid-course interceptor might be able to reach altitudes of 1,000 km, zero direct ASAT capability is not achievable in an ASAT agreement. The ASAT capability of treaty-permitted BMD should not be exaggerated -- neither side could intercept satellites in Molniya orbits with southern perigees, nor satellites with orbits inclined at less than $40^{o}$-$50^{o}$ (current designated ABM deployment areas are Grand Forks, $48^{o}$ north, and

Moscow, 56° north), nor satellites orbiting above interceptors' ceilings. If ABM interceptors are nuclear-armed, as the Soviet Galosh is reported to be, they are not a plausible threat to space assets except in a nuclear war, and then a variety of other nuclear hardware could be brought to bear as well. But non-nuclear, high altitude ABM interceptors could be very capable ASATs for targets entering their range envelopes, if their guidance and tracking systems were fed data from a spacetrack network. The US Army conducted the first successful, non-nuclear, exo-atmospheric intercept of an ICBM reentry vehicle in June 1984.[21]

An ASAT agreement that limited testing of <u>any</u> weapon, whatever its primary mission, against space objects would serve to reduce decision makers' confidence that a dual-capable system could successfully engage satellite targets on short notice. But testing of non-nuclear mid-course ABM hardware and software could continue to provide experience with engagement of objects in space. There is, in short, a two-way synergy between mid-course BMD and ASAT that could only be interrupted by prohibitions on space-testing for both ASAT and missile defense purposes. Such modification of the ABM Treaty, along with an ASAT agreement, would clearly limit ABM development to endo-atmospheric systems suited basically to defense of hardened point targets. Analysis of the desirability and feasibility of such restrictions is beyond the scope of this report.

Removing or reducing such residual destructive threats to space objects could encourage more extensive dependence on satellites for both peacetime and wartime missions. But to the extent that new space systems orbited beyond the lethal range of ground-based systems having residual ASAT capability (in semi-synchronous or higher orbits, for example) such capability would be unimportant.

<u>ASAT and "Star Wars"</u>

Buying boost-phase BMD buys extensive ASAT capabilities automatically. If the ABM Treaty were terminated to permit boost-phase missile defenses, it would not be technically possible to restrict their ASAT capabilities, because ASAT requirements would never exceed those of BMD. Orbiting "battle stations" would pose a threat to other satellites and to each other while they waited to perform their primary missions. Systems designed to be lifted into space only when needed would be equally ASAT-capable.

Even if it were possible technically to limit ASAT capabilities under such circumstances, it would most likely not be feasible politically. As noted earlier, the vulnerability of orbiting "Star Wars" stations to laser or kinetic ASATs, not to mention nuclear weapons, is essentially unavoidable (as is the vulnerability of "pop-up" systems to systems like themselves). Missile defense stations would be very attractive, high-value strategic targets. A serious "Star Wars" program thus would also be a stimulus to ASAT programs, as well as a stimulus for programs to defend ABM components.

## SCENARIOS

What might the United States (and the Soviet Union) gain in time of crisis or war by having dedicated ASAT capabilities; what could either lose through the other side's possession of such capabilities? Conversely, what might be the military impact of zero dedicated, direct attack ASAT capabilities? Such questions are best addressed in terms of particular scenarios. Three kinds of scenarios are discussed below: US engagement in support of an ally or client at war with a state actively supported by the USSR; a non-nuclear NATO-Warsaw Pact conflict; and nuclear war.

### Engagement in the Third World

In the past two decades, the United States and the Soviet Union have both been involved in wars and crises in the Third World. Both have been cautious in their use of force where both have been directly involved in supporting a client or an ally. Naval forces were augmented by both sides during every major Middle East conflict from 1967 through 1973, for example, yet there were no superpower clashes.[3] Where major troop commitments have been made by one side (Vietnam, Afghanistan) they have been in situations where the other side was unlikely to intervene directly. If, however, US and Soviet forces should become engaged with one another in the course of supporting respective clients, what impact could ASAT weapons have on the conflict?

ASAT's task in a distant, localized conflict, especially one in which naval forces are involved, might be to sever communication links to central command authorities, or to counter real-time space surveillance, especially ocean reconnaissance satellites (active radar [RORSAT] and passive ELINT [EORSAT]). Used in pairs to locate naval forces and target long-range strikes, Soviet ocean reconnaissance satellites have been cited in Congressional testimony as a primary motivation for the US ASAT program. Whereas those satellites would be in range of the F-15/MV system, high-altitude Soviet COMSATs would not be.[25]

Securing the fleet against a satellite-guided Soviet first strike, however, would require neutralizing those satellites long before the first Soviet salvo was fired, to deny targetting data to Soviet forces. There are several problems involved in doing that with an ASAT weapon. First, US spacetrack must measure the orbital parameters of a newly-launched RORSAT for input into ASAT guidance and to guide the launching aircraft. The RORSAT must overfly several spacetrack radars for its orbit to be established. Then ASAT squadrons must wait for the RORSAT's ground track to pass within range of a base, which might take several more hours. Depending on its launch direction (northeast or southeast), a newly-launched RORSAT could be made to pass over Pearl Harbor, Angola, and the Eastern Mediterranean on its first orbit; or the Greenland-Iceland-UK gap (GIUK), the Persian Gulf, the Arabian Sea and the approaches to Diego Garcia. On this southerly track, the RORSAT may be detected by spacetrack radars in the eastern Indian Ocean or New Zealand, but it would not be seen again by ground-based systems until it crossed the Gulf of Mexico headed for Cleveland, Goose Bay, the GIUK and the Gulf. A Norfolk-based ASAT squadron would have less than 10 minutes to position itself for attack after redetection.[20]

In the case of an already-orbiting RORSAT/EORSAT constellation, much of its work will be done long before hostilities break out. Indeed, these constellations can be viewed as cost-effective substitutes for peacetime naval tattletales. Since they are useful primarily as supplements to other Soviet search capabilities, it follows that their greatest utility is pre-engagement; indeed, they would facilitate engagement by vectoring other Soviet air and naval assets to the area. To be useful, then, in protecting forces that might have to fight the "battle of the first salvo," ASAT attacks against RORSAT constellations would need to be made well in advance of other fighting. Otherwise, the first line of defense for such forces in most instances would appear to be ECM.

Soviet ocean reconnaissance satellites travel in low orbits inclined at $65^{\circ}$ (see Table 1). Unlike other (air or naval) surveillance assets, a given constellation would have a given locale in view for just a few minutes at a time and would revisit that locale at predictable intervals (the number of visits per day depending on its ability to maneuver). Electronic countermeasures could be readied and used when those satellites were expected to come over the horizon. If capabilities were available to spoof the satellites and thus misdirect Soviet forces, it may be more in US interests to leave them in orbit than to destroy them. A good ECM capability also makes less important any Soviet capacity to reconstitute RORSAT rapidly. Effective ECM is, like most countermeasures, a perishable commodity whose wartime effectiveness will of course depend on accurate peacetime assessments of Soviet capabilities, including counter-ECM.

It is a commonplace among many analysts of nuclear forces and doctrine that neither superpower knows how to win a nuclear war and neither knows how to terminate one. By the same token, neither superpower really knows how to terminate, win, or lose a conventional war with the other, because the party that is losing retains the option of escalating to a higher level of violence or to another region, or both. ASAT attacks in the context of a local, conventional US-Soviet engagement could nudge it in such escalatory directions in two ways.

First, ASAT attacks could be considered intrinsically inflammatory. Destroying a RORSAT in advance of other fighting could also tip a crisis into war, or expand a regional conflict into one of wider scope. Space systems are by definition global in their coverage (or, in the case of geosynchronous satellites, part of a global sensing or communications net). Thus an attack intended to produce local advantage (by eliminating space surveillance over the battle area, for example) could be taken to indicate intent to widen the conflict. Or the space attack itself could precipitate conflict. If one side views space as a quasi-sanctuary while the other considers it part of the local battlefield, the scale of response to ASAT use could be grossly disproportionate to the attacker's actual intent, whatever the actual operational effect of the attack for either side.

Second, ASAT attacks could trigger escalation by degrading the flow of intelligence, operational reporting or headquarters commands needed to maintain control of forces in the field. Anything that contributes to confusion on the battlefield makes mistakes more likely, the gamble, of course, being that the other side's mistakes are worse than one's own.

These potentially serious side-effects of ASAT use must be balanced against its potential military utility in this type of scenario. That utility would reside primarily in protection afforded the movement of seaborne supplies and reinforcements to the distant combat theater. The most economical approaches to interdicting reinforcements, however, involve the endpoints of the supply line -- points of departure and the combat theater itself. In a limited conflict scenario, interdicting reinforcements approaching the theater would be less likely to escalate the conflict to other regions, and theater air- and sea-based search assets could be brought into play. The utility of antisatellite attacks to cover movements of reinforcements outside the theater thus may not be that great. Moreover, what utility there is in such a limited scenario must be weighed against the costs and risks of unrestrained ASAT development and deployment for other uses of space and other crises and conflict scenarios.

## NATO Region Crisis or Conflict

A crisis involving NATO and the Warsaw Pact could involve great risk of war, escalation, and even resort to nuclear weapons by one side or the other. But because forces and their support systems have been in place for years, of all the regions where the United States and the Soviet Union jointly deploy forces the European theater may be least tied to space for wartime support.

In a period of tension, before any engagement of forces, space assets would clearly be important for monitoring the activities of the other side. Use of ASAT to deny the other side strategic intelligence under those circumstances would be a visibly hostile act suggesting willingness to engage, imminently, in further hostilities. Non-destructive interference could send a similar signal, but the other side is under no general obligation to make intelligence collection easy, so the intention communicated by ECM would be far more ambiguous.

Should hostilities commence, systems key to the management of a European conflict would be those under theater command. A space system controlled from CONUS may be occupied with priority missions outside the immediate theater at critical times. Low altitude satellites, moreover, are within sight of a given theater only for brief periods, a few times a day, and thus cannot be relied upon for time-critical tactical intelligence. Reconnaissance and surveillance in particular would tend to be more timely and more easily shifted to meet a rapidly changing tactical situation if they were conducted by in-theater assets.

More important to theater support than near-earth spacelanes would be sea lines of communication, supported by satellites such as FLTSATCOM and, in the 1990s, NAVSTAR and MILSTAR. All of these orbit well out of reach of the current Soviet kinetic ASAT. However, high-frequency communications can, if necessary, supplant a satellite link, particularly for transmissions between areas as proximate as CONUS and the North Atlantic. The Navy also has considerable experience operating with less than the 15 meter navigational accuracy NAVSTAR is to provide.

A question for future dependency of naval and other forces on space support, however, is the extent to which budgets, spare parts, training and exercises are maintained for the older non-space systems once new satellite systems, more efficient and cost-effective in peacetime, come to be used by most forces. Cost-conscious planners and funders could promote exclusive dependence on such systems. Clearly this would not be a good idea, but there are peacetime pressures in this direction. Prudent planning would suggest attention to non-space backups. Feasible in-theater substitutes for space-based systems could include hard-wired land lines (including fiber optics) for rear-area $C^3$ and elevated-line-of-sight battlefield surveillance and communication systems using aircraft, remotely piloted vehicles, balloons, helicopters and sounding rockets. Sounding rockets could also be used for high altitude weather photo-reconnaissance.

If the West comes to rely more on space-based systems for European battle management (because of their peacetime cost-effectiveness, for example), then its wartime operations become more vulnerable to loss of space support and its space assets become highly attractive targets. Soviet incentives to assign higher priority to ASAT programs would increase. Soviet dependence on space systems for primary battlefield support need not (and likely would not) increase accordingly. Threats of reciprocal attack would likely not prove very effective in deterring Soviet ASAT use early in the conflict, under those circumstances.

If, on the other hand, both sides rely more on in-theater systems, available ASATs may not be used at the outset of hostilities because both wish to hold space systems in reserve, to replace in-theater assets as these are subject to attrition. Might mutual possession of ASATs then act to preserve space systems in a mutual deterrent standoff?

ASAT means might be withheld to deter Soviet ASAT attacks on NATO satellites, or they might be used in an effort to protect US forces from Soviet systems like RORSAT, but using them both ways at once would be difficult. Once Soviet satellites began to disappear, there would be little point to continued Soviet ASAT forebearance (that is, Soviet deterrence of US ASAT use would have failed). If the United States were in a position to pose an overwhelming threat to Soviet space systems, Soviet resort to ASAT might still be deterred. But in an unrestrained competition the United States is unlikely to get that far ahead of the USSR, or to stay there for long. (The USSR lagged the United States in deploying MIRVs on its ICBMs by about four years, and its deployment of long-range air-, sea- and ground-launched cruise missiles is lagging by no more than that.[42]) The number of operational Soviet military satellites, the reconstitution capability suggested by peacetime Soviet space launch rates, and the apparent availability of spare boosters and spacecraft, suggests that American ASAT squadrons could be very busy (assuming that Soviet launch facilities and overseas U.S. spacetrack facilities remain operational), whereas Soviet ASATs would have relatively few targets to hit which for the most part could not be directly replaced (particularly if launching replacements means exposing a shuttle to attack).[15,35]

The differences in US and Soviet approaches to space in a European contingency can be cast in terms of likely outcome preferences with respect to wartime space access.[18] The first Soviet preference clearly would be a situation in which their space assets were intact and US satellites were destroyed. That outcome could be achieved by exhausting US ASAT inventories through quick replacement of damaged satellites and/or by a situation in which the USSR possessed an effective direct attack capability and the United States did not.

The second Soviet preference would likely be a situation in which neither side had access to satellites. If the Soviet Union were fighting US forces in Europe, or elsewhere on the Soviet periphery, internal lines of communication and supply would reduce its reliance on space and increase that of the United States, at least in the initial stages of a conflict.

In a longer-duration conventional war, as ground- and air-based primary systems suffered attrition, the USSR might have increasing need to use satellite backups. Expectation of an extended conflict might lead Moscow to fall back to its third preference: both sides' space systems intact. On the other hand, if a war has produced severe attrition of ground- and air-based $C^3$ it is likely that the ground facilities vital to satellite operation will have been destroyed as well.

The fourth Soviet preference would be the situation in which the USSR had lost its satellites, but US systems remained intact. Soviet leaders might fear that an ASAT exchange, once begun, might net this result, with Soviet ASATs missing their targets and American ASATs hitting theirs.[18]

US interests dictate preferences that are almost the inverse of the suggested Soviet priorities, with first preference to unilateral US access to space assets, second to joint access, third to joint denial, and fourth to Soviet space dominance. Unlike the USSR, US interests clearly would be better served by a situation in which both sides had use of space than one in which neither did. Though NATO field commanders may not need access to satellites on a continuing basis, communications with CONUS and forces in other operational theaters would always be facilitated by satellite systems. Thus, the US' first fallback preference logically calls for satellite survival; the Soviets' may not. That may not be a good base on which to build an ASAT deterrence policy.

Nuclear War

A good deal of concern about ASAT focuses on its potential catalytic role in a future nuclear war. The discussion here is divided between present and possible future uses of space relevant to the deterrence, conduct and control of nuclear war.

Present nuclear war-related satellite missions can be characterized as peacetime, transattack or post-attack. Peacetime missions include strategic intelligence (including treaty verification); target planning, including geodetic and geophysical measurements; strategic warning; SSBN guidance update; and meteorology (to aid bomber sorties). Transattack missions include tactical warning; attack assessment (including detonation detection, a capability building as NAVSTAR/IONDS deployment continues); and emergency communication with the US command structure. Post-attack missions include enduring communications (principally via proliferated AFSATCOM transponders) and guidance for secure reserve SSBNs.

Most attention focuses on the transattack missions. Tactical warning is used to authorize launch of alert bombers and airborne command posts and could, potentially, be used to authorize launch of ICBMs before they could be destroyed in their silos. Warning data obtained before impact, and detonation detection after impact, might be the only clear indication that policymakers would have of the extent and specific intent of a Soviet attack. Since loss of warning could jeopardize bomber survival (and thus limit damage, somewhat, to the Soviet Union) an ASAT attack against warning sensors is at least militarily attractive.

Such an attack before Soviet missiles were launched would be counterproductive, eliminating the strategic surprise it is supposed to create. So, the worrisome scenario calls for near-simultaneous attack on warning satellites and launch of ICBMs and SLBMs. Since even a reasonably swift direct-ascent attack on geosynchronous satellites would take much longer than ICBM flight time, threats to worry about would be proximate mines, beam weapons and pre-planned sabotage of ground stations.

Proximate mines would share their target's orbit, remaining at a discreet distance until called upon to approach it and explode. One approach to the mine problem might be a keepout zone sufficiently wide that the time required by a co-orbital Soviet spacecraft to cross it would at least equal the flight time of an ICBM (about 30 minutes). Zone radii become quite large, however, unless one could assume that a mine's $\Delta V$ was minimal. Spotting changes in relative orbital positions using ground-based spacetrack might require substantial separation at geosynchronous altitudes to be operationally useful (that is, to allow time to detect relative position changes, track and confirm them, and react). An apparent separation of one degree, as measured from the ground, would require a geosynchronous keep-out zone with a radius of about 725 km.

Second, the US could deploy warning satellites in orbits that Soviet satellites would have no particular reason to share at close quarters. An example might be geosynchronous altitude but 10-20 degree inclination. An unidentified companion to such a satellite would be immediately suspect.

Neither keep-out zones nor unique orbits would defeat a mine threat, but either would give spacetrack systems better criteria for identifying potential hostiles. Active defense of high-altitude satellites would not be a much better solution to the problem, as it would have the effect of proliferating the space mine threat, with each friendly satellite accompanied by a friendly space mine (or other ASAT device) that could be unfriendly to foreign satellites, space mines or not. Active defenses would increase both the cost and the risk of operating in space.

For directed energy, the distance to geosynchronous orbit is probably too great for immediate kill using currently-available technologies (especially if ground-based). Overheating might be feasible but would not satisfy the timing constraint. Previewers and filters might also be effective against blinding or "crazing" of infrared sensors by in-band lasers. In short, direct attack against early warning satellites is not currently a worrisome threat.

Even if it were, loss of warning satellites would not spell the difference between warning and surprise attack. BMEWS (Ballistic Missile Early Warning System) and PARCS (Perimeter Acquisition Radar Attack Characterization System) radars would give some warning of ICBM attack, and PAVE PAWS radars provide backup to satellites for detection of SLBM launch. Moreover, such ground-based radars could be supplemented with ship-borne radars, airborne long-wave infrared sensors (on aircraft or RPVs), or rocket-launched infrared probes.

Present transattack communication missions supported by satellite include communications from warning/assessment sensors to command posts; Emergency Action Message dissemination; and command conferencing. The COMSATs that would relay transmissions from warning satellites also operate at geosynchronous orbit and would be at least as difficult to attack in timely fashion; and lacking sensitive infrared sensors, they can be made more resistant to lasers. Emergency Action Messages can be transmitted to ICBMs by cable, VLF, and UHF on line-of-sight transmissions from airborne command posts. VLF and UHF can also be used to communicate with bombers enroute to their turnaround points. There are problems with SSBN communications, but they have more to do with the properties of seawater than the vulnerabilities of satellites.[34]

Future use of space for nuclear war functions is a more speculative subject. Potential roles for satellites could include worldwide communications for war termination discussions; real-time surveillance and retargeting of mobile forces; post-attack reconnaissance and restrike; mid-course ballistic missile guidance; ABM weapons or sensors; air defense weapons or sensors; or (more hypothetically) anti-submarine surveillance.

Many of the above developments may not be desirable from the standpoint of crisis stability and if so the less costly and destabilizing approach would be to avoid building them rather than build them and then worry about their impact on stability. But it should also be noted that arms control measures which restrict threats to satellites so as to enhance crisis stability and preserve desirable functions (early warning and communications, for example) would also restrict threats to functions that may undermine the survivability of strategic forces (real-time surveillance of bomber escape routes or SSBN positions, for example). An arms control regime that removed much of the threat to space-based systems could promote dependence on such systems, including some capable of supporting a first-strike strategic policy. Existence of non-nuclear ASAT capabilities might deter such dependency. On the other hand, such ASAT capabilities might just be factored into force plans and themselves be attacked early in a conflict. Moreover, nuclear missile warheads would work as well or better than dedicated ASATs to counter space-based counterforce assets if the context were nuclear war. The latter threat cannot be eliminated and thus is a major (irreducible) deterrent to basing counterforce assets in space.

## INCENTIVES FOR ASAT AND ARMS CONTROL: A NET ASSESSMENT

What are US and Soviet incentives for building and deploying antisatellite weapons, on the one hand, and for negotiated measures to control such weapons, on the other? This section will draw upon the material presented thus far in assessing these questions.

### Incentives for ASAT Weapons

The White House fact sheet on National Space Policy released July 4, 1982 stated that the primary purposes of an operational US ASAT system would be to:

> deter threats to space systems of the US and its Allies and, within such limits imposed by international law, to deny any adversary the use of space-based systems that provide support to hostile military forces.[43]

Principal incentives for the United States to develop and deploy antisatellite weapons are thus (1) Soviet possession of an ASAT; (2) a desire to deter that weapon's use in wartime; and (3) a desire to disable certain Soviet satellites held to pose a direct wartime threat to US forces. Each of these incentives will be examined in light of the threat criteria suggested earlier and with reference, where appropriate, to specific conflict scenarios.

Soviet possession of a low-altitude ASAT capability suggests an asymmetry in capabilities that ought to be matched so as not to give the USSR a "free ride" in space. The USSR may have little incentive to give up that capability, it could be argued, unless it can win comparable concessions from the US.

Deterrence of Soviet ASAT use could apply in either the Third World or the NATO-Warsaw Pact scenario. (A deterrent ASAT threat made in the context of a nuclear war would probably be lost in the nuclear noise.) In the Third World engagement, it seems unlikely that either side would risk an attack on space assets, and thus escalation of the conflict, if vital interests were not at stake. Deterrence of ASAT use in that context would be as much a function of its unknown secondary effects as of any specific threat of reciprocity. In the NATO-Pact scenario, the utility of a Western deterrent threat would depend on the respective ratios of ASAT capabilities to space target sets and the importance of those target sets to the respective sides. If the West were not heavily dependent on space support systems at the outset of the conflict and could pose a much greater, and more robust, threat to Soviet satellites than the USSR could pose in return, such a deterrent threat might prove credible. It is unlikely, however, that either side could sustain such a dominant position in ASAT capabilities in an unrestrained competition. The desired endpoint of that competition, moreover, would be roughly equivalent to its starting point: a situation in which neither side stages direct attacks on the other's spacecraft.

Turning to the third incentive for ASAT: in a broad sense, all Soviet satellites threaten US forces and all US satellites threaten Soviet forces, to the extent that satellites improve intelligence, navigation, and command and control, and generally "multiply" military capabilities. The ASAT mission, broadly construed, is to negate these force multipliers just as other weapons negate other Soviet forces. US force planners, however, would like to be able to single out certain systems like RORSAT and disable them while continuing to deter Soviet ASAT use; in essence, to maintain escalation dominance in space. As argued previously, that is likely to be difficult to do. In crises involving potential engagements of superpower naval forces in distant theaters, there are likely to be particular problems of timing (shooting soon enough to have operational impact) and escalation (shooting prematurely and tipping a crisis into war).

Incentives for the USSR to increase the priority it gives to antisatellite weapons include: (1) US testing of an ASAT weapon more advanced than its own; and (2) likely increased Western use of space for military/operational purposes in the next decade.

The test program for the current Soviet ASAT has shown mixed results, reportedly running up a string of failures with a new optical sensor. [15] It may be that the low-key test pattern evidenced by that program (compared with other Soviet development programs) reflects technical problems only and that its priority has in fact been high; or the priority may be high but accorded to beam weapon technologies and not to the existing mid-1960s concept.[18] Whatever previous development priorities, however, the USSR is unlikely to fail to respond to a vigorous American ASAT program.

Even if the United States were not proceeding with an ASAT test program, the USSR would have some incentive to upgrade its own capabilities as Western military uses of space increase in scope and sophistication. Large communications platforms, surveillance and tracking satellites, or space-based weapons would present high value targets. Since the spacecraft supporting many of these newer applications will use higher orbits, there would seem to be greater incentive for the USSR to develop beam, as opposed to kinetic weapons. As noted previously, Soviet launch vehicles can readily place heavy payloads in low Earth orbit, but expend a good deal of V in plane changes required to reach geosynchronous equatorial orbit. Rather than attempt to lift bulky kinetic ASATs to such altitudes (miniaturization and low mass have not been characteristic of Soviet weapons designs), Soviet planners may prefer to propagate a laser beam from lower orbit. Such a station, however, would be highly vulnerable to attack, as suggested earlier, a disincentive to deployment and perhaps an incentive for arms control.

Incentives for Arms Control

United States incentives for ASAT arms control look very different depending on the time scale used. If one looks only at the present situation they are not very high. Incentives are low not because the USSR poses a severe ASAT threat that the US must counteract but because that ASAT threat is rather low. The current Soviet system is limited in altitude/inclination capability and has not been tested against uncooperative targets, nor has more than one ASAT ever been flown at any one time. Because it would give at least 90 minutes warning of attack, many would-be targets could probably be maneuvered out of its path.

Looking five to ten years ahead, however, the situation looks potentially quite different. In another decade, the United States will be flying frequent space shuttle missions, and Soviet shuttles will most likely have joined them. [5,42] Those vehicles will be used, in part, to service, supply and bring fresh crews to continuously-inhabited space stations. Those stations in turn would be engaged in scientific experimentation, oversight of industrial satellites, probably some military research and, in the Soviet case, military-related Earth observation.

Those stations could be sharing near-earth space with orbital ASAT lasers. The lasers would be as vulnerable to one another as silo-based ICBMs are said to be today, but the "flight" time of their kill mechanisms would be much less. They would in all likelihood be supplemented by direct ascent weapons, space mines and nearsats targetted at high-altitude satellites.

The development and deployment of space-based ASAT beam weapons would be difficult to distinguish, as noted previously, from weapons designed explicitly for an ABM role. Such ambiguous systems would themselves undermine the integrity of the ABM Treaty and raise suspicions of intent to circumvent or abrogate its provisions. It is not clear that criteria could be developed that would permit a system designed for the ASAT mission to be defined as not "capable of substituting" for ABM components without revealing the vulnerability of one's ballistic missile systems to beam weapon damage.

With respect to expenditures and security, in the absence of agreed restraints ASAT will be a growth field for spending. Current official estimates of F-15/MV system development and procurement are $3.6 billion; other estimates place the cost of a high-altitude-capable system at $15 billion. [25]

Space basing of ASAT systems would be more costly. (One orbital demonstration of a laser ASAT has been estimated to cost roughly $2-4 billion.[4]) Not only must equipment be designed to high tolerances, and be delivered into orbit, it must be designed to maintain its orbit and respond on short notice to activation commands (and only to such commands) after periods of dormancy. The effects of long-term dormancy might be mitigated by periodic testing, which would reassure its owners but hardly those whose satellites orbited within range.

Since space basing would very likely bring opposing systems within range of one another periodically, and since space-based ASATS would be high-value targets of ground-based ASAT, space-based systems would need to be able to fight and defend themselves against attack. An ongoing measure-countermeasure competition would mean major expenditures to upgrade existing systems or devise defensive companions for them (resulting in a kind of space-faring carrier task group).[1,44]

Finally, it would be more difficult to roll back ASAT capabilities a decade hence, when they may pose highly problematic threats to American use of space, than it would be at the current time, when effective, dedicated ASAT capabilities are still under development. Arms control agreements, historically, have been less difficult to apply as preventive, than as remedial measures.

American incentives to negotiate limits on space-directed weaponry derive, then, from expectations about the probable impact of evolving ASAT capabilities on the security of other uses of space, military and civilian; the escalatory potential of ASAT use in lower level conflicts; the potential for accidental use of orbital antisatellite weapons against manned space stations, the shuttle, or other satellites; the cost of a competition in those weapons; and the difficulty of reaching an effective limitation agreement once weapon development and deployment has reached an advanced stage.

Soviet incentives for space weapon arms control derive from the threat that space weapons could pose to the apparently ambitious Soviet manned space program and other Soviet use of space, and from an abiding concern about advancing American military technology. The 1983 Soviet Draft Treaty submitted to the United Nations in August 1983 (discussed below) may be a reaction to the US ASAT development program and/or to the President's March 23rd speech and follow-on study activities. Nonetheless it suggests that there is sufficient incentive within the Soviet leadership to start negotiations on these issues without American weapon systems actually reaching an advanced stage of development or production. Indeed, forestalling such development is likely a key Soviet incentive.

Balancing Incentives

If one takes into account the relative wartime utility of antisatellite weapons; their potential impact on crisis stability; future use of space for non-weapon applications; the likely evolution of space-based and space-directed weapons in the absence of negotiated restraints; the cost of developing and deploying those weapons and the cost of an ongoing measure-countermeasure competition, the security benefits of restraints on space-based and space-directed weapons seem clear. The net benefit, however, would depend importantly on the types and levels of restraint involved, and the extent to which one side was satisfied with the other's adherence to those restraints. These are the subjects of the following section.

## ARMS CONTROL FOR ANTI-SATELLITE WEAPONS

This segment discusses objectives for antisatellite arms control, followed by a discussion of the concept of balance, or fairness, that has been politically crucial to viable arms control agreements. It then addresses the general subject of verification before evaluating several potential approaches to arms control that seem to meet the requirement of fairness, looking at each especially in terms of verification and negotiability.

### Objectives for Arms Control

The classic three-fold objective of arms control is to reduce the likelihood of war, the cost should it occur, and the cost of preparing for it. Objectives for ASAT arms control can be cast in those terms, but the endeavor may have additional direct military utility, as a means of halting the development of future destructive threats to US satellites with command, control, communications or intelligence functions and thus a means of improving prospects for enduring $C^3I$ in future non-nuclear conflicts.

In terms of the classic objectives of arms control, limits on antisatellite weapons could

-- contribute to crisis stability by removing a potential source of escalation from future East-West crises;
-- bolster strategic stability by reinforcing the ABM Treaty; and (depending on the specific type of agreement)
-- save the cost of development and procurement of ASAT weapons.

These objectives look ahead five to ten years, when the sophistication of military space assets, relative dependence of forces on those assets, and the capabilities of antisatellite weaponry all can be expected to have advanced in the absence of explicit policy decisions to alter current trends. Attacks against satellites are clearly not the only avenue by which a future crisis could arise or be tipped into conflict, but they could be a particularly visible means, politically. It has been argued in this report that space should neither be treated as a separate military theater nor romanticized, but things and people in space seem to have a special status nonetheless, due in part to a quarter century of political leaders according them status as symbols of national technical prowess, courage and leadership, and in part to the image of space as a challenging "frontier." This historical record guarantees that the first direct attack on one country's space objects by the weapons of another will be a politically momentous event. If that space object were manned (a station, shuttle or transfer vehicle), the repercussions would far exceed that from the Korean Airlines incident of 1983. If

ASAT capabilities come to be based in space, prospects for such an incident, if only by inadvertence or miscalculation, would clearly increase for the reasons suggested previously.

An ASAT agreement could be designed, second, to plug some of the technical loopholes in the ABM Treaty described previously. This assumes, of course, that the ABM Treaty itself is considered a good thing from the standpoint of strategic stability, crisis stability, and arms control. Retention of the ABM Treaty regime may well be an essential prerequisite for meaningful ASAT limits. It is not clear how the objectives of an ASAT limitation regime could be met in the context of ABM Treaty termination. Even with that treaty in force some permitted ABM systems have at least some ASAT capability.

The potential costs of a space arms competition were suggested in the previous section. Part of the savings realized from reduced weapons costs could be redirected toward improved means of monitoring and continued satellite survivability measures, both of which would enhance stability.

What kinds of agreements would advance the objectives for ASAT arms control suggested in this section? To answer that question, let us begin with the notion of the "military balance."

## Measuring an ASAT Balance

The concept of the military balance is engrained in Western thinking and has become equally engrained in the arms control process, where numerical equality has become its surrogate, particularly with regard to central strategic systems. A recent Senate Foreign Relations Committee report reflected a concern for balance in the ASAT field.[38] It is not clear, however, that such an approach would be necessary, or particularly desirable, in negotiating restraints on antisatellite weapons, except within the broadest parameters.

Just as numerical equality is a simplifying surrogate for "balance," the latter is a catch-all that encompasses a number of concepts, prominent among them the notion of "comparable military utility." The military utility of an ASAT weapon depends on the range of targets it can reach and the importance of those targets to the enemy in particular conflict scenarios. Two identical ASAT systems, stockpiled in identical numbers by the United States and the Soviet Union, would have differing military utility for the two sides because of the differences in their respective satellite constellations and how they are used. That in turn derives from differences in the two sides' military style, technology, geography, and geopolitical situation.[18] Thus an ASAT balance that left the two sides with identical arsenals would be unfair in terms of relative military utility; but a balance calculated in terms of comparable utility might appear quite out of kilter to all but the experts familiar with its most minute operational details. And the experts do not vote for ratification.

In practice, the appearance of fairness seems to have become one of the two minimal political requirements for ratification of arms control agreements (the other being some acceptable level of verification). In the strategic arms area, disagreement remains on just what makes a good agreement; on what indices to make equal -- warheads, launchers, throwweight, destructive power. Equality can substitute for a more precisely calculated utility-balance in this particular case because the capabilities of the two sides' nuclear arsenals simply overwhelm most of the details, as they would overwhelm most of their target bases.

In the case of ASAT, calculating the "balance" is more complex but there is a saving grace in that capabilities are low relative to target bases. The appearance of fairness generated by equal launcher or weapon ceilings in START might thus be most closely approximated in ASAT by a "zero-zero" agreement that required dismantling of existing direct attack ASAT means; next by a "zero development and testing" regime that used the passage of time to create de facto zero-zero through progressive atrophy of existing systems; and finally by a "one each" agreement that allowed either party one type of direct attack ASAT, capping the development of new means. Before turning to a discussion of these specific approaches, however, it is important to discuss in more general terms the issue of verification, which is often referenced as a key obstacle to a workable ASAT agreement.

## Verification: Standards and Risks

Verification and monitoring are not synonomous. Monitoring is an intelligence function which collects information about Soviet military programs and practices, whether or not there are arms control agreements in place. Verification is the process that uses data generated by the monitors to decide whether observed Soviet behavior is in compliance with the negotiated constraints imposed by an arms control agreement. Standards of verification will vary according to the risks and uncertainties associated with a given agreement.[19]

Any arms control agreement will involve some uncertainty about compliance, given the nature of the technologies involved and the nature of Soviet society. Arms control for antisatellite weapons would be no exception. The issue in defining adequate or effective standards of verification for such an agreement is the extent to which uncertainties about compliance translate into risks for United States security. The risks assigned to uncertainties involved in monitoring different activities (or their absence) would depend on (1) the military value of the feasible range of undetected violations, and (2) the military value of "legal" activities which nonetheless could undermine the intent of an agreement.

It is possible to conceive of agreements where the monitoring requirements are high but the risks are relatively low. An example might be an agreement involving dismantling of the current Soviet ASAT, where the risk of covert stockpiling must be weighed against the risk to US security posed by the near certainty of a next-generation weapon developed in the absence of an agreement.

It is equally possible to conceive of agreements where the relationship between monitoring and risk is reversed. An example might be a stand-alone ASAT non-use agreement, which might be relatively straightforward to monitor via ground-based spacetrack complemented by laser light detectors deployed aboard satellites. Being able to monitor use would not, however, reduce the wartime ASAT risk to US satellites, because a non-use agreement, by itself, would not constrain ASAT development, testing, or deployment.

If the risks are acceptable in view of (1) the benefits of restraint, and (2) the options available to the United States to offset the consequences of breakout, then verification requirements can be considered satisfied.

Verification standards should take into account these trade-offs between uncertainty and risk, plus the impact of a high-certitude approach to monitoring on the "false alarm" rate.

As monitoring requirements become more refined, requiring that monitoring instruments distinguish increasingly detailed shades of difference between types of objects or events, the probability of false detection of violations will increase. Judges will need to discriminate increasingly fine differences in the data, and their false positive rate will also tend to rise. Whether these indications are filtered out of the verification process or reach the political level depends in part on the climate of political relations between the treaty parties, which influences both expectations of performance and interpretations given particular data. On the other hand, a high false alarm rate generated by an effort to miss no potentially significant datum can itself strain relations and undermine an agreement. For further discussion of these questions, see Meyer [19].

## Approaches to ASAT Arms Control

The discussion of three approaches to control of ASAT means will be followed by a discussion of an ASAT "non-use" agreement that might supplement any of the three. Whether some of the approaches might also benefit from the specification of cooperative measures will also be examined.

Ban Weapons for Damaging or Destroying Space Objects

A ban on weapons for damaging or destroying space objects would incorporate prohibitions on development and testing of any weapon designed for or dedicated to that mission. This appears to be a goal of the August 22, 1983 Soviet draft treaty on space weapons submitted to the UN.[6] The approach would also require dismantlement of any existing direct-attack ASAT capabilities. Such an across-the-board ban establishes a "balance" that is easiest to view as equitable. It does not require counting or monitoring of performance limits. It does not limit residual ASAT capabilities or non-destructive ASAT means.

An immediate negotiating task (for this approach, and for the others) is the definition of capabilities to be limited by the agreement. It is desirable that the approach only ban possession of "dedicated" ASAT systems, that is, systems whose primary mission is the damage or destruction of space objects. Residual ASAT capability, including capability to "displace" a space object, is better addressed in the context of a ban on ASAT testing or use (see below).

Directed energy weapons may present a particular definitional difficulty (or opportunity, depending upon one's perspective). The ABM Treaty does not prohibit development and testing of fixed, ground-based laser ABM components (though it does prohibit the deployment of such components). Because such components at test ranges would very likely have significant ASAT capability, however, and could be physically and operationally indistinguishable from ASAT lasers, a ban on ASAT possession could be interpreted to prohibit development and testing of all laser weapons, including those which are fixed, ground-based and under development for ABM purposes.

It would be desirable that the definition of ASAT weapons encompass future as well as present systems. Defining ASATs in terms of specific performance criteria could create problems with respect to restraining future ASAT capabilities. A possible way around that definitional problem might be a side agreement (modeled after the agreed statements in SALT) that one party would dismantle system X and the other party would dismantle system Y without prejudice as to whether these systems constitute the universe of possible dedicated ASAT systems. Dismantling procedures would be worked out in a consultative mechanism (see below). Such an approach may argue for the existence of an operational US ASAT system to trade, but not necessarily. The Soviet-proposed joint moratorium on space-testing of ASATs is consistent with the hypothesis that the US F-15/MV program (and the "star wars" research initiatives) provide adequate bargaining leverage at current stages of development.[29] Yet the Soviet tendency to balance action for action and charge for charge suggests that the US would need to have something to toss into the bonfire; dismantling whatever remains of the Thor launch facilities on Johnston Island, under agreed procedures, might meet that requirement for the appearance of symmetry.

How existing capabilities are to be dismantled is a third problem, however. The current Soviet interceptor is launched by the same booster (F-1-m) used for RORSAT and EORSAT missions. Since the inclinations of all these missions are all essentially $65^{\circ}$, and Congressional reports suggest that Soviet launch practices specialize launch pads for particular inclinations, it is not unreasonable to assume that all share the same Tyuratam launch site and launch control facilities as well.[35] Thus dismantling the Soviet ASAT would also dismantle the RORSAT/ EORSAT program, a capability that the Soviets are not likely to give up, but one which the United States probably would not mind seeing dismantled. On the other hand, the US probably would not be inclined to give up commensurate capabilities if the USSR were to offer such an exchange. If the complete launch facility were not dismantled, on-site storage of ASAT payloads probably would not be monitorable by NTMs, inasmuch as non-ASAT payloads may require similar launch site storage and ready buildings.

There are two mitigating factors here. First, cooperative measures might make the task of monitoring Soviet dismantlement somewhat easier (inspection regimes are discussed below). Second, the risk to US security interests posed by a worst case scenario under a zero-possession regime (covert storage of interceptors) must be weighed against the risks posed by the no-limits case, as discussed above. The current Soviet ASAT is of limited capability; and the military utility of covertly retained ASAT vehicles would decline over time for lack of testing and troop training. Covert tests with an SS-9-size booster and an interceptor of known characteristics weighing several tons would be difficult.

Ban Tests of ASATs in Space or Against Space Objects

A test ban would not prohibit possession of ASAT means, nor testing in the lab or, presumably, in the atmosphere. It would be designed to erode confidence in existing ASAT capabilities over time by increasing uncertainty about hardware reliability, adequacy of software, and proficiency of operators. It would therefore aim at establishing a "balance" in effective ASAT capabilities over time without specifically requiring dismantlement of any current system. If established after a US space-test program with the MV system, the effect would be equivalent to a "one current type" limit (see below) with an added testing constraint -- both sides' systems would sit on the shelf until and unless used in conflict, without benefit of recent test launches into space or against space targets.

In its latest series of ASAT tests, the USSR has had only mixed success, less than 50% overall and reportedly zero successes with a new homing sensor.[15] With that track record, Soviet confidence in the ability of their system to operate successfully on its first mission against an uncooperative satellite, at an untried inclination, after a long testing drought, could be low, depending on the purposes of the tests that failed, and the nature of the reasons for the failures. Experience with the poor performance of the new ASAT sensor also would not encourage Soviet planners to expect that covertly-accomplished system upgrades would perform as designed upon first launch in a crisis.

Quantity can to some extent make up for qualitative shortcomings. There are two launch pads suitable for the current Soviet ASAT system at Tyuratam[42], although the Soviets have never attempted to control more than one ASAT at a time. Indeed, until the large mid-summer 1982 strategic exercise, apparently no other space launches while an ASAT mission was in progress.[15:1982] A system configured like the F-15/MV, on the other hand, would be more capable of multiple launch and shoot-look-shoot strategies, given adequate spacetrack.* That potential capability would be offset by the limited amount of testing that the system would have had should an ASAT test moratorium go into effect in the next year or so.

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* Shoot-look-shoot for ASAT would involve either spacing interceptors along the target's ground track, with spacetrack facilities for damage assessment located between them, or attacking the target on successive orbital passes, shifting interceptors to account for precession of the orbit. The latter approach would give spacetrack more time and opportunity to detect changes in the target's visible light or infrared image, tumbling, or the presence of debris in its expected location, any of which could indicate ASAT impact.

The Space Detection and Tracking System (SPADATS) includes radars in the Philippines and on Kwajalein (the "Pacific Barrier"); also radars in Hawaii, Massachusetts, Florida, Antigua, Ascension Island, and Turkey; plus optical tracking (Baker-Nunn cameras) in California, New Mexico, New Brunswick, Italy, South Korea, New Zealand and Hawaii. This system is supplemented by the Perimeter Acquisition Radar Attack Characterization System (PARCS) in North Dakota, and the Cobra Dane radar on Shemya Island in the Aleutians, plus the NAVSPASUR radars in the southeastern US. It is to be further supplemented by the Ground-based Electro Optical Deep Space Surveillance System (GEODSS) located in South Korea, Hawaii, New Mexico and aboard two mobile stations, in the South Atlantic and Indian Oceans. Source: <u>The Military Balance 1983-84</u> (London: IISS).

If a test ban refers only to tests "in space or against space objects," it may become important to reach a common definition of "space." Up to the present, no boundary between sovereign national airspace and outer space has been incorporated into international law. The USSR has suggested, in the United Nations, that the upper bound of national airspace be set at 100-110 km. But the perigees of elliptical orbits associated in Congressional and other listings with "close look" reconnaissance satellites approach that altitude. A cooperative U.S.-Italian space shuttle experiment will winch a tethered sub-satellite down to roughly 100 km. Future reusable orbital transfer vehicles that brake in the atmosphere upon return from high orbit may also breach that altitude. Reusable space vehicles transition from orbital to aerodynamic flight as they reenter for landing. These are reasons to leave the region of transition from "air" to "space" undefined; indeed, a boundary could only be an artificial construct, since the atmosphere does not end but approaches a limit that is the near-vacuum of deep space.

If "space" is undefined, however, ASAT tests might be conducted at high altitude but short of a unilaterally-defined threshold of "space." Such actions would clearly undermine an ASAT agreement yet remain within its letter, and the USSR has indicated by various means and at various times that its actions are constrained by the letter, not the spirit, of agreements.[26] On the other hand, it would be easier to test a direct ascent system at altitudes below 100 km (against hypersonic high altitude drones, for example) than it would be to test the current Soviet ASAT in such a manner. In a normal test, the Soviet launch vehicle would climb above 100 km before second stage burnout and payload separation. In a depressed trajectory test resulting in a less-than-100 km orbit, the interceptor would have little or no opportunity to home on a target -- atmospheric drag would cause both it and its target to reenter in short order.

If tests of ASAT weapons were banned, there would be concern that non-ASAT weapons or other space vehicles might be tested or configured for ASAT use. The ABM Treaty, with its tight restrictions on ABM weapons, confronted this same issue and coped with it by banning tests of other systems "in an ABM mode." An ASAT accord might require a comparable restriction, though there is the added complication that the profile of an ASAT attack may more closely resemble other non-ASAT activities than, for example, an ABM intercept resembles air defense. One case, as noted previously, would be automated orbital resupply capabilities. However, such non-ASAT systems may not add measurably to the ASAT threat under a ban on ASAT tests (or possession); satellite survivability measures adequate to cope with the residual threat posed by an untested Soviet kinetic ASAT are likely to be able to cope with the residual threat posed by other capabilities untested "in an ASAT mode."

In the case of directed energy weapons (assuming a test ban is not part of a ban on possession), the ABM Treaty would confine their testing to specified ABM test ranges, which would limit their flexibility and utility as ASAT weapons. A ban on testing such weapons against space objects (ie, "in an ASAT mode") would serve to undercut the gathering of test data on brightness and dwell times needed to reliably effect damage to space objects, particularly those in high orbits (where damage assessment would be more problematic than for objects in low earth orbit).

A test ban could stand on its own, or be buttressed by a possession ban (previously discussed), a no-further-deployment agreement, or a non-use agreement.

### Permit One Current Type or One Generic Type ASAT

This approach defines the upper bounds of ASAT capability by allowing certain types of antisatellite systems but prohibiting the development of others. In essence, it concedes low earth orbit but seeks to confine ASAT capabilities to that region, with satellites in such orbits protected by other agreements (the ABM Treaty for NTMs, and perhaps a non-use agreement to cover other satellites). It would allow both superpowers to retain means of destroying space objects in low orbit considered hostile. Current-type ocean surveillance satellites, for example, would remain within ASAT range. Its potential impact on crisis stability, then, would not be as great as an outright ban, but potential targets of high value, such as early warning and communications satellites, would remain out of range.

A "one current type" approach would permit, but ban further modernization of, current ASAT interceptors, where "current" includes the US F-15/MV system. Thus it allows the US a system that may be more capable than the Soviets' in terms of sheer performance. Yet, as noted, the relevant comparison is not ASAT to ASAT, but ASAT to target list, within scenarios, and the US target list tends to be longer and more robust, by dint of the number of Soviet satellites potentially within range and the possible Soviet wartime reconstitution rate. Moreover, the USSR may be more concerned with possible future US systems than with the F-15/MV per se. Should Soviet interest in an ASAT accord remain high after US space testing commenced, then this hypothesis would gather strength.

A "one generic type" approach would differ by setting common performance standards that treaty-permitted ASAT weapons could not exceed. Within those standards, the sides could modernize or change systems. The standards could specify attack modes, technologies (eg, types of sensors), or altitude capability. Modernization of the Soviet ASAT would be permitted, for example, or the US would be permitted to develop a substitute system if the

MV for some reason failed to meet operational requirements, provided the new system fell within specified limits.

The tendency under the "generic" approach would be to set performance ceilings equivalent to whatever systems were on the drawing boards on either side. The two sides could spend much negotiating time and energy trying to smoke out the other side's expected next generation capability while trying to protect their own. Alternatively, the performance standards set under the agreement could be set higher than either expects to reach over the succeeding five years or so. Thus the "generic" approach could encourage less, rather than more, restraint.

Common performance may not be a good criterion to use, for the reasons listed previously. Any attempt to negotiate asymmetric limits, on other hand, would likely run into technical problems at the table and, if those were overcome, problems in selling an agreement to the Congress which, on its face, may appear "imbalanced."

The "generic" approach also poses verification problems. It would always be possible, for example, to test a new system at less than its full potential (though rough estimates of that potential could be made from size of booster, size of payload, evidence of plane shifting or terminal maneuvering, etc.). It could also be difficult to tell whether older ASAT systems were in fact being traded in for newer ones or retained in the inventory -- the dismantlement problem discussed above. Finally, the type of ASAT permitted would have to be kinetic, else the concept of an altitude cap would have little meaning. Because of its ready access to power, the lethal range of a ground-based laser ASAT could probably extend beyond low earth orbit, and an ASAT based in low orbit could be made to illuminate geosynchronous satellites, since its damage mechanism can be made to work over greater distances by increasing the per-target dwell time and/or allowing greater beam spreading to reduce pointing and tracking requirements. (Dwell time would be constrained to that fraction of the weapon's orbit where the geosynchronous target was in view -- 45 minutes per revolution at most. Two or three weapons would be needed for continuous coverage. A ground-based laser, on the other hand, would have continuous coverage of an arc of the geosynchronous orbit, weather permitting.)

If it did ban directed-energy weapons (including developmental ABM weapons, as discussed previously), the "one...type" approach would create a "safe zone" for satellites beyond low earth orbit, and newer generations of military satellites might tend to be moved out to that zone. Efficient photo reconnaissance would still demand low orbits, but that capability is basically strategic, necessary for continual peacetime monitoring of force levels and trends and compliance with arms control agreements. In wartime, space-based reconnaissance would be useful for monitoring troop movements in the deep rear areas, but closer to the fighting front other means would provide nearer real-time tactical reconnaissance to field commanders. Moreover, non-space means, such as drone or piloted aircraft, which would be impolitic or impossible to use in peacetime (because of the violation of sovereignty and lack of air defense suppression, respectively), could be used for wartime strategic reconnaissance. Keeping photo satellites in low orbit thus would not run much risk of loss when they are of greatest military utility. For satellites in higher orbits with greater potential tactical wartime utility (for example, communications or navigation), a "current type" approach in particular could, over time, buy most of the benefits of a more comprehensive ban on ASAT possession, without incurring the verification liabilities.

The major negotiability question, again, would be whether both sides viewed the approach as meeting their respective objectives. If the major objective of the United States is to maintain a basic antisatellite capability, and the objective of the Soviet Union is to prevent the deployment of space-based weapons, then the objectives of both sides might be satisfied. On the other hand, questions of "balance" may intrude to pose considerable negotiating problems.

A "current type" approach would be similar in philosophy to the approach taken in SALT II, that is, capping existing inventories at roughly existing levels. A good deal of the criticism levelled at arms control over the past decade, however, has had to do with such "ratification" of existing force plans. In the case of ASAT, where substantial direct-attack capabilities do not yet exist, it may be argued that a "current type" approach actually sanctions the acquisition of forces. On the other hand, a "current type" approach would support the objectives suggested for an ASAT arms control regime. It would serve to head off more destabilizing future weapon developments, while helping safeguard high-alitude space-based $C^3$ functions. It could reduce outlays for ASAT R&D, and it would reinforce the ABM Treaty to the extent that it prohibited development of directed energy ASAT weapons and multiple-warhead kinetic ASATs.

It would not achieve any of these arms control objectives, however, as well as a near-term ASAT test ban, with or without a corrollary ban on possession of ASAT means.

Ban the Use of ASATs in a Rules of the Road Agreement

Without some type of limit on means, this approach would offer at best tenuous protection to satellites in periods of conflict, but it could work to reduce the probability of provocative actions during peacetime or crisis, and reduce misunderstandings or miscalculations about the other side's actions in space. A "rules of the road" agreement could be modelled on the US-Soviet

Incidents at Sea agreement of May 1972. In addition to banning actions intended to damage, destroy or displace space objects, it could specify other types of behavior in space or with respect to space objects that are to be prohibited. Unauthorized "close approaches" might be treated in that way. The agreement could specify keep-out zones to increase response times to the mine threat (which no agreement could fully eliminate) by providing early indications of attack.

A keep-out zone could be difficult to enforce, however. Zones large enough to buffer their satellites against energetic mines (a mine with 1 km/sec $\Delta V$ could cross a separation distance of 1800 km in about 30 minutes) could prove very unwieldy if applied to most satellites -- creating moving bubbles of sovereignty which could make technical violations hard to avoid. With a high false alarm rate, the intent of the zone would be diluted. Moreover, current ground-based spacetrack systems, although global in coverage, cannot watch all space objects all of the time. When the Payload Assist Modules failed during the tenth space shuttle mission, several hours passed before the misplaced satellites were located. If an important satellite were found to have a dark companion where no companion was supposed to be, that satellite's owner may have limited options (see, however, the discussion of space inspection, below).

Suggesting close approach as an impermissible activity for space objects could, however, open negotiations to inclusion of other "impermissible" or "hostile" activities. It could open up a number of areas, like the legitimacy of space reconnaissance or the air-space boundary, that have never been specifically resolved but which do not now cause major problems in the use of space. Second, the negotiation of impermissible activities may appear to sanction countermeasures, including destructive countermeasures, should those activities occur. Third, negotiating impermissible activities may encourage "fishing expeditions" seeking mission definitions for satellites suspected to have intelligence functions (such expeditions would be deterred to the extent that both sides have systems which they would prefer not to identify).

If, however, the only impermissible activity defined is "damaging, destroying or deliberately displacing [changing the trajectory of]" another state's space object(s), then a non-use agreement provides a mode of defining ASAT activities in operational terms. Limits on ASAT means might define ASATs in complementary terms, as weapons designed primarily to damage or destroy space objects.

## Cooperative Measures

In theory, monitoring compliance with an ASAT arms control might be advanced by cooperative measures designed to supplement

National Technical Means. These could include arrangements governing launch of satellites, inspection regimes, and standing arrangements to work out details of implementation and to consult on compliance issues.

Launch Constraints

An ASAT agreement could specify procedures for launching spacecraft that would make their use as ASATs more difficult (or, if contravened, clearly signal a violation of the agreement). An example would be a requirement not to launch a satellite within two degrees of the orbital inclination and right ascension of another state's satellite. Such requirements may place a heavy burden on spacetrack, and serve to narrow satellite launch windows. On the other hand, access to and use of space is bound to become more constrained as space becomes more heavily used. Just as there are sealanes in busy international straits, there are already minimum separation distances, for purposes of electronic non-interference, in geosynchronous orbit. This orbit is a special case, but it illustrates the point.

Inspection Regimes

On site inspection (OSI) was at one time a standard feature of US proposals in arms control and disarmament. With the advent of NTMs, space-based reconnaissance in particular, the requirement for OSI became less siginificant for many treaties, though in some cases on site inspection is still deemed necessary to monitor compliance. The USSR historically has been resistant to the idea, though it has complied with the on site inspection provisions of the Antarctic Treaty, and in 1980 was willing to have certain on site inspection provisions written into a comprehensive test ban treaty, and in early 1984 offered some limited concessions on inspection of chemical weapons facilities in connection with an agreement stipulating destruction of stockpiles. In the case of ASAT, given problems with verifying dismantlement and the potential for launching weapons (that is, space mines) in the guise of spares for other satellites, launch site and/or payload inspection may be thought to have particular utility, but there are clear problems.

Ad hoc inspections limited to launch sites and their immediate vicinity (whether or not such inspections are subject to veto by the inspected party) would be unlikely to uncover treaty violations because activities in violation of treaty provisions (for example, production and storage of boosters or prohibited payloads) could be undertaken off-site. On the other hand, launch-site OSI would deter stockpiling of ASATs, or mating of ASATs and boosters, at the launch site. This would reduce capabilities for rapid launch of the current Soviet ASAT. It would also be important to designate permitted launch sites, moreover, so that activities detected off-site by means other than OSI could be subject to challenge in consultative channels.

Neither side would want to allow the other the option of engaging in intelligence "fishing expeditions," and this would necessitate prior agreement on the specifications of the inspecting equipment and the procedures used by designated inspection personnel. If agreement could be reached on these difficult issues, there could remain the problem of targetting OSIs. In the Soviet case, this would involve "F" booster launch sites; in the US case, it could conceivably involve every airfield at which F-15s are based or from which they operate. The small size of the US ASAT would make off-site storage and rapid transport to bases relatively straightforward. Thus the value of launch site OSI to Soviet monitoring procedures (under a "current types" regime, for example) could be marginal.

If inspection rights were not confined to launch sites, the potential for harassment would be greater and the US would face the problem that inspection practices might clash with domestic laws and basic constitutional guarantees (for example, could Soviet inspectors be granted warrants to search private contractors' premises for contraband missile production? What would constitute probable cause?). An inspection quota could reduce the proportion of nuisance inspections, but would not eliminate the extraneous prying problem. That problem would tend to make the parties resistant to inspection, which could in turn raise suspicions, create grounds for charges of cheating or, indeed, encourage creation of "potemkin violations" to exhaust the other side's inspection quota. On the other hand, if inspections were not confined to launch sites, the utility of off-site cheating would decline.

If the inspectee had the right to veto inspections, there would be no chance that the inspections which were undertaken would find anything of consequence. Such "challenge" inspections would, at best, serve to reinforce suspicions that the party thwarting inspection really had something to hide (which might in some cases be an important objective of policy).

Space inspection is another approach. The Outer Space and Antarctic treaty regimes provide for in situ inspection of installations, facilities and equipment. In the former case, all such installations on the Moon or other celestial bodies (but not in space) are to be open to representatives of other States Parties on the basis of reciprocity, upon "reasonable notice." In the latter case, inspections are specifically provided for, and all installations are to be "open at all times" to designated inspectors who are to have "complete freedom of access at any time to any and all parts of Antarctica." [30]

Such an inspection regime might be appropriate for space if the environment was to be demilitarized. However, the sorts of limited measures contemplated in this report would be designed in part to safeguard, not eliminate, other military uses of space. Moreover, there is little point to negotiating a procedure that could readily be undertaken unilaterally as an NTM function directed toward space objects rather than the surface of the earth. If there is concern that attacks might be masked by inspection missions, a keep-out zone arrangment as part of an ASAT agreement would tend to reduce the problem if coupled to a two-key inspection system.

A two-key space inspection system may provide future recourse for the space mine problem. A dark satellite detected within another satellite's keep-out zone or in an orbit which routinely intersected that zone could be subject to close inspection if not identified and its orbit shifted by its operator. Close inspection could be accomplished by means of teleoperated maneuvering systems (TMS) similar to the orbital transfer vehicles contemplated for NASA's space station complex. Inspections would be requested by the infringed party and the TMS could be operated by a technically competent third party not allied militarily with either superpower or, perhaps, operated by a joint US-Soviet team. This system would assure that "inspections" did not serve as pretexts to eyeball sensitive satellites at close range, nor end up being conducted by the owners of the infringing spacecraft. If, as space launch capabilities grow, rogue mines become a serious problem, the TMS may be equipped as a mine sweeper, with carefully negotiated and closely controlled capabilities to disable such rogue spacecraft.

Such an inspection system may seem farfetched but in its technical requirements it is far less demanding than an automated, orbiting laser battle station. It does require some international cooperation, and a recognition that countries other than the United States and the Soviet Union have an increasing stake in the stability and security of the regime of outer space. But this is only recognizing the inevitable.

Clearly, no control regime could be sustained in the face of more than occasional mine incidents, if those objects were traceable to a source (with improved spacetrack capabilities, especially space-based, such tracing should be feasible). Nor would even a modest mine-clearing capability be useful against a deliberate mine-seeding effort that used multiple-satellite launches. Such an overt attempt at blackmail would, however, destroy the element of surprise that "dark" space mines are conjectured to pose and could trigger an immediate international crisis encompassing threats of terrestrial reprisals unless mines were moved away from their potential targets and detonated.

Finally, no control regime could (or should) eliminate all satellite self-destruct capabilities. Destructive charges can protect sensitive equipment from falling into the wrong hands, for example. Satellites at the end of their operational life could thus, theoretically, be held in reserve as mines. This may be a further source of residual ASAT capability. Such objects could be required by law, however, to deorbit, fragment and reenter.

### Automated Monitors

In monitoring regimes where proximity is crucial to picking up a signal (for example, in the case of International Atomic Energy Agency safeguards for nuclear fuel cycles or in the case of seismic detection of nuclear tests) automated systems may be more reliable and less intrusive than on site inspections involving people directly. Black boxes stay in one place and their monitoring is continuous; if the regime has been carefully designed, the party on whose soil or in whose facilities they rest need not be concerned about extraneous intelligence collection.

In the case of an ASAT regime, automated monitoring may have some limited utility. If the objective were to ascertain, for example, that a facility agreed to be shut down was indeed shut down (for example, a launch pad or a ground-based laser facility), then heat, motion and light sensors might accomplish the task. If the problem were to ascertain which if any of several similarly-sized and similarly-shrouded payloads in a ready facility were prohibited items, then automated sensors would not help.

### Consultative Mechanisms

Any ASAT agreement would be helped by the existence of a mechanism to which either side could have recourse to hammer out details of implementation or to challenge suspected treaty violations. The Standing Consultative Commission serves this function for US-Soviet strategic arms control agreements. The Incidents at Sea Agreement of 1972 sanctions protests through embassies, with annual meetings to review the year's record and improve implementation.[12]

The value of such channels for raising questions about practices uncovered by monitoring means should not be dismissed. A formal agreement legitimizes questioning which would be brushed aside by the USSR under other circumstances. Because such consultative mechanisms provide routine channels for grievances, problems can be addressed out of the political limelight, where they are more likely to be resolved than if first breached in public, necessitating a public reply and the requisite political posturing.

## LEGAL MATTERS

An ASAT agreement would not be negotiated in a legal vacuum. There are precedents relevant to such an agreement to be found in existing international law, and important issues related to categories of space objects that would be covered by an agreement.

### Current Space Law

The United Nations Charter applies to activities in space. Article 2(4) bids states to refrain from the "threat or use of force," while Article 51 permits individual or collective self-defense. In addition, over the past twenty years a number of bilateral and multilateral agreements have addressed aspects of the use of space for military purposes. Space is one of the environments in which nuclear test explosions are prohibited by the Limited Test Ban Treaty of 1963 (Art. I). The Outer Space Treaty of 1967 prohibits placing nuclear weapons or other weapons of mass destruction in orbit around the earth, or "stationing" them in space in any other manner, or installing weapons of any kind on the moon or other celestial bodies (Art. IV). The ABM Treaty of 1972, as noted, prohibits the development, testing, or deployment of space-based ABM systems or components; and the Environmental Modification Convention of 1977 forbids the "military or any other hostile use," in space among other environments, of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to any other State party (Arts. I and II). [30]

The Outer Space Treaty reserves the Moon and other celestial bodies "exclusively for peaceful purposes," but neither defines that wording nor applies it to outer space per se. The United States has consistently interpreted "peaceful" in this context to mean "non-aggressive," an interpretation that allows any military activity not involving the use of force to achieve some prohibited objective. The Soviet Union has officially interpreted "peaceful" in this context to mean "non-military." Soviet legal scholars acknowledge that the Outer Space Treaty does not so limit the use of space today. Reserving space "exclusively for peaceful purposes" remains a declaratory objective of Soviet space policy, but in practical terms that objective has become focused on forbiding the stationing of weapons in space and the threat or use of force in or from space (see discussion of the 1983 Soviet draft treaty, below).

Current international law also addresses, to some extent, the question of interference with spacecraft operation. The Outer Space Treaty (Art. IX) requires signatories to undertake international consultation before proceeding with any activity in space which "would cause potentially harmful interference" with other signatories' activities in the "peaceful exploration and use" of space, but there is no specific ban on interference.

Among US-Soviet agreements, the Measures Agreement of 1971 (Art. III) provides for consultation in the event that either party detects interference with its missile early warning systems or related communications, though it does not prohibit interference per se. The ABM Treaty (Art. XII) prohibits interference with National Technical Means of verification used to monitor treaty compliance in a manner "consistent with generally recognized principles of international law" (the SALT I Interim Agreement and the unratified SALT II agreement contain identical language).

Interference, as used in these agreements, may be understood to encompass both damaging and non-damaging measures, that is, not only interception but such actions as jamming, sensor blinding, and spurious commands. None of these agreements addresses possible means of interference. Where interference is prohibited, however, an agreement provides grounds, and can provide specific channels, for protest.

There is no current international limitation on the testing of non-nuclear anti-satellite weapons against space objects (provided that testing is not against another state's object). Domestically, however, the Tsongas Amendment to PL 98-94 (section 1235), prohibited tests of ASAT "warheads" against objects "in space," except where the President certified that he is

> "endeavoring in good faith to negotiate with the Soviet Union a mutual and verifiable ban on anti-satellite weapons; and . . . that pending agreement on such a ban, testing of explosive or inert anti-satellite warheads against objects in space by the United States is necessary to avert clear and irrevocable harm to the national security.

The Amendment does not prohibit tests directed at unoccupied points in space and Sen. Tsongas stated during Senate floor debate that an expression of willingness on the part of the President to negotiate an ASAT ban would satisfy the "endeavoring in good faith to negotiate" criterion.[39]

In August 1983, the USSR informally proposed a moratorium on testing of ASAT pending the start of ASAT negotiations.[29] In late May 1983, the House of Representatives voted to prohibit testing "of the space defense system (antisatellite weapons) against an object in space" unless the President certifies to the Congress that the Soviet Union has resumed testing of a "dedicated antisatellite weapon."[33] The Senate adopted a much more complex formula that carries forward and to some extent strengthens the 1984 language on ASAT testing. Added to it was a requirement for a report to the Congress on Soviet ASAT programs, U.S. space system survivability programs, verifiability of ASAT arms control measures in light of programmed reductions in the vulnerability of U.S. satellites, and specific ASAT arms control measures that the administration is prepared to endorse.[40] As of this writing, Congressional conferees have not reached agreement on joint language.

Should the United States choose to respond positively to the Soviet ASAT test moratorium offer, there are legal considerations adhering to the mode of response. The offer could be adopted tacitly and de facto by the United States, or adopted publicly on a qualified basis (as in the case of the qualified statement of continued US adherence to the SALT I Interim Agreement in 1977), without entailing requirements for legislative authorization under the Arms Control and Disarmament Act. In weighing whether to make a public announcement in the matter of a test moratorium, the Nuclear Test Cases of 1974 would also be relevant. In these cases, the International Court of Justice held that unilateral public statements which promised a halt to atmospheric nuclear testing bound the government of France internationally to carry out its declared intent.[13]

## The Question of Coverage

Coverage refers to the categories of space objects to which an ASAT agreement would apply. Arms control negotiations do not normally include definitions of the types or locations of targets at which the objects of negotiation could or would be aimed. In the case of ASAT, however, previous negotiations reportedly contemplated limiting coverage of a non-use agreement to those space objects in which either party had an "interest," a formulation that would encompass satellites used by the parties jointly with other states (for example, NATO communications satellites. The USSR apparently also wished to limit coverage to those space objects not engaged in "hostile" acts.[10]

Coverage limitation poses a number of problems. Because explicit prohibitions against attacking space objects would apply only to certain classes of those objects, the agreement may be interpreted by a party implicitly to sanction the use of force against space objects not belonging to those classes. The case of the USSR and China may serve as an example.

The USSR may attend to potential Chinese military space activities in a way that parallels its attention to the Soviet-Chinese border -- that is, more than Western analysis of China's relative military capabilities would consider warranted. There is circumstantial evidence to support this view. Soviet ASAT tests follow orbital parameters not too different from those of Chinese satellites launched in 1975-76, some of which have been identified in public sources with photo reconnaissance missions. Tests resumed, following a four-year hiatus, only three months after a Chinese satellite first returned a capsule to earth. Soviet ASAT tests do not match US satellites' orbital parameters nearly as closely.[15]

This potential negotiating problem may have been reduced by China's ratification of the Outer Space Treaty in December 1983.

Limiting depth of coverage to space objects operating in accordance with "generally recognized principles of international law" or other treaty-specified criteria also runs the risk of transforming an agreement controlling ASAT into an agreement specifying appropriate behavior for space objects, that is, an agreement not only about activities forbidden, but about activities permitted. Such language could invite future problems with respect to new types of activities, new space technologies, or the specific missions of particular satellites.

THE AUGUST 1983 SOVIET DRAFT TREATY

Do present Soviet positions provide any realistic basis for negotiation? The August 1983 Soviet "Draft Treaty on Banning the Use of Force in Space and From Space with Respect to the Earth" is a much different document than the draft treaty submitted two years before. The earlier document did not address ASAT testing (indeed, did not address ground-to-space systems at all); admonished Parties to use space objects "in strict accordance with international law"; and limited its ban on the use of force against space objects to those objects not carrying "weapons of any kind." Moreover, its coverage extended only to the space objects of the states party to the agreement. In short, it was a defective and perhaps not serious proposal.

The same cannot be said for the 1983 draft treaty, which borrows and modifies language from the preamble of the Outer Space Treaty. In the preamble of the Soviet draft, the parties express their desire "to contribute to the objective whereby the exploration and use of space . . . is effected exclusively for peaceful purposes." The draft does not otherwise propose actually to reserve outer space for peaceful purposes. By aspiring to a goal, rather than seeking to prescribe a status for space, this approach finesses problems of differing national interpretations without abandoning the "peaceful purposes" language, and maintains a conceptual link to the Outer Space Treaty.

The 1983 draft does incorporate a test ban and calls for elimination of anti-satellite systems already in signatories' possession. It does not restrict breadth of coverage, nor does it limit depth of coverage by setting behavioral criteria for space objects. Prohibitions on the threat or use of force against space objects, or against terrestrial targets from space, are unconditional. Clearly, not all of the proposals contained in the draft, nor all of its specific language, would be acceptable in an ASAT agreement. For example, Article VI of the draft appears to reach back as far as the 1946 Gromyko Plan (the Soviet response to the Baruch Plan for UN control of nuclear weapons technology) for a unilateral enforcement mechanism to supplement National technical means. Thus Article 6 states,

> Each state party to this treaty undertakes to adopt any internal measures which it considers necessary in accordance with its constitutional procedures to prohibit and prevent any activity contravening the provisions of this treaty which comes under its jurisdiction or control, wherever it may be.

Article III of the Gromyko Plan of 1946 stated:

> The high contracting parties shall... pass legislation providing for severe penalties for violators of the statutes of the present convention.[7]

The emphasis on internal enforcement measures in the current treaty draft is curious, but may be an effort to ensure that state parties apply its provisions to non-state actions under their jurisdiction who make use of space. Article II[5] limits testing and use of "any manned spacecraft" for "military, including antisatellite, purposes." Such a formulation clearly would be unacceptable as it would prohibit use of the space shuttle for the launch of military payloads (and, for that matter, eliminate the Salyut system, which has been used for military observation purposes).[15,42]

Moreover, in seeking to prohibit the threat or use of force in space or from space with respect to the earth, the 1983 Soviet draft is more encompassing than an antisatellite agreement needs to be. On the other hand, its language closely parallels that of the UN Charter (Art. II[4], noted above). Thus it may be argued that the Soviet draft merely reiterates obligations already binding on UN member states; it may also be argued equally, for that very reason, that the language is redundant and unnecesssary.

On the whole, the 1983 Soviet draft is a much different and more serious proposal than its predecessor. If public accounts are reasonably accurate, it also reflects considerable evolution of the Soviet approach to this subject since the last US-Soviet bilateral talks in June 1979.

## CONCLUSIONS AND OPTIONS FOR POLICY

It is the conclusion of this study that arms control for antisatellite weapons can support United States security interests. It must be emphasized that arms control measures are not panaceas and are no substitute for programs to enhance satellite survivability and to monitor Soviet activities with respect to space. Yet survivability measures backed up by an arms control regime will, other things being equal, afford better protection to US satellites than the same measures enacted in the context of an unconstrained weapons competition. Monitoring, moreover, can afford to be no less rigorous in the unconstrained case than under an arms control regime. Missing significant and relevant activities in either case can mean the future emergence of an unanticipated threat. Yet different standards are often applied to the two cases.

In the unconstrained case, monitoring is called upon to indicate threat; in the case of arms control it is asked to demonstrate compliance, that is, to prove the absence of threat. Proving a negative is a logical impossibility and to that extent monitoring is called upon to perform an impossible task. The verification process will always be based on incomplete monitoring data, as is virtually every other intelligence assessment. Core concerns, rather, should be (1) whether the agreement halts the development of threats likely to have materialized in its absence and, (2) whether significant threats to US security and/or to the integrity of the agreement can arise undetected, for which timely countermeasures cannot be taken.

High standards of verification arguably address the second of these concerns, combating the "lulling" effect of arms control, the erosion of the perceived need to keep one's powder dry. It seems clear, however, that excessively high standards can generate a high false positive rate with respect to compliance questions, in an effort not to miss any potential violations, however ambiguous. Such efforts may undermine policymakers' confidence in the means of monitoring, or their confidence in other parties' compliance, when such erosion is unwarranted.

The standards of verification suggested for ASAT arms control in this study seek to take into account the concerns listed above. Some approaches clearly pose difficulties for verification. In the limiting case, verification difficulty could be so severe as to leave one or both parties able to violate the terms of an agreement with relative impunity. Such agreements are clearly unwise if either party has any incentive to violate; and potential incentives are not always clear, and they may change over time. In other than the limiting case, verification uncertainties must be measured against the risk posed by undetected cheating, against the costs of the wholly unconstrained case, and against other arms control approaches.

Any ASAT arms control approach is necessarily limited in its scope, and it is important to catalog those limitations before proceeding to a list of policy options:

1. No ASAT agreement will eliminate non-destructive means of frustrating the mission of satellites (though an agreement might serve to deter their use).

2. No ASAT agreement will eliminate the nuclear threat to space objects posed by strategic ballistic missiles (thus ASAT arms control is a means of affecting the likelihood and the course of conflict only below the nuclear threshold).

3. No ASAT agreement will remove all antisatellite capability (though it can place a ceiling on such capabilities).

4. No ASAT agreement would be meaningful in the context of ABM Treaty termination (that is, ABM capabilities, particularly those designed for exo-atmospheric interception or basing, incorporate ASAT capabilities).

With these caveats in mind, let us review several combinations of objectives and options for ASAT arms control, drawing on the discussions in the previous sections. All of these options assume that the object of arms control is the limitation, in some fashion, of dedicated, direct attack ASAT capabilities, and all assume that negotiations would be bilateral, at least initially.

<u>If the objective of policy is to eliminate all dedicated, direct attack ASAT capabilities</u>, options for arms control would include, (a) a zero-possession regime coupled with a test ban, and (b) a test ban only, of indefinite duration. Option (a) entails verification of the dismantlement or equivalent decommissioning of the current Soviet co-planar ASAT capability, which may be difficult. An accompanying test ban and launch site inspection regime would seek to reduce Soviet confidence in covertly-retained interceptors, and to increase the amount of time required to use such interceptors, respectively. Option (a) is negotiable in principle, as dismantling and a ban on tests are both incorporated in the 1983 Soviet draft space treaty, but the USSR has not publicly acknowledged its own ASAT capability.

Option (b) would bypass the problem of dismantling and produce the operational results of option (a) through decay of existing capability from lack of testing and troop training. Because it does not seek to eliminate the current Soviet ASAT system and makes no provision for testing a US system to a comparable level of proficiency, option (b) could be viewed as unbalanced. However, considering the limited reach of the current Soviet co-planar system, its spotty success record, the effective difference between a dismantling regime and a test ban would be low and would diminish over time. Moreover, a test ban would address future capabilities, such as improved orbital or direct ascent interceptors, or beam weapons, that could pose a real threat to American satellites. Negotiability seems feasible, since the USSR has proposed a moratorium on space testing of ASATs.

A modified form of option (b) would be consistent with the research program associated with the strategic defense initiative, namely, a 3-5 year testing moratorium in lieu of one of indefinite duration.

Options (a) & (b) would require that the United States forego testing and deployment of the F-15/MV system. Thus the US would not develop a capability to destroy by impact such targets as Soviet RORSAT/EORSAT constellations. It would retain the option to negate those constellations by non-destructive means.

If the objective of policy is to place a ceiling on ASAT capabilities with one operational system each, options would include (c) possession of "one current type" ASAT with further testing allowed, or (d) "one current type" with a declining test quota and a test ban on all other types of ASAT means. Option (c) permits the United States to test and deploy the F-15/MV system, and conceivably to test upgraded systems. The USSR would be able to do the same with its system. This option avoids the dismantling question, but its negotiability is uncertain. If the USSR's major objective in undertaking such a negotiation is indeed to ban space weapons, then this approach may be acceptable, even though it tends to provide the United States a technological edge which is permitted to maintain. Restraining US technology is, however, frequently a key arms control objective for Moscow. Finally, this approach does less for the potential impact of ASAT on crisis stability than either option (a) or option (b).

Option (d) allows the United States to develop the MV system but closes down testing after an agreed period of time and/or number of tests; and it bans outright the testing of all other types of ASATs (eg, directed energy systems). It would thus fall between the first two options and option (c) in terms of immediate impact on crisis stability: over time, both sides would tend to lose confidence in their ASAT systems. It would prohibit space-based ASAT capabilities, and testing of high-altitude direct-ascent or ground-based co-orbital systems. It is likely to be somewhat more negotiable than option (c); if enacted after 1985-86, it reduces to option (b).

Any of these options could be associated with an ASAT non-use agreement, as discussed previously. A non-use agreement would extend to all satellites the type of protection now enjoyed by satellites used as national technical means of verification.

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