F.A.S. PUBLIC INTEREST REPORT

Journal of the Federation of American Scientists (FAS)

SPECIAL ISSUE ON ANTI-SATELLITE WEAPONS

Volume 36, No. 9

November 1983

SPACE WEAPONS RACE—STOP IT NOW

Today we are on the verge of an arms race in space. This arms race will greatly reduce the stability of the strategic balance, and will further fuel the arms race here on Earth. If we are to avert a space weapons competition, we must act now. The growing military utility of satellites has provoked renewed interest in the development of anti-satellite (ASAT) weapons. ASATs are first-strike weapons that would be used to shoot down crucial military satellites at the outset of a major war, in the hope that this would degrade the effectiveness of an opponent's forces. The only way to protect vital American satellites is by limiting the development of such weapons.

The failure to limit Multiple Independently-targeted Re-entry Vehicles (MIRVs) in the early 1970's is now regarded as a major mistake. The failure to limit ASATs now may come to be seen in a similar light. Future anti-satellite weapons will reduce strategic stability, and their continued development will encourage a renewed Anti-Ballistic Missile (ABM) competition.

There are two immediate steps that must be taken to avert a space weapons competition that could have unforeseeable and potentially tragic consequences.

1—The Administration should immediately agree to a mutual moratorium on the testing of anti-satellite weapons against objects in space. A test moratorium would limit development of the homing guidance sensors of these weapons, the most critical and least developed element of ASAT technology. A test moratorium will enhance the national security of both the United States and the Soviet Union. At present neither the United States nor the Soviet Union has an ASAT capability that poses a threat to the other country's vital satellites; thus a test moratorium is possible today. But in the absence of restraint, this will soon change. More advanced ASATs will also present more difficult verification problems, which may preclude limitations on these weapons in the future. A test moratorium will also provide the time needed to negotiate a treaty limiting ASATs.

2—There should be an immediate resumption of negotiations aimed at limiting anti-satellite weapons. These negotiations began in 1978, and in three sessions over a period of a year there was some indication that a useful agreement might be possible. Recently the Soviets proposed a new Draft Treaty limiting ASATs that includes many positive and constructive provisions, but the United States has not yet formulated a response.

The Reagan Administration has asserted that arms control in this area would present insurmountable definitional and verfication problems. It is difficult to avoid the impression that the Administration is simply not interested in an arms control option in this area and intends to proceed with deployment, regardless of the alternatives or the consequences. If the Administration is sincerely interested in the possibility of negotiating limits on anti-satellite weapons, it should agree to a test moratorium. Two decades ago John Kennedy took the first step toward halting the nuclear arms race, with the Test Ban Treaty. Now is the time for a similar initiative, to avert a space arms race, before it is too late.

—reviewed and approved by the FAS Council

ANTI-SATELLITE WEAPONS

The world is poised on the brink of a space weapons competition which will reduce the national security of both the United States and the Soviet Union. Satellites provide important support functions to military forces on Earth and make a significant contribution to the stability of the strategic balance. At present neither the United States nor the Soviet Union has the capacity to pose a significant threat to the other satellites. But advances in anti-satellite (ASAT) technology will soon change this situation.

There is a narrow window of opportunity to avert a space arms race, but the window will gradually close over the next two years. During 1984 and 1985 the United States will conduct a test program for a new ASAT system that will constitute a significant improvement over the existing Soviet ASAT. The new American ASAT, known as the Prototype Miniature Air Launched System (PMALS), consists of a small rocket launched from an F-15 fighter. Because of its small size, it will pose potentially insurmountable verification problems.

The Soviets have proposed an immediate moratorium on the testing of ASATs, and the United States should agree to this proposal. The two countries should resume negotiations to conclude a treaty banning these weapons.

This special issue on ASATs was prepared by FAS Staff Assistant for Space Policy John Pike. It is based on a 25,000 word monograph that will be available from FAS in December, at a price of $10.

However, the Reagan Administration seems indifferent to the danger of an ASAT competition and has expressed little interest in arms control in this area.

The recent growth of interest in anti-satellite systems is a result of the increasing use of satellites to directly support military forces on Earth, both in low-level conventional conflicts and in any future protracted nuclear war-fighting. Communication, navigation, weather and other satellites serve as force multipliers, supplying the information needed to increase the military effectiveness of terrestrial weapons systems. These satellites provide early warning of a nuclear attack in addition to supporting retaliatory forces. Thus they are a critical component of strategic deterrence. Both the United States and the Soviet Union are highly dependent on military satellites, and both countries have an interest in reducing the vulnerability of these vital assets.

The United States has a growing investment in military activities in space. Including those parts of the NASA budget that go to support military activities, and secret expenditures for reconnaissance activities, military spending for space will exceed $14 billion this year. By the end of this decade military spending may reach four times that of the civilian sector.

Since the launch of Sputnik 1 over 25 years ago the Soviet Union has maintained a very active space program. Although the sophistication of Soviet technology has generally lagged behind that of the United States by several years, the Soviets have nonetheless managed to equal most of the achievements of the American space program. The Soviet Union launches over 100 satellites each year for a variety of civilian and military purposes: this is about five times the annual launch rate of the United States. But US satellites on the average have a useful life that is about five times that of Soviet satellites, which in large measure explains the difference in the current levels of launch activity.

Although it is frequently asserted that the US is more dependent on space than the USSR, the case is far from clear. This assertion is usually made in explanation of American interest in achieving limits on ASATs. But the other, unexamined, side of this coin is that it would follow that the Soviets should have comparatively little interest in ASAT restrictions.

While the US may have been more dependent on space than the Soviets in earlier years, this seems no longer to be the case. Increasingly the Soviet on-orbit force structure has approached that of the United States, and there are indications that this convergence will accelerate in coming years.

It is difficult to make a definitive assessment of the relative dependence of the US and Soviet Union on military satellites. A number of indicators suggest that both countries place roughly equal reliance on space. Both countries seem to be spending about the same amount of money on space, and it is safe to assume that this burden is seen as proportionate to the need. Both countries have about 100 active military and military-related satellites in orbit at any one time, another point of rough equivalence.

Moving to a more detailed level, looking at specific

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FAS FUND

The Federation of American Scientists Fund, founded in 1971, is the 501(c)(3) tax-deductible research and education arm of FAS. It is governed by eleven trustees, of whom six are appointed by the FAS Chairman.

The FAS Public Interest Report (USPS 188-100) is published monthly except July and August at 307 Mass. Ave., NE, Washington, D.C. 20002. Annual subscription $25/year.

AMERICAN & SOVIET SATELLITES IN ORBIT 1983 & 1989

ORBIT	MISSION	USA 1983	USA 1989	USSR 1983	USSR 1989
LOW		**11**	**3**	**5**	**6**
100–500 km	Photo Reconnaissance	4	2	2	2
	Radar Surveillance	—	—	2	2
	Electronic Intelligence	6	—	—	—
	Manned	1	1	1	2
MEDIUM		**16**	**19**	**54**	**16**
500–3000 km	Communication Military	—	—	29	2
	Navigation	5	—	10	—
	Electronic Intelligence	6	14	10	8
	Weather Military	2	2	3	3
	Weather Civil	2	2	1	1
	Remote Sensing Civil	1	1	1	2
SEMI-SYNCHRONOUS		**2**	**2**	**21**	**4**
400 x 40000 km	Early Warning	—	—	9	—
	Communication Military	2	2	4	4
	Communication Civil	—	—	8	—
SEMI-SYNCHRONOUS		**6**	**21**	**2**	**12**
20000 x 20000 km	Navigation	6	21	2	12
SYNCHRONOUS		**59**	**96**	**10**	**29**
36000 x 36000 km	Early Warning	3	3	—	3
	Electronic Intelligence	4	4	—	—
	Communication Military	*20	*22	—	12
	Communication Civil	**30	**65	10	13
	Weather	2	2	—	1
TOTAL		**94**	**141**	**90**	**67**

* Includes NATO satellites
** Includes INTELSAT satellites

functions of particular satellites, reveals some asymmetries but no change in the overall picture. Both countries are highly reliant on space, and both have generally equivalent interest in limiting ASATs, one way or the other. Neither country stands to benefit from an ASAT competition, although each country might like to negate certain satellites of the other country.

AMERICAN ANTI-SATELLITE WEAPONS

Although the United States is about to begin testing a new anti-satellite, this country first started work on ASATs over a generation ago. But the threat that these systems were intended to counter, orbiting nuclear weapons, had failed to materialize. And the detonation of an ASAT's nuclear warhead would damage other American satellites. Because of the limitations of early guidance systems, these anti-satellite weapons could not be counted upon to place a warhead any closer than a few miles of their target, which meant that they had to use a nuclear warhead. The sensitive electronics on satellites proved to be particularly vulnerable to nuclear explosions in space. The military utility of such an indiscriminate weapon is not great. As an anti-satellite weapon it threatened to do as much or more damage to friendly satellites as it did to its intended target. When the threat of orbiting nuclear weapons did not materialize, both the American ASATs were dismantled.

Program 505 Nike

The United States Army's Nike-Zeus was originally developed as part of an Anti-Ballistic Missile (ABM) system. After years of research it became clear that it would be largely ineffective as an ABM. But from 1964 to 1967 a few of these rockets were deployed as anti-satellite weapons, with the potential for shooting down satellites a few hundred kilometers above the Earth's surface.

Program 437 Thor

The US Air Force, not to be outdone, also tested and deployed several Thor rockets which were modified for the anti-satellite mission. These became operational on Johnston Island in the Pacific in 1964 and could intercept a target at much greater range than the Nike-Zeus. The Program 437 Thor system was tested at least 16 times from 1964 to 1970, prior to its retirement in 1976. This system reportedly can be restored to operational status on 6 months' notice.

Other Experimental ASATs

In the early 1960's, two other programs demonstrated the concept of an air-launched ASAT. Bold Orion, which was tested by the Air Force four times starting in October 1959, launched rockets from a B-47 bomber. In the two Hi-Ho tests in 1962, the Navy launched rockets from an F-4 fighter. Both the Bold Orion and Hi-Ho ASAT test programs of the early 1960's used the Altair as a second stage, the same upper stage as the new American ASAT.

The New Prototype Miniature Air-launched System—PMALS

The new American ASAT program, the Prototype Miniature Air-Launched System (PMALS) began in the early 1970's, with full-scale development initiated in 1977. In early 1981 a series of major contracts was awarded for the production of test prototypes.

The booster for the ASAT is a small two-stage rocket, about 18 feet long and a little more than 18 inches in diameter, with a total weight of 1200 kilograms. Apart from the heat-seeking homing sensor used in the ASAT's Miniature Homing Vehicle (MHV) warhead, the PMALS is based on well-proven technology for which there is limited need for an extensive test program. But the ASAT heat-seeking sensor is very similar to that used in the Army's Homing Overlay Experiment ABM test program, which has failed on both of its two initial tests this year.

The remaining elements of the PMALS ASAT are based on "off-the-shelf" technology. The launch platform for the PMALS is the F-15 fighter, which has been in service with the Air Force since the mid-1970's. The first stage of the PMALS is a derivative of the nuclear-tipped Short Range Attack Missile (SRAM), which was first deployed in 1972, with over 1500 missiles delivered. The second stage of the PMALS is the Altair, which is a solid rocket motor that is also the fourth stage of the Scout space launch vehicle. The Scout has achieved over a 90% reliability in more than a hundred launches over the past two decades.

PMALS Operational Concept

PMALS will be carried to high altitude by an F-15 fighter, which will launch the rocket to attack and destroy satellites in much the same way as air-to-air missiles shoot down airplanes. The ASAT will be launched by F-15 fighters that are normally assigned to other duties. Because these airplanes can take off from short runways, they can transform almost any airport into a base for war in space. The F-15 fighters will receive targeting and guidance instructions from the Space Defense Operations Center at Cheyenne Mountain. They will seek to maneuver to directly under the path of the target satellite. In order to minimize the relative velocity between the two craft, the PMALS is fired along the course of the target satellite, which quickly overtakes the ASAT. The PMALS Miniature Homing Vehicle will home in on the heat of the target satellite, using very small on-board rockets for terminal course corrections. The impact of the target satellite destroys both the MHV and its target.

The maximum speed attained by PMALS is less than four kilometers per second, and the velocity of the MHV at impact is considerably less. Press reports that suggest a maximum speed of 8 miles per second (about thirteen kilometers per second, well in excess of escape velocity) are in error.

PMALS Testing

Initial engineering testing of the first prototype began in late 1981, and the prototype was first fitted to its F-15 carrier in December 1981. In 1982 the PMALS was flown on the F-15 to study electrical connections and handling characteristics. But the advanced heat-seeking sensor has encountered a series of problems which have led to a number of program delays. The overall schedule has slipped by several years. As of 1982 the first test against a target in space was planned for March of 1983, but technical problems have postponed this test by about a year.

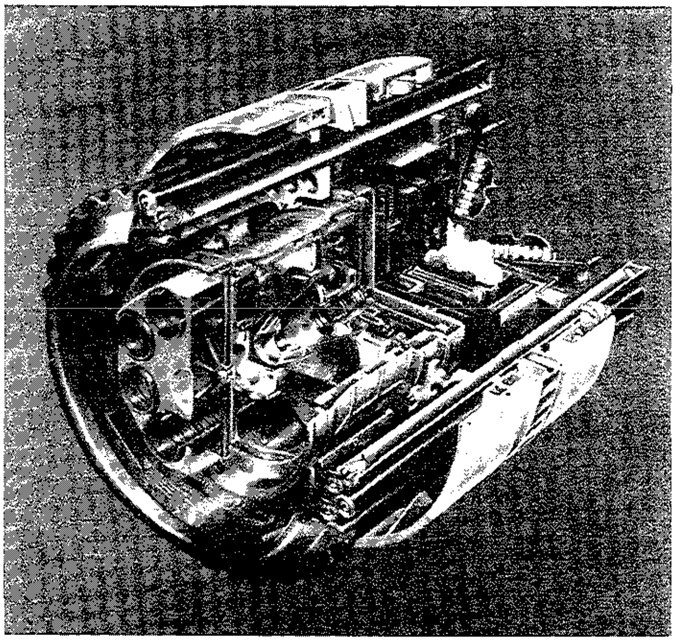
The first test firing of the PMALS is scheduled for late 1983, but no MHV will be included. In early 1984 the second PMALS test will fire an MHV toward a "point-in-space," rather than an actual target. The first test of the ASAT against an actual target will be in the spring of 1984, when PMALS will be fired toward a 6-foot-diameter balloon placed in orbit by a Scout rocket launched from Wallops Island, Virginia. A total of six Scout launches are planned, and each Scout will carry two of these balloons, which are known as the Instrumented Target Vehicle (ITV), permitting at least a dozen intercept tests over the next three years.

PMALS Capabilities

The performance of PMALS is surprisingly modest. Although the exact figures are classified, based on the known characteristics of the two rockets that are its booster, the maximum altitude at which it can engage a target satellite is probably no more than 500 kilometers, and 400 kilometers probably represents a limit on the normal effective maximum altitude. Another ASAT performance variable is known as reach, which is the ground track distance from the launch point of the ASAT to the intercept point. For the PMALS itself the nominal reach is probably on the order of 50 to 100 kilometers, and of course there is a trade-off between reach and altitude.

The reach of the PMALS is greatly augmented by the range of the F-15 carrier aircraft. Under normal circumstances the F-15 would have a radius of action of 2500 kilometers. Aerial refueling can extend this radius of action to 7500 kilometers.

The initial operational capability of the PMALS ASAT is planned for 1987. However, there are reports that the Air Force may declare the system operational after the fifth successful test against a target. The initial PMALS force will consist of 28 modified F-15s with 56 rockets, stationed at Langley Air Force Base, Virginia. A second wing of F-15s at McChord Air Force Base, Washington, will subsequently bring the entire force to 112 PMALS. These airplanes could be relocated to any other Air Force base that is prepared to service the F-15 and, with some additional effort, to any airfield that could be so modified on an emergency basis.



The American ASAT Miniature Homing Vehicle is less than 30cm in diameter, and can be adapted for a variety of launch vehicles.

The launch rate of the PMALS is limited only by the number of aircraft available for ASAT service and the rate at which targets come within range of the F-15s. In practice, this means that all the satellites that are vulnerable to PMALS can be destroyed within a matter of a few hours. Because the MHV uses a passive sensor, there is no warning of attack, and the entire sequence from rocket launch to intercept takes about ten minutes.

PMALS Costs

When first studied a decade ago, the cost of the Miniature Air Launched System was projected to be about half a billion dollars. As recently as a year ago, costs of the system were estimated at about $1.5 billion. Now the Air Force predicts that the total system cost will be in excess of $3.6 billion. Earlier this year the General Accounting Office reported that the ultimate cost of the system could run into the "tens of billions of dollars." These cost estimates do not include the expense of operating the global tracking system needed to support the ASAT, or the costs of acquiring and operating the F-15 fighters that will be used to launch the ASAT. These additional elements of the ASAT would further increase these already-high cost estimates.

Residual ASAT—Homing Overlay

There is a great deal of similarity between ASAT technology and Anti-Ballistic Missile (ABM) technology. The PMALS Miniature Homing Vehicle is very similar to the intercept vehicle employed in the Homing Overlay Experiment ABM test program. This test program and its follow-ons could create a limited ASAT capability against a small number of low-altitude targets.

Residual ASAT—the Space Shuttle

On various occasions the Soviets have expressed concerns about the ASAT capabilities of the Space Shuttle which are not entirely without basis in theory, if not in planning. The Shuttle could maneuver to within a few hundred feet of a Soviet satellite, which could be disabled by the Shuttle's Remote Manipulator System 'robot arm,' or by a space-walking astronaut. But it is unlikely that the US would risk bringing the Shuttle so close to a hostile satellite. The Shuttle could carry out the task of disabling a Soviet satellite from a safe distance by using its Teleoperator Maneuvering System, which is a small rocket with robot arms, guided by television from the Shuttle.

Perhaps the most troubling ASAT potential of the Shuttle from the Soviet perspective would involve the capture of a Soviet satellite, for return to Earth for analysis by American intelligence agencies. There is some evidence that this concern has already lead the Soviets to install self-destruct mechanisms on their electronic intelligence satellites to prevent their capture. The reality of this threat to the Soviets should not be underestimated. The unique ability of the Shuttle to return satellites from space to Earth must seem reminiscent of the CIA using the *Glomar Explorer* to recover parts of a Soviet submarine that had sunk in the Pacific Ocean.

Advanced Miniature Air Launched System—AMALS

Given the limited altitude of the PMALS, some work has been done on defining an advanced version that would use a larger first stage to attack satellites in higher orbits. Although no design details on this system have been released, it is possible to determine an upper range for the performance of such a system. The pylon on the F-15 that is used to carry the PMALS has a maximum design strength of 2300 kilograms, with a 5.5 G safety margin. Since the F-15 is not required to be highly maneuverable during the interception, it is possible to relax the stress margin on the centerline pylon, so that a 5000-kilogram payload can be accommodated. A Castor solid rocket, which is the second stage of the Scout, would fit into this weight envelope and give the Advanced Miniature Air Launched System the ability to attack virtually any satellite in lower orbits. The estimated cost of such a system, which would probably take less than two years to develop, is $2 billion.

Advanced Miniature Ground Launched System—AMGLS

A more capable system that could use the MHV to attack satellites in geosynchronous orbit would require a booster too large to be air-launched. But the principal advantage of air-launch is the ability to maneuver the launch platform to under the target's ground track, which is not really a requirement for high altitude targets. A Trident SLBM would be an excellent high-altitude booster for the MHV and could be based in silos, or in other ways if needed. The cost for such a system would be about $1.5 billion for research and development, and procurement of the operational system would cost about $6 billion.

Directed Energy Weapons

The United States has an extensive program of research on directed energy weapons, particularly lasers. One of these programs could provide a near-term ASAT capability. The Defense Advanced Research Projects Agency (DARPA) Triad program consists of the Alpha two-megawatt infrared chemical laser, the Talon Gold pointing and tracking system, and the Large Optics Demonstration Experiment (LODE). These programs are intended to support a decision by 1988 as to whether to proceed with an integrated test in space of these systems, which could take place by 1992. The Triad laser would have a significant capability against a variety of Soviet satellites. Other ground-based and space-based laser experimental programs that may be accelerated as part of the 'Star Wars' effort will also have a significant ASAT capability. Indeed, they may be portrayed as ASATs in an attempt to quiet concerns over compliance with the 1972 ABM Treaty. The initial costs of such systems could range from $2 to $6 billion, and the ultimate cost of a space laser ASAT could approach $50 billion.

SOVIET ANTI-SATELLITES

In 1968 the Soviet Union began testing its own anti-satellite weapon, launched atop a modified version of its largest ICBM, the SS-9. The rocket places a multi-ton satellite into low Earth orbit, and this interceptor satellite maneuvers to within striking range of its target. When the interceptor comes within a few kilometers of its target, a small explosive charge is detonated, showering the target satellite with shrapnel. Delicate satellites would be immediately destroyed by this explosion.

SUASAT Testing

The Soviet ASAT has been tested 20 times, in three different forms, each of which uses the same basic satellite. The maximum altitude at which this system has demonstrated an interception is about 1500 kilometers. From 1968 to 1971 an interceptor was tested that used an active radar to home in on its target within two orbits after launch, achieving a 70% success rate in 7 tests. This intercept trajectory requires the ASAT to be placed into an initial orbit that is very similar to that of its target. This imposes significant limits on how readily targets can be attacked.

In 1976 the Soviets began testing an active radar interceptor that would attack its target on the first orbit, which made it possible to attack targets in orbits that are somewhat different from that of the initial orbit of the interceptor. However it also results in a greater difference in the relative velocities of the ASAT and its target, which accounts for the lower success rate.

The Soviets also began testing that year of a more advanced interceptor that homes in on the heat emitted from its target. This system, which is less vulnerable to countermeasures such as evasive maneuvering and jamming, has failed in all 6 attempts, including the most recent ASAT test in June 1982. Continued testing of the two-orbit radar interceptor has yielded a 66% success rate in 3 tests since 1976.

SUASAT Status

The Soviet ASAT is not operational in any meaningful sense of the term as it is commonly used in the United States. The Soviets' ongoing search for a satisfactory guidance system and a more direct intercept trajectory indicates the experimental nature of the Soviet ASAT. And the actual military utility of the Soviet ASAT is open to doubt. During the SALT II hearings Air Force Chief of Staff Gen. Allen noted of the Soviet ASAT that "it is difficult to assign it a very high degree of credibility because it has not been a uniformly successful program and they have changed parameters with many of the different launches they have made...we give it a very questionable operational capability for a few launches...it is a threat that we are worried about, but they have not had a test program that would cause us to believe it is a very credible threat."

SUASAT Capabilities

In addition to the two dedicated ASAT launch pads at Baikonur, there are at least two other F-LV launch pads there, as well as four others at the Plesetsk launch center. If all eight of these pads were used in an ASAT campaign, they would be able to shoot down US satellites at the rate of about one a day, and a campaign against all 18 US satellites in low Earth orbit would require several weeks to complete. Such a campaign could require as many as fifty F-LV launches. During 1982, by contrast, there were just 8 F-LV launches from Baikonur and only 2 from Plesetsk.

Residual ASAT—Galosh

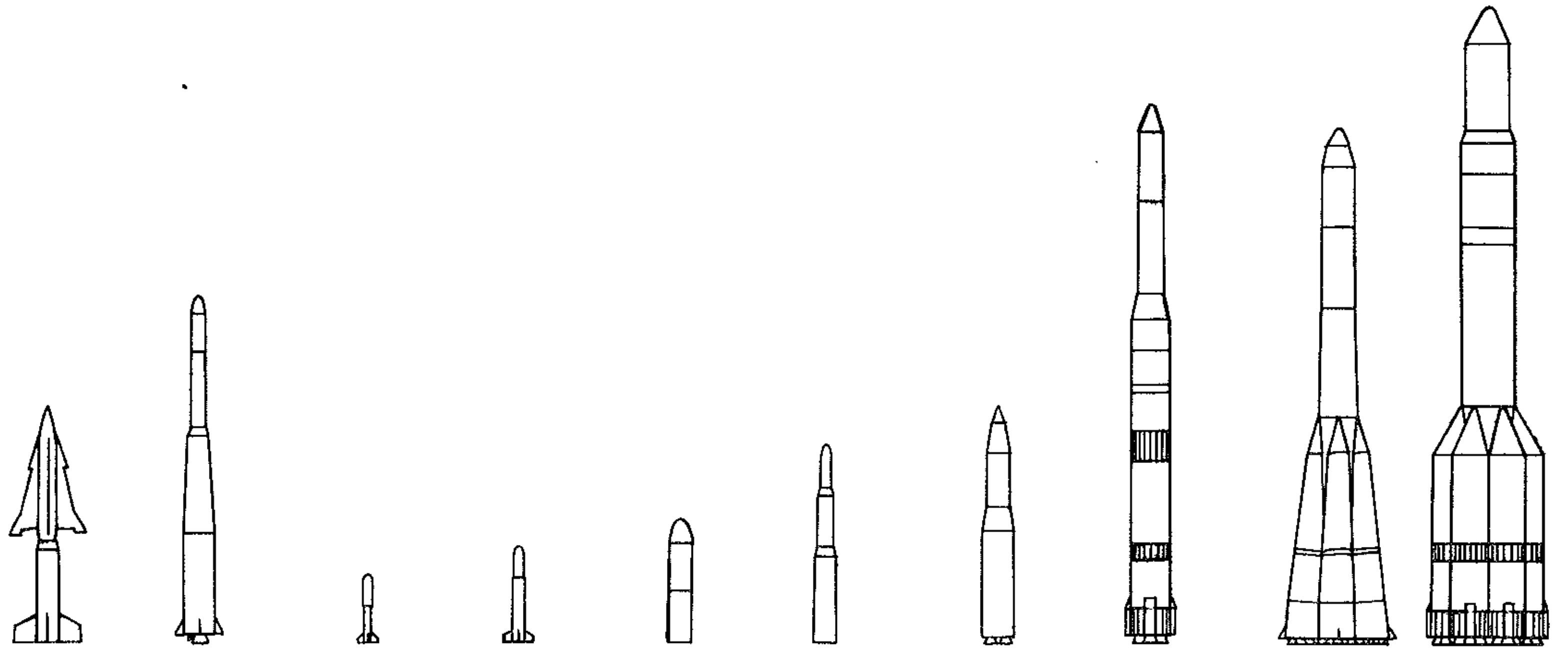
Although the Soviet Galosh ABM interceptor missiles could also have residual capabilities to destroy satellites, there are limits to the seriousness of this threat. Because it uses a high-yield nuclear warhead, application of the Galosh to the ASAT role would entail a risk of collateral damage to Soviet satellites, as well as to their command and control facilities in the Moscow area, as a result of the electromagnetic pulse (EMP) phenomenon.

Other Residual ASATs

The Soviets have two other rockets that can launch a payload as heavy as the Soviet ASAT interceptor. The A-LV, which is used to launch the Soyuz manned spacecraft and the unmanned Progress resupply vehicle, is limited by its use of unstable fuels, and there are only a handful of pads that can launch this rocket. The D-LV, which launches the Salyut space station and various satellites to geosynchronous orbit, has demonstrated a very low launch rate and reliability. Both could provide a marginal residual ASAT capability, against a limited number of targets.

Directed Energy ASATs

During the late 1970's there were a number of allegations concerning possible Soviet development and use of laser and particle-beam weapons. The nuclear research facility at Semipalatinsk was said to be building a large nuclear-pumped particle-beam weapon, but nothing seems to have come of it. Sensor problems on various early warn-



Designation	505	437	PMALS	AMALS	AMGLS	HOE	Galosh	SUASAT	Progress	Proton
Mission	ASAT	ASAT	ASAT	ASAT	ASAT	ABM R&D	ABM	ASAT	space	space
Operational	1963-67	1964-75	1987	(1989)	199?	1983	1964	1971	1978	1964
Number	5?	6?	112	80?	100?	4+	32+	10	—	—
Launch	ground	ground	air	air	surface	ground	ground	ground	ground	ground
Type	pad	pad	F-15	F-15	various	silo	pad	pad	pad	
Number	2	2	56	80?	100?	1+	64+	2+6?	8?	2+3?
Booster	Nike-Zeus	Thor	SRAM	Castor	Trident	MM-1	ABM-1B	F-LV/SS-9	A-LV	D-LV
Length	19.2m	29.1	5.5m	8.0m	10.3m	16.5m	19.8m	45.1m	42.5m	54.0m
Diameter	1.5m	2.5m	.5m	.8m	1.9m	1.8m	2.5m	3.2m	10.3m	9.2m
Weight	18 tn	63 tn	1 tn	5 tn	15 tn	29 tn	33 tn	230 tn	305 tn	1075 tn
Stages	3	3	2	2	3	3	3	3	3	4
Propellant	solid	liquid	solid	solid	solid	solid	liquid?	liquid	liquid	liquid
Interceptor	50 kt?	1 MT	impact	impact	impact	impact	4 MT	explosive	—	—
Sensor	radar	radar	IR	IR	IR	IR	radar	radar/IR	radar	—
Kill Radius	20 km+	30 km+	.1 m	.1 m	.1 m	10.0 m	50 km+	1-8 km+	—	—
Length	1 m?	3.0 m	.3 m	.3 m	.3 m	2.0 m	—	6.5 m	8.0 m	5.5 m
Diameter	1 m?	1.3 m	.3 m	.3 m	.3 m	1.0 m	—	2.0 m	2.2 m	2.0 m
Weight	300 kg?	750 kg	15 kg	15 kg	15 kg	300 kg	1000 kg?	2300 kg	7000 kg	3000 kg
Trajectory	direct	direct	direct	direct	direct	direct	direct	orbital	orbital	orbital
Flight Time	10 min	15 min	8 min	12 min?	350 min	10 min	12 min	45-180 min	—	350 min
Reach	500 km	2400 km	250 km	500 km?	12000 km	2500 km?	500 km	—	—	—
Altitude	400 km	1200 km	500 km	1500 km?	40000 km	2500 km?	400 km	1800 km	350 km	40000 km

ing satellites that some argued were the result of laser attacks are now generally believed to have resulted from natural phenomena.

There is a belief in certain quarters that the Soviet Union is actively working on a space-based laser that would perhaps be launched by the G-type launch vehicle (equivalent to the American Saturn V moon rocket). The first flight of this space laser could come within the next few years. Because the Soviet Union typically goes to a full-scale prototype of a weapon system much earlier in the development cycle than does the United States, the actual military utility of this space laser is likely to be quite marginal. But the political impact on American decision-makers of such a 'big-flashlight' is likely to approach or rival that of Sputnik, impelling the United States toward an accelerated development of similar weapons.

ASAT MISSIONS

The starting point for any evaluation of anti-satellite weapons must be an assessment of the role they perform in a country's strategy and force posture. It is not sufficient to merely note that a country has an ASAT capability. Rather, it is necessary to relate the performance characteristics of specific ASATs to various target sets of satellites of a potential opponent. The question then becomes whether the ASAT performs a unique and significant military function.

There seem to be three general categories of ASAT missions. The first are those that are of marginal military significance and can also be performed by non-dedicated residual ASAT capabilities, such as attacks on small numbers of low-altitude photographic or radar reconnaissance satellites. The second group includes attacks on a small number of other satellites, such as passive electronic intelligence satellites, that are at the margins of the performance of the present generation of ASATs. The third category consists of large-scale attacks on many high value satellites, requiring capabilities greatly in excess of those of existing dedicated and non-dedicated ASATs. Because of the very negative impact that the ability to perform these missions would have on arms race and crisis stability, it would on the whole be preferable to avoid a situation in which either or both sides could plausibly contemplate such attacks.

Photographic Reconnaissance Satellite

It is difficult to imagine that ASATs would be employed against photo reconnaissance satellites for the purpose of preventing treaty verification. Such an act would be far more provocative than merely abrogating or withdrawing from a treaty, and would be considered an act of war, or certainly a prelude to a conflict in which the denial of verification would pale to insignificance.

In addition to treaty verification, photo reconnaissance satellites provide information on fixed targets for strategic forces, as well as information on mobile targets for strategic and conventional land, sea and air forces. This latter function is performed under the Tactical Exploitation of National Capabilities (TENCAP) program. The improved resolution and real-time data return provided by the KH-12 photo reconnaissance satellite will further increase the utility of satellites to tactical situations.

But these tactical applications are of interest primarily in low-threat conflicts in which an ASAT attack is quite unlikely. In these and more serious conflicts between the US and the USSR it is difficult to imagine a scenario in which this capability would be a major concern, or provide the Soviets with a meaningful, let alone decisive, advantage. In the European theater these satellites could provide warning of an impending Soviet attack. However in previous instances the warning provided was not unambiguous, with anticipated moves not materializing and actual invasions coming as something of a surprise. Paradoxically, the most valuable use of photo reconnaissance satellites in such a situation might come if they were destroyed by an ASAT, thus providing an unambiguous signal of intentions. Of course recognition of this fact would discourage an attack until very late in the game, by which time various aerial sensor platforms would come into play.

The United States is developing systems to be added to low-flying satellites, such as the KH-12 photographic reconnaissance satellite, that will detect the radar beam of the Soviet ASAT and maneuver the satellite to avoid attack. Such systems are the reason that the Soviets have sought, thus far without success, to develop heat-seeking guidance sensors that will not provide warning of an impending attack. Thus the present Soviet ASAT poses a limited and declining threat to low-altitude American satellites.

Radar Ocean Reconnaissance Satellites (RORSATs)

The new American ASAT is usually justified on the basis of a need to shoot down the Soviet Radar Ocean Reconnaissance Satellite (RORSAT) that the Soviets use to keep track of American carrier battle groups. But the significance of this threat, and the unique requirement for an ASAT to meet this threat, seems to have been overstated. The Soviets do not seem to place great reliance on the system, perhaps because of its significant operational limitations. American naval forces will face many threats in combat, which can be countered by means that will be equally effective against the RORSAT. There is little reason to believe that the RORSAT provides a unique targeting platform for weapons that the fleet is not equipped to counter, and in the final analysis, the survival of the fleet during a central nuclear conflict is neither likely nor significant. The United States has studied for many years the use of radar satellites, and these studies have consistently concluded that such systems would be of marginal utility. There is no reason to believe that the Soviets have perfected a more capable system.

This re-enforces the conclusion that the primary mission of the new American ASAT is political, a bargaining chip for negotiations, rather than military. Given a political requirement to develop a credible short-term ASAT capability to gain bargaining leverage, the Prototype Miniature Air-Launched System was a very marginal capability in search of a mission. Fortunately, the orbit of the RORSAT

SOVIET SATELLITES VULNERABLE TO AMERICAN ASATS

	1983				1989			
	photo recon	radar recon	early warning	all orbits	photo recon	radar recon	early warning	all orbits
SOVIET SATELLITES	**2#**	**2**	**9**	**92**	**2#**	**2**	**3**	**67**
CURRENT ASAT								
Early ASAT	2	2	—	—	2	2	—	—
PMALS	2	2	9	26	2	2	—	10
RESIDUAL ASAT								
Homing Overlay	2	2	—	(59)	2	2	—	(22)
Space Shuttle	2	2	—	(59)	2	2	—	(22)
ADVANCED ASAT								
Advanced MALS	2	2	9	80	2	2	—	26
Trident MHV	2	2	9	92	2	2	3	67
Ground Laser	2	2	—	59	2	2	—	22
Space Laser	2	2	9	92	2	2	3	67

AMERICAN SATELLITES VULNERABLE TO SOVIET ASATS

	1983				1989			
	photo recon	radar recon	early warning	all orbits	photo recon	radar recon	early warning	all orbits
AMERICAN SATELLITES	**4**	**12**	**3**	**94**	**2***	**14**	**3***	**141**
PRESENT ASAT								
FLV ASAT	4	12	—	29	2?	14	—	24
RESIDUAL ASAT								
Galosh ABM	4	6	—	11	2?	—	—	3
Progress	4	6	—	(11)	2?	—	—	3
ADVANCED ASAT								
DLV ASAT	4	(12)	3	(94)	2?	(14)	3	(141)
Ground Laser	4	12	—	27	2	14	—	22
Space Laser	4	12	3	94	2	14	3	141
Space Mine	—	—	3	59	—	—	3	96

( ) Numbers in parentheses indicate the total number of satellites that the system could attack for systems that have a number of interceptors that is smaller than the number of satellites in the target set.

These satellites have demonstrated a very high annual launch rate that suggests a considerable potential for the rapid reconstitution of the on-orbit constellation.

* These satellites will incorporate a very substantial maneuvering capability and on-board attack warning features that will greatly reduce their vulnerability to explosive and impact type ASATs.

? The new KH-12 satellite incorporates a radar-warning system that would degrade the capabilities of the radar-guided Soviet ASAT, but not the passive/optical guided system.

is the lowest of any Soviet satellite, barely skimming the atmosphere at an altitude of 250 kilometers. A more capable ASAT that could attack other, higher-altitude, satellites would have taken much more time and money to develop.

Soviet deployment practices for the RORSAT do not suggest that they are highly reliant on the information that it provides. In recent years the Soviets have maintained the full constellation of two RORSATs, along with two passive Electronic Ocean Reconnaissance Satellites (EORSATs) for less than three months each year. Since the Cosmos 1402 accident in January 1983 there have been no further RORSAT launches.

Even the full constellation of two satellites faces a number of serious operational limitations. Continuous tracking of a target requires frequent scanning of the target area. As the interval between revisits increases, the ability to correlate targets detected on subsequent passes deteriorates. The revisit interval in the crucial North Atlantic corridor between the US and Europe could be as low as 45 minutes, and at the equator the interval could be as high as five or six hours. This suggests that the RORSAT might lose sight of the fleet in areas of dense marine traffic.

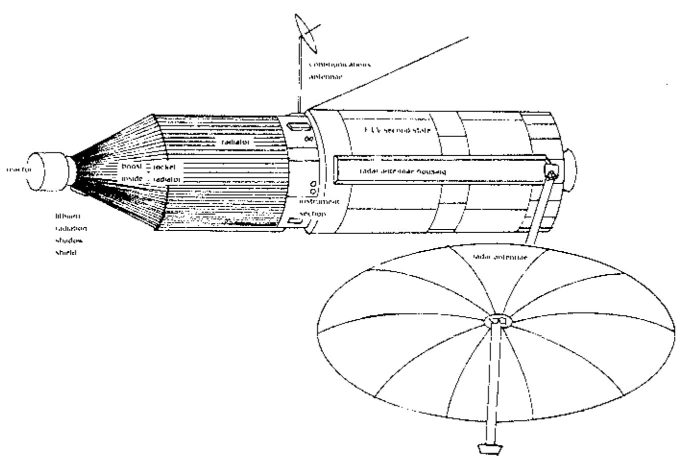
The quality of the information available from the RORSAT is uncertain, but it cannot be very high, given the inherent limitations of such systems and long-standing Soviet difficulties with critical signal-processing techniques. Thus it is entirely possible that the RORSAT would have a hard time distinguishing an aircraft carrier from a large super tanker, particularly if efforts were made to intentionally blur the signatures of the vessels.

Performance of the RORSAT is also degraded by surface conditions. Very rough seas substantially impair the ability to separate targets from waves. The typically stormy state of the North Atlantic greatly reduces the utility of the RORSAT for targeting ships in this area.

Some operational plans for American carrier battle groups call for their deployment in time of crisis in areas where they would be subject to detection and targeting by attack submarines and Backfire bombers, using both active and passive sensors. The best response to active radar tracking is deploying the fleet in a semi-random pattern, as opposed to the present concentric deployment pattern which places the aircraft carrier at the center of a bulls-eye of ships. The use of passive countermeasures such as chaff and corner reflectors would further confuse Soviet radars. Another response is jamming, which would be very effective against the Soviet radar satellite. These countermeasures are equally effective against threats on Earth as well as those in space. If they are not employed, the fleet will have much more to worry about than being tracked from space.

The argument is sometimes made that the RORSAT would be used to locate targets that could then be attacked by Soviet SS-11 ICBMs. If this were true, then an ASAT might be needed to protect the fleet from a threat that it might not otherwise be able to meet, assuming that electronic countermeasures were ineffective. But there is no direct evidence to support this suggestion. Rather, this argument rests on the circumstantial and rather speculative assertion that since the SS-11 seems to be the product of a Soviet design bureau that specializes in naval rockets, it must therefore have some naval mission. The assignment of specific rockets to specific design bureaus is at best an imprecise art, and such allocations cannot conclusively determine the operational commitments of the bureau's products.

Of course, it is impossible to demonstrate that the SS-11 or some other, more capable, ICBM would not be used to barrage American naval forces, and there is a certain military logic to such a strategy. But there are a number of aerial, surface, and subsurface platforms that would be tracking the fleet, and targeting information would be available from all of these, in addition to the RORSAT. The Soviets always have at least one small surveillance ship in contact with carrier battle groups. Soviet strategic doctrine calls for massive and decisive attacks at the outset of a nuclear exchange. There would be little time for the fleet to negate these various sensor platforms before it was itself attacked. Indeed, initial American efforts to destroy these platforms would signal the Soviets that 'the balloon was going up,' triggering a Soviet attack.



Soviet Radar Ocean Reconnaissance Satellite (RORSAT).

While this discussion may be somewhat interesting from a tactical standpoint, in terms of US strategy it is all rather irrelevant. It has been several decades since carrier aircraft were part of American strategic war plans. Thus the fate of the carriers during the sort of major war that would trigger massive nuclear barrages is of little consequence to the outcome of the war.

In sum, it is difficult to avoid the conclusion that the Soviet RORSAT 'threat' is not a proper justification for the new American ASAT. This conclusion is augmented by the rather curious fact that while the national threat is to the Navy, the counter to the threat is an Air Force project. If the threat is indeed to the fleet, there are strong practical arguments for basing the ASAT on the carriers themselves, substituting the navy's F-14 for the marginally more capable F-15. Taken at face value, such inter-service cooperation, without even the benefit of a multi-service joint program office, is without precedent, and certainly not in keeping with traditions of inter-service rivalry and competition for money.

Passive Electronic Ocean Reconnaissance Satellites (EORSAT)

Negation of the Soviet RORSAT will be of little avail if various Soviet Electronic Intelligence (Elint) satellites, including the EORSAT, are not also eliminated. Indeed, the superior target characterization capabilities of these satellites pose a greater threat to naval forces than that of the RORSAT. However, there are means short of direct attack for countering this threat, and as with the RORSAT, these countermeasures will need to be invoked to meet other surface and airborne threats. Passive electronic detection of the fleet is best countered by reducing or eliminating emissions from radios and radars.

But to the extent that these measures are deemed inadequate, the limited range of the PMALS calls into question its ability to fulfill this mission. The orbit of the EORSAT, which seems to be dedicated to the ocean surveillance mission, is at the outer limit of the PMALS range. And there is no reason to believe that the EORSAT orbit could not be raised to beyond the range of the PMALS, either on a normal operational basis, or as an emergency measure during times of heightened tension. The orbits of the other two classes of Soviet Elint satellites are also beyond the range of the PMALS, and these satellites could be used for targeting surface forces, including those at sea.

Defensive Anti-Satellite (DSAT)

In theory it would be possible to use the new American PMALS ASAT to attack the Soviet ASAT before it could complete its mission. However in practice, this might prove to be rather difficult. The most likely operating area for the PMALS would be the Northern Pacific, perhaps flying out of Shemya, Alaska. Here the Soviet ASAT could be engaged about 15 minutes after launch. Unfortunately, at this point in its trajectory the Soviet ASAT would in all likelihood be above the maximum range of the PMALS. Soviet concerns about such US initiatives have led to efforts on their part to complete the interception maneuvers during their ASAT's first orbit. Indeed the new Soviet radar at Abalakova may be part of an ASAT space combat battle management system to enable their ASAT to intercept targets while over Soviet territory.

Early Warning Satellites

Early warning satellites constitute a uniquely tempting target set, given the essential role that they play in warning of ICBM attack and their potential for facilitating a 'launch under attack' response to a nuclear first strike. The significance of this target set is also enhanced by the comparatively small number of satellites that perform this mission: about four for the United States, and perhaps twice as many for the Soviet Union. An offsetting factor is the relative difficulty of attacking these satellites, which are in high orbits.

Soviet early warning satellites are in orbits that circle the Earth twice a day, bringing satellites to within a few hundred kilometers of the Earth's surface in the far southern hemisphere every twelve hours, where they could be vulnerable to attack by the new American PMALS. However, this mission would require the F-15 carrier aircraft to fly almost as far as the Antarctic Circle over the Pacific or Indian Ocean. There are three ways for overcoming this problem. The F-15's could fly from forward American bases at Diego Garcia or in the Pacific, but it is unclear whether the planes or their pilots would have the endurance needed for the very long flight to the intercept points. Alternatively, the F-15's could be flown to areas closer to the intercept point, such as New Zealand or the Falklands. Finally, the PMALS could be launched from F-14's flown off an aircraft carrier near the intercept area. However, it is likely that by the end of the decade the Soviets will have migrated their early warning satellites to geosynchronous orbit, far beyond the range of air-launched ASATs.

Ground-launched ASATs could attack early warning satellites in high orbits. But the launch of such interceptors would be quickly detected and identified. The six-hour flight time to intercept would permit a variety of countermeasures. Although such ASATs would not be an effective prelude to a surprise nuclear attack, they could degrade an opponent's capabilities to deal with an intense crisis situation, although this initiative would be laden with uncertainty.

Covertly pre-positioned 'space mines' as well as laser ASATs could destroy early warning satellites as part of a larger surprise attack. But the existence of such capabilities would place a hair trigger on nuclear arsenals. In a time of crisis, the vulnerability of early warning satellites would create an incentive to initiate a nuclear exchange, to preemptively attack the other side's forces before the other side could do the same. The loss of the attack characterization capabilities provided by these satellites would also preclude limitations on the scope of exchanges, as the blinded side(s) would have to assume the worst and order massive strikes. Under such circumstances, there is a very real danger of accidental malfunctions of satellites leading to an unintentional nuclear war.

'Sky-Sweeping' Attacks on All Military Satellites

Attacks on the full range of reconnaissance, navigation, early warning, and communication satellites would be conducted as part of a first strike, in order to disrupt an initial retaliation and suppress residual retaliatory capabilities. This mission places great emphasis on initiating hostilities and a general nuclear exchange, and has very negative implications for crisis stability. At this point, neither the United States nor the Soviet Union has a strategic force that could come close to conducting a credible first strike, though both countries seem to be moving in this direction. However, in the absence of an effective 'sky-sweeping' ASAT capability, it is difficult to imagine plausible scenarios for the use of counter-force first strike weapons. Communication, navigation and targeting satellites could be used to coordinate surviving strategic forces, which could continue to be used in selective counter-value strikes as part of the 'inter-war bargaining process,' effectively negating the strategic aim of the first strike.

Thus there are powerful incentives for a 'sky-sweeping' ASAT campaign at the outset of a general war. But these incentives virtually guarantee that any such war will involve massive exchanges, with little prospect for control or damage limitation. The prospective loss of command and control connectivity, and the loss of attack characterization capabilities, would make a persuasive case for unleashing strategic forces that might otherwise remain dormant.

Fortunately, such attacks are clearly far beyond the capabilities of the existing generation of ASATs. The American Navstar and Soviet Glonass navigation satellites are in orbits that circle the Earth twice a day, at an altitude of over 10,000 miles, beyond the range of present-day ASATs. Most American satellites, and all of those that would be used in a nuclear war for early warning and communication, orbit tens of thousands of miles in geostationary orbit above the Earth, and are far beyond the range of the present Soviet ASAT. Critical Soviet satellites will be in similar orbits by the end of the decade.

And as long as these critical satellites remain free from the risk of direct attack, it is rather difficult to make a good case for first strike weapons, since such weapons would remain largely unusable unless accompanied by more advanced ASATs. However, in the absence of agreed limitations on ASATs, 'sky-sweeping' campaigns may soon enter the realm of the possible. This would substantially increase the risk of unintentional war triggered by the accidental malfunction of critical military satellites.

There are several types of ASATs that could perform this mission. Existing interceptor vehicles, such as the American MHV, could be fitted to larger boosters, which could propel them to their targets with a flight time of between three and six hours. Such an attack would require perhaps 150 interceptors for the United States, and about twice as many for the Soviet Union, which would need to attack Western commercial communications satellites in addition to dedicated military satellites. However, the advantage of surprise would be lost, greatly degrading the utility of the subsequent strategic strike. The long flight time and low velocity of the kill vehicles as they approach their targets would permit various active countermeasures such as maneuvering, to protect endangered satellites.

Pre-positioned 'space mines' have been offered as a solution to the problems of achieving surprise and defeating countermeasures. But it would be rather difficult to covertly deploy a 'space mine field,' and an overt deployment would surely provoke a major crisis. An effective interceptor with an explosive or kinetic kill warhead would of necessity be of non-trivial dimensions and limited lifetime. There would thus be a considerable amount of associated launch activity and on-orbit maneuvering that would very soon give the game away. It would be very difficult to hide this activity among other activities at the geostationary orbit, and probably impossible to do so in other less crowded and less uniquely defined orbits, such as those used by the Navstar navigation satellites.

A nuclear warhead would be able to destroy a number of satellites, reducing the total number of space mines to a potentially manageable level. But in many instances constellations of Soviet and American satellites are located only a few thousand kilometers apart along the geostationary orbit. This poses the risk of significant collateral damage to friendly satellites. Indeed, one is reminded of the basic NATO tactic of moving as close as possible to enemy troop concentrations as a means of discouraging attacks by tactical nuclear weapons.

Long range directed energy weapons could solve many of these problems. Atmospheric interference will probably limit the effective range of ground-based lasers to a few thousand kilometers, but space-based lasers would constitute an effective 'sky-sweeping' ASAT adjunct to a massive first strike. The arguments against achieving such a first strike capability are so persuasive, however, that the desirability of such an ASAT capability is highly questionable.

SATELLITE SURVIVABILITY

Given the importance of space assets to terrestrial military operations and the strategic balance, both the United States and the Soviet Union have taken a number of initiatives to enhance the survivability of their military satellites. Although these survivability measures go a long way toward negating the threat posed by the existing generation of ASATs, it is clear that in the absence of arms control, the future ASAT threat will greatly reduce confidence in satellite survivability.

Satellites are the most visible, though not necessarily the most vulnerable, element of a complex web of military command and control systems. ASATs are not the only threat that this network faces, and there is little merit to enhancing the survivability of satellites to a level in excess of their associated ground segment. Today the ground segment of satellite control facilities, space tracking stations and launch facilities, is quite vulnerable to a direct attack which would degrade or negate the effectiveness of military satellites. The principal survivability strategy for these facilities is proliferation and mobility, ultimately in the form of long-endurance air-borne platforms.

The communications link between a satellite and its ground segment is subject to jamming, particularly on the ground-to-space uplink. Anti-jam countermeasures include using higher frequencies, particularly those above 20 gigaHertz (ten times higher than that used by earlier communications satellites) and improved antenna designs. There are a number of signal manipulation techniques such as frequency hopping that can also enhance jam resistance.

The satellite itself can be hardened against the effects of radiation from nuclear explosions, and sensors can be hardened against blinding by lasers. Satellites can also be equipped with on-board threat sensors, such as radar detectors, and given substantial maneuvering capability to evade interceptors. Vulnerability to ground segment attacks and jamming can be reduced by increasing the ability of the satellite to maintain itself without external assistance.

There are a number of additional measures that can enhance satellite survivability. These include:

- migration—moving the satellite's orbit to a higher altitude, beyond the range of the threat;
- proliferation—increasing the number of satellites,

thus reducing single-point vulnerabilities;
- hosting—placing critical payloads on a number of satellites, in effect creating multifunction space platforms in various orbits;
- reconstitution—having replacement satellites ready for launch on short notice to replace combat losses;
- duplication—relying on non-space-based systems to back up satellites;
- surrogates—air-borne systems, such as Remotely Piloted Vehicles, that incorporate many of these strategies.

Both the United States and the Soviet Union have taken a variety of survivability measures. The US has concentrated on anti-jam, satellite hardening and hosting, and in coming years will emphasize autonomy, maneuvering and migration. Ground segment vulnerability fixes and surrogate satellites are also receiving more attention. Two examples are indicative of the nature and scope of this work: the KH-12, and Navstar.

The KH-12 photographic reconnaissance satellite was substantially redesigned in 1977-78, adding about 3,000 kilograms of maneuvering fuel to its total weight. This greatly increased the satellite's total weight, and a program of thrust augmentation was undertaken to upgrade the Shuttle's maximum payload. The KH-12 will also incorporate a radar warning system that will enable it to avoid the radar-guided Soviet ASAT. The KH-12 is a multipurpose platform that replaces the earlier KH-8, KH-9 (Big Bird) and KH-11 satellites.

The Navstar Global Positioning System replaces the Transit navigation satellite. In contrast to Transit, there are three times as many Navstars in the total constellation, which orbits at an altitude almost ten times higher than Transit. Navstar is also a multipurpose platform, carrying the Integrated Operational Nuclear Detection System.

The Soviet Union has a limited reconstitution capability inherent in its high annual launch rate, which in recent years has averaged over two satellites per week. But the significance of this capability is difficult to judge, and may be less than some have suggested. There have been a number of instances when it might be assumed that the Soviets would be interested in monitoring a situation via satellite, when they have been slow to move. Most recently, the outbreak of the Falklands War caught the Soviets with a badly degraded ocean reconnaissance capability, and it took them many weeks to get their nominal on-orbit constellation up to full strength. Announced plans indicate that in coming years the Soviets will be concentrating on migrating their satellites to higher orbits as a key survivability measure, and other initiatives such as hardening can be assumed.

Survivability measures reduce the benefits that might accrue from having an ASAT, or being the first to use it. They should be pursued, as an adjunct to efforts to limit ASATs through arms control agreements. For it must be admitted that no combination of survivability initiatives can guarantee the survival of critical military satellites in the face of an unconstrained ASAT competition. Although these various measures can protect satellites from the present generation of ASATs, and from any covert or non-dedicated ASAT threat that might obtain under an ASAT arms control regime, an all-out ASAT competition will place all satellites at risk before the end of the century, if not the end of the decade. In the final analysis, an ASAT Treaty will be the single most important satellite survivability measure possible, and in its absence, all the others will be largely in vain.

VERIFICATION

Verification is properly viewed as the central issue in arms control. Nowhere is this more true than with respect to limiting the arms race in space. Administration officials have indicated that they regard questions pertaining to verification as a key unresolved matter in this area. They note that even a massively intrusive program of on-site inspection could not guarantee that the Soviets did not retain a few of their killer satellites, hidden under the floor of some farm house. But this is like worrying about whether someone has a bullet in his pocket when it is plain that he is not carrying a gun. Without the gun, the bullets are of little concern. The Soviet ASAT is launched atop a rocket that is about the size of three buses parked end to end. A ban on the deployment of such a massive weapon could be readily verified. The real verification problem is posed by the new American ASAT, which is the size of two coffins placed end to end; once this new weapon is tested to operational readiness, the Soviets would have little confidence in their ability to verify a ban on its deployment. Clearly, the time to achieve limits on such weapons is now, while it is still possible.

What Needs to be Verified

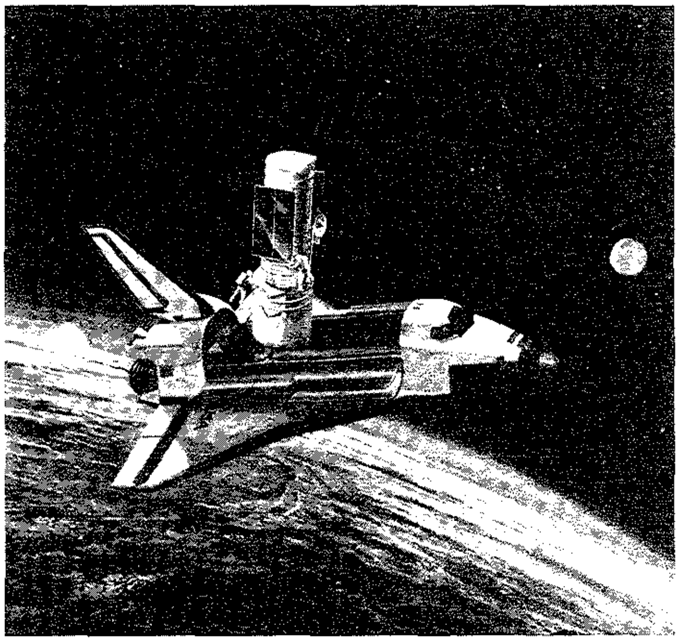
In the past, arms control negotiations have sought a balance between what could be verified and what should be verified. Most arms control agreements consist of limits on testing and deployment, in recognition of the difficulty of verifying limits on possession. An untested system that is not deployed poses very little actual threat. Thus the SALT and START negotiations have concentrated on limiting the types and numbers of delivery systems, rather than on seeking limits on the total number of warheads that each side has produced. In the absence of a suitable delivery system, warheads are of little consequence. This is true for ASATs as well as for nuclear weapons. The mere possession of even a large number of orbital intercept vehicles would pose little threat, in the absence of a significant deployment of its delivery vehicles, which could be readily verified.

Present Soviet ASAT and Verification

Limits on the testing and deployment of the Soviet ASAT could be readily verified by national technical means. There is no need to attempt to limit mere possession by the Soviet Union of ASAT interceptor satellites. The inability to verify the physical destruction of interceptor satellites is the expressed reason that the Administration is not moving forward to limit ASATs. But readily verifiable limits on testing and deployment would adequately control ASAT capabilities.

Present Soviet ASAT—Testing and Verification

The Soviet ASAT is launched into orbit atop a modified version of the SS-9/SS-18 ICBM known as the F-LV. The launch is readily observable by early warning satellites. Once in orbit, the interceptor can be tracked by a variety of ground-based radars and cameras. The intercept maneuvers are readily distinguishable from the activities of other satelittes. The telemetry stream from the ASAT is subject to monitoring by ground- and space-based sensors. Because of its unique characteristics, testing of the Soviet ASAT could be readily verified.



Beginning in 1986, the Shuttle will launch the re-usable KH-12 photo reconnaissance satellite, which will be able to out maneuver the present Soviet ASAT.

Present Soviet ASAT—Deployment and Verification

The F-LV launch vehicle of the Soviet ASAT is over 10 feet in diameter and 150 feet long and is readily observable from space. It is over 30 feet longer than the SS-18 ICBM, with which it shares a common technological heritage, and is substantially different in appearance. A ban on the deployment of the Soviet ASAT could be adequately verified.

Defense Department statements concerning the operational status of the Soviet ASAT are based on reconnaissance satellite observations that the Soviets maintain several (the exact number is not clear based on the open literature, but it seems to be between two and five) launch pads at a high state of readiness, indicated by such activities as prompt snow removal. Under a deployment ban, at a minimum the operational readiness of these pads should be reduced. A much higher level of confidence as to compliance with the deployment ban would be achieved should the Soviets agree to dismantle these launch pads and their supporting facilities, which are in excess of what is required by their space program and strategic training activities. A further measure of confidence would be provided by a Soviet commitment not to increase the capacity (observable by an increase in floor space and railroad connections) of other launch facilities that are capable of supporting launches by their ASAT rocket booster. The capacity of the vehicle processing and fuel storage facilities at these sites would have to be greatly expanded to support a major ASAT campaign, and such an expansion would be readily observable.

Dedication of existing SS-18-type silos to the ASAT role would be readily observable. There are about 18 such silos at Baikonur, and a lesser number at Plesetsk, that are used to launch SS-18's for crew training and reliability checks. These could support F-LV launches of ASATs. However, since the F-LV is over 30 feet longer than the SS-18, because of its much larger third stage, these silos would need substantial modification, such as the construction of a three-story building over the silo. The greater support requirements of the ASAT vehicle itself, compared to the payload of an SS-18, would also necessitate the construction of additional support facilities. Dedication of these silos to the ASAT role would also remove them from their regular duties, resulting in a changed pattern of activity which would be observable. Despite the "rapid reload" capability of these silos, they will suffer greater damage from a launch than the regular F-LV launch pads, resulting in long repair times and a lower volume of launches. The basing of ASATs in operational silos would be immediately apparent, and any significant deployment would reduce Soviet strategic force levels.

Present Soviet ASAT—Possession and Verification

The Reagan Administration has argued on many occasions that since it would be nearly impossible to verify through national technical means alone the dismantling and destruction of the Soviet ASAT system, there is no real basis for an agreement limiting these weapons. But the standard of verifiability they require is so stringent, is so strict, that one wonders as to its seriousness. Clearly, they are correct in assessing the limits to verifying such a measure. Even if all the personnel of the CIA and the FBI (and even the Post Office) were loosed upon the Soviet Union to roam the country at will, the task of hiding a handful of interceptor satellites no larger than a small car would still be child's play.

However, there is no need to seek a ban on possession of ASATs, since a ban on use, testing and deployment is an adequate guarantee for American security. The number of launch vehicles and launch pads available for placing these interceptors into orbit is small, and could be reduced even further by an agreement limiting ASATs. Given the operational limitations of the Soviet ASAT (low reliability and limited launch windows), coupled with the slow pad recycle time of these launch facilities (probably on the order of several days), it would be difficult for the Soviets to assemble covertly the dozens of large rockets that would be needed for an extended ASAT campaign.

Residual Soviet ASAT and Verification

The low-altitude satellites that would be vulnerable to such a campaign are at risk regardless of the provisions of arms control agreements, or of Soviet compliance with them. A number of Soviet systems, which would not be limited by any plausible ASAT Treaty, would provide some residual ASAT capability, should it be desired. The manned Soyuz spacecraft, and its unmanned Progress counterpart, could be readily applied to the task of disabling a few low-altitude satellites.

Future Soviet ASAT and Verification

While some Soviet satellites might incorporate some marginal ASAT capability without detection, dedicated space-based ASATs would be difficult to disguise. A space-based laser with an effective range of more than several hundred miles would of necessity have a mirror many yards in diameter, and on the whole be quite a massive structure with a rather distinctive configuration.

Although the external physical characteristics of a space mine might not differ from those of other types of satellites, the limited maneuvering capabilities that such a disguise would impose on the space mine would require it to be stationed in an orbit rather similar to that of its intended target. While one or two such space mines might escape detection, given the variety of orbits that the dozens of American military satellites occupy, it would be virtually impossible to deploy a "space mine field" without detection.

American ASAT and Verification

Limits on the testing of the US ASAT could be readily verified, since the tests involve unique equipment and operations. But because of its small size and the small number of rockets that would be an effective force, a ban on the deployment of the US ASAT would be difficult to verify once its testing is complete. The testing program itself will produce potentially operational capabilities.

American ASAT—Testing and Verification

The testing of the MALS ASAT will be readily observable by the Soviets. In addition to press reports, their national technical means will observe mission-unique support equipment accompaning the F-15's in the test program, and will monitor the telemetry of the tests themselves. The Instrumented Target Vehicles (ITVs) that the ASAT will be shot at are 6-foot-diameter balloons, whose orbital characteristics and flight dynamics are unique. Tests against a point in space without benefit of an ITV will not provide adequate assurance in testing the error-free accuracy needed for the MALS impact kill mechanism. Thus a ban on testing the American ASAT would be verifiable.

American ASAT—Deployment and Verification

Because of its very small size, and the small number that will compose the operational force, a ban on the deployment of the MALS will be very difficult for the Soviets to verify and could pose a major stumbling block for limiting the arms race in space.

The MALS is comparable in size to the Phoenix air-to-air missile and the Air Launched Cruise Missile (ALCM). All these missiles are normally transported in coffin-like protective containers that are normally stored in buildings until just prior to use. Thus there will be very little to distinguish the MALS from many of the other types of ordnance normally seen at Air Force facilities. This situation is further complicated by the fact that the operational force of ASATs will number only 112, a small force that could be easily hidden in almost any warehouse or other small building.

The F-15's that will launch the MALS are not dedicated to the space defense role, but rather are assigned to the Tactical Air Command for continental air defense and other duties. These are provided with kits that can adapt the F-15 for the ASAT role in about six hours. These kits are normally stored indoors, and even when installed on the underside of the F-15, they are not observable to national technical means.

American ASAT—Possession and Verification

The MALS test program will generate a number of intercept vehicles and other types of equipment that are essentially identical to the operational items and not subject to ready detection by national technical means. Although Aviation Week would no doubt report on any tests of the ASAT, neither this nor any other open source would be able to account for the whereabouts of all the various MALS components produced as part of the test program, and of those components produced for the operational system prior to the assumed ban on possession. Thus as the test program continues and the scheduled deployment grows closer, the verifiability of a ban on possession of ASATs including MALS inexorably errodes.

Future American ASAT and Verification

This erosion would be particularly troubling from the Soviet point of view with regard to more advanced American ASATs, which could be assembled by merely adding a larger first stage to the existing second stage and MHV. Thus it would be a very straightforward task for the United States to field an ASAT capability, either against Soviet satellites in medium altitude orbits using a larger air-launched system or against Soviet satellites in geostationary orbit, using a Trident SLBM as a booster. To the extent that the MHV is tested to operational readiness, it can be expected that Soviet interest in a ban on possession will increase.

Conclusion

In sum, it is neither possible nor necessary to achieve verifiable limits on dedicated anti-satellite systems that are more restrictive of ASAT capability than the level of ASAT capability that would reside in non-dedicated systems with some residual ASAT capability. The alternative responses are either to seek to restrain ASAT developments that in coming years may place a growing number of satellites at risk or to take the all-or-nothing approach of the Administration, saying that the only alternative to perfect ASAT control is no ASAT control. The Administration seems to judge arms control by a more stringent standard, requiring that it never fail, than the standard imposed on weapons, which are assumed to have a finite and limited reliability. Arms control and weapons procurement are twin paths to national security, and should be judged by equal standards of performance; indeed if arms control fails, we can resort to weapons, but if weapons fail, arms control will be of no avail.

The longer testing of ASATs continues, the more difficult it will be to control these weapons. A mutual moratorium on ASAT testing will slow the momentum of the arms race in space and should be implemented as soon as possible.

A Moratorium on ASAT Testing

Meaningful limitations on ASATs must be achieved soon, or not at all. Once the new American ASAT is tested to operational readiness, the Soviets will have little confidence in their ability to verify a ban on its deployment. One likely Soviet response will be testing and deployment of a space laser, a move with potentially disasterous implications for international stability.

Soviet leader Yuri Andropov proposed a moratorium on the testing of ASATs on August 18, 1983 during the course of a meeting with a delegation of United States Senators. According to press reports, Andropov said that "The USSR assumes the commitment not to be the first to put into outer space any type of anti-satellite weapon, that is, imposes a unilateral moratorium of such launchings for the entire period during which other countries, including the USA, will refrain from stationing in outer space anti-satellite weapons of any type."

There is some confusion as to just what this moratorium covers. Does the proposal apply only to "stationing" of space-based systems? Or does it include "launching" ground-based and air-based systems "into outer space", and thereby cover the existing Soviet and American systems? Would the moratorium cover only the all-up testing of ASAT systems, that is against objects in space, or would it apply also to the testing of ASAT components?

To avoid these various definitional ambiguities, in June 1983 FAS proposed that the United States and the Soviet Union should agree to a moratorium on the testing of anti-satellite weapons against objects in space. Such interceptions are the only way of testing the homing guidance sensors on ASATs, which are the least proven elements of these systems. The use of homing guidance sensors against realistic targets in space is the only way that this critical technology can be adequately tested. The Soviets have yet to perfect satisfactory radar or heat-seeking sensors, and the American heat-seeking sensor is currently experiencing problems. A moratorium on their testing would effectively freeze the development of such weapons.

AN ASAT TREATY

The US and USSR conducted three negotiating sessions in 1978 and 1979 concerning ASATs. These talks were discontinued when the Carter Administration decided to concentrate its arms control efforts on ratification of the SALT II agreement, and they were never resumed, as a result of the general deterioration of US-Soviet relations following the Soviet intervention in Afghanistan. The Soviets proposed a Draft Treaty on space weapons to the UN in 1981, but it was seriously flawed and attracted little attention.

The Soviet Union proposed a new Draft Treaty on space weapons in August 1983. In a number of important respects the recent Soviet initiatives include very positive improvements over their previously articulated positions. In contrast to the rather modest 1981 Draft Treaty, the new set of Soviet proposals covers a broad range of activities, including prohibitions on the use, threat of use, testing and deployment of all space-based weapons, as well as of all types of anti-satellite weapons. The scope of the new proposals seems to suggest a very real Soviet interest in dealing with the major issues posed by the space weapons competition:

There are a number of ambiguities in these proposals that will need to be resolved before the willingness of the Soviets to agree to meaningful limits on space weapons can be fully assessed. Some of these ambiguities might be regarded as an effort by the Soviets to suggest the possible scope and nature of an agreement without having to 'give away the store' in advance of actually signing a Treaty. Other ambiguities are of the sort that normally arise when translating from one language to another and could be readily resolved. However, some of the provisions of the Draft pose problems that are more substantive in nature and may pose greater difficulties. But the place for these ambiguities to be resolved is the negotiating table.

FAS PUBLIC INTEREST REPORT (202) 546-3300
307 Mass. Ave., N.E., Washington, D.C. 20002
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November 1983, Vol. 36, No. 9

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