Chapter Five

The United States and Soviet ASAT Programs

> While space itself is relatively remote from human conflict, certain kinds of satellite could have a potentially decisive impact on the outcome of conflicts on earth. Both sides recognize this fact. In peacetime, their satellites operate freely. But each side maintains some capability to interfere with or attack satellites that—given the outbreak of war—might threaten to reveal the location, size or readiness of their terrestrial or maritime forces.[1]

This chapter first examines the United States policy during the Cold War toward antisatellite weapons. Initially it analyzes the philosophy which believed that ASAT weapons had a destabilizing effect on the United States' relationship with the Soviet Union. The chapter then addresses the successive administrations" policies toward ASAT weapons and discusses the technological systems. The chapter also outlines the development of the Soviet ASAT in terms of both the organizational structure and eventual ASAT testing and the development of its capability. It analyzes the Soviet ASAT testing methods to gain an insight into the strengths and operational capabilities of its program. Toward the latter period of the Cold War in the late 1970s ASAT arms control measures began to be debated. These ASAT arms control measures are also analyzed. With the end of the Cold War the ASAT issue has not gone away. Indeed the issue has risen to the fore, especially in the light of U.S. policy which seeks to control space. The final section addresses the U.S. approach to this. Having analyzed the extensive Soviet ASAT development during the Cold War the chapter analyzes Russia's continuing work on ASAT weaponry.

Antisatellite Weapons and Strategic Stability

Antisatellite weapons are sometimes deemed to have a similar impact on strategic stability as ballistic missile defense, in that they are seen as destabilizing.[2] ASAT weapons threaten the satellites which are said to enhance strategic stability namely early warning satellites, communication satellites, and photoreconnaissance satellites. Early warning satellites are vital to strategic stability in that they provide warning of an impending attack, especially in a nuclear context. In a nuclear arena warning time is essential to strategic stability in that it prevents one side achieving a surprise first-strike attack on the other side's more vulnerable retaliatory nuclear assets, namely ICBMs and nuclear-equipped aircraft. An ASAT capability targeting early warning satellites is seen as extremely destabilizing in that it undermines a central essence of nuclear deterrence, namely that a surprise attack is unachievable. Also, the targeting of photoreconnaissance satellites which are important in the context of arms control verification, undermines the stability of the international security environment which arms control can provide. It is for these reasons that ASAT weapons are deemed to be destabilizing in an international security context.

The United States ASAT Program during the Cold War

The Eisenhower administration's position toward the development of an antisatellite system was founded on the belief that the United States was more reliant on reconnaissance information provided by satellites than the Soviet Union and subsequently did not want to initiate anything which could jeopardize that. This was because of the closed nature of the Soviet society that did not allow the United States to gain information concerning it, whereas the U.S. society was a very open and provided a great deal of information which the Soviets were able to use. Indeed, the following quote from Herbert York, the former Director of Defense Research and Engineering, encapsulates this belief:

> The President himself, in recognition of the fact that we didn"t want anybody else interfering with our satellites, limited [one ASAT] program to study only status and ordered that no publicity be given either the idea or the study of it.[3]

Implicit within this belief was that the United States, by forgoing the development of an ASAT capability, would have a subsequent effect on the Soviet Union's own desire to have such a system. Indeed this policy flowed from the sanctuary school of space policy, despite the fact that the Eisenhower administration was seen to be "hedging its bets" by pursuing the conceptual development of an ASAT system.

The Kennedy administration's like Eisenhower's, was willing to authorize the development of other ASAT programs in the eventuality of an unforeseen Soviet space threat. In February 1963 the Kennedy administration published the following statement by Marshal Biriuzov, chief of the Soviet Rocket Forces: "It has now become possible to command from earth to launch missiles from satellites at any desired time and at any point in the satellite trajectory."[4] Indeed further evidence of Soviet intentions was provided by Secretary of Defense McNamara testifying before Congress a month prior: "the Soviet Union may now have or soon achieve the capability to place in orbit bomb-carrying satellites . . . [and] we must make the necessary preparations now to counter it if it does develop."[5] This had led McNamara to instruct the U.S. Army in May 1962 to develop and modify NIKE-ZEUS in an ASAT role.

The ASAT was Program 505 which was an adaptation of the Army's NIKE-ZEUS Anti-Ballistic Missile; work began in 1955. The technology of an ABM is able to be adapted for an ASAT role since both missiles are intended to intercept targets in space. The differences however lie in the geometry of the interceptions; an ICBM observes a curved trajectory compared to the horizontal path of a satellite. There are also differences in angle, distance, and speed of the target which must be adjusted by the guidance radar. An ABM also has to be operational at all times. In many ways an ASAT capability is less demanding than that of an ABM since only one target would be engaged at a time. The target's flight path, direction and altitude would be known well in advance, whereas an ABM has to contend with multiple targets, decoys, jammers, and booster debris simultaneously, with little warning time.

The first NIKE-ZEUS ASAT test successfully intercepted an imaginary target in space at an altitude of 100 nautical miles (185km), and was within the lethal distance of the nuclear warhead.[6] A second ASAT test was conducted and intercepted an imaginary target in space at a range of 151 nautical miles (279km). However several failed tests followed and Program 505 was eventually phased out in 1966, while the rival Air Force Program 437 received the ASAT mission.[7]

Program 437 used a Thor intermediate-range ballistic missile to reach its target. The first intercept by Program 437 occurred in February 1964. The Thor missile was launched at a target, a Transit 2A rocket body, occupying a 564 by 335 nautical mile orbit, inclined at 66.7 degrees. The intercept point was at an altitude of 540 nautical miles, and the warhead passed close enough to the target to be considered a successful interception.[8] The following two tests were also deemed to be successful. In June 1964 the Thor ASAT system was declared operational. However, the effects of using a nuclear armed ASAT was considered in terms of its nondiscriminating effect on friendly satellites and the search for a nonnuclear ASAT began. Consequently on 1 April 1975 Program 437 was terminated partly due to its inability to deal with the threat from the increasing number of Soviet military satellites.[9]

The United States position for a U.S. ASAT capability in the 1970s was that the United States should match the Soviet ASAT capability as a means of deterring attacks on U.S. satellites. A weakness of this position was that it was argued that the United States was more dependent upon its satellites for military effectiveness than the Soviet Union, therefore in a tit-for-tat exchange the United States would be in a weaker position. The United States would have been in a weaker position vis-a-vis the Soviet Union since the Soviets had fewer military forces deployed beyond their borders and could rely on ground-based lines of communications, as well as the fact that the Soviets had less need for worldwide communications and navigation aids.[10] For these reasons it is unlikely that the possession by the United States of an ASAT capability would have acted as a deterrent for the Soviet Union making use of its ASAT capability.

The outgoing Ford administration and the incoming Carter administration recognized the Soviet "antispace defense" system as a threat to U.S. space assets. In response to this newly perceived threat the Ford administration planned to "increase significantly the U.S. space defense effort over a broad range of space-related activities which include space surveillance, satellite systems survivability, and the related space operations control function (meaning a U.S. ASAT)."[11] The Carter administration, unlike any of the previous administrations was faced with the likelihood of a Soviet ASAT becoming operational. However, like the Eisenhower and Kennedy administrations, the Carter administration pursued a policy of negotiating arms control on ASATs while maintaining research and development of an ASAT system as insurance. Research and development into ASAT technologies was heavily constrained. The following quote from the Carter administration's Secretary of Defense Brown encapsulates the essence of this policy:

> As the President has clearly stated, it would be preferable for both sides to join in on an effective, and adequately verifiable ban on antisatellite (ASAT) systems; we certainly have no desire to engage them in a space weapons race. However, the Soviets with their present capability are

> leaving us with little choice. Because of our growing dependence on space systems we can hardly permit them to have a dominant position in the ASAT realm. We hope that negotiations on ASAT limitations lead to a strong symmetric control. But in the meantime we must proceed with ASAT programs (for the present short of operational or space testing), especially since we do not know if the Soviets will accept the controls on these weapons that we would think necessary.[12]

The Carter administration engaged the Soviets on three separate occasions from 1978 to 1979 in the pursuit of an ASAT limitations treaty, but the Soviets were unwilling to come to an agreement during this era.[13] The Soviet invasion of Afghanistan put an end to the negotiations in late 1979.

There were several key events early in the Reagan administration that polarized the ASAT issue. The Soviets in 1981 submitted to the United Nations a draft ASAT treaty calling for the banning of weapons in space. Soviet Premier Andropov two years later continued the Soviet "peace initiative" by denying Soviet first use of ASATs in outer space and offered to dismantle the existing Soviet ASAT system and prohibit further development. In 1983 the Soviets proposed another draft treaty to the UN. This called for "a ban on the use of force in space and dismantlement of existing ASAT systems."[14] The Soviets at the same time as these proposals tested their co-orbital ASAT system for its twentieth and final test in 1982. The Soviet Union shortly after unilaterally declared a moratorium on any further tests of its co-orbital ASAT.[15] This unilateral declaration of a moratorium provided ammunition for opponents in Congress of the U.S. development and deployment of an ASAT. However, the Reagan administration determined that the development, procurement, and deployment of a U.S. ASAT was vital to national security interests despite the Soviet proposals.

The Reagan administration showed strong support for a U.S. ASAT capability by requesting additional funding from Congress from fiscal year 1982 through to fiscal year 1985. Indeed, Congress appropriated each year what the administration requested.[16] In addition to the funding increases the Reagan administration provided a rationale for the acquisition of an ASAT capability. In a report to Congress on 31 March 31 1984, President Reagan cited two primary reasons for pursuing a U.S. ASAT. First, a U.S. ASAT capability to destroy satellites was required to deter Soviet attacks on U.S. satellites in a crisis or conflict. The policy statement cited the example that if the Soviet Union used its ASAT capability in a crisis or conflict to disable or destroy a U.S. satellite, the United States would have no means to respond in kind to avoid escalating the conflict.[17] Second, it was argued, "a comprehensive ASAT ban would afford a sanctuary to existing Soviet satellites designed to target

U.S. naval and land conventional forces."[18] Therefore, the Reagan administration argued a capability was required "for U.S. and Allied security to protect against threatening satellites."[19] The Reagan administration's policy for an ASAT requirement was thus as a means to deter the Soviets from using their co-orbital ASAT to attack U.S. space systems and a means to negate Soviet space systems designed to target U.S. forces. The Reagan administration's policy toward ASAT represented a departure from the policies espoused by previous administrations in that arms control measures were no longer deemed desirable. This was mainly due to the ideological standpoint of the administration which did not see space as being different to any other geographical environment and hence free from weaponization. The twin-track policy under the Eisenhower and Carter administrations of simultaneously pursuing research and development and ASAT arms control measures was effectively over.

The air-launched U.S. ASAT capability began in the early 1970s with full-scale development commencing in 1977. The system involved the "direct ascent" of an interceptor to its target, in contrast to the Soviet co-orbital ASAT system tested between 1968 and 1982. The interceptor consisted of an miniature homing vehicle (MHV) on a two-stage missile. The system was mounted under an F-15 fighter, the SRAM first stage and the Altair second stage would have taken the interceptor up another 500 kilometers, from where the MHV would use its eight heat-seeking infrared sensors to acquire the target, and then fire small rocket thrusters to ram the target. Destruction was to be achieved by velocity impact.

The weapon was launched from information supplied by the ground-based satellite tracking network.[20] Homing was to be achieved through a combination of eight infrared telescopes, a set of small thrusters and a laser gyroscope. The infrared sensors identified the target against the cold background of space. This guaranteed accurate data and prevented the miniature vehicle from "attacking" stars.[21] It spun at twenty revolutions per second, which not only kept it stable but assisted the eight telescopes in acquiring and locking on to the target. The cylinder rotated while the gyroscope determined when the various thrusters were to be fired in order to bring it into the path of the target. The outer shell of the miniature vehicle was composed of fifty-six small cylinders of solid rocket-propellant, the nozzles of which pointed out to the side. When fired, under control of the guidance system, they moved the vehicle body to keep it on a collision course. The rockets were fast-burning so as not to upset the spin stabilization. The guidance task of firing the correct rocket at the proper time was a major one requiring extremely sophisticated electronics, and timing was of the essence because of the vehicle's fast spin rate.[22] After the miniature vehicle's course had been corrected, counterfiring stopped the lateral drift. To achieve accuracy a laser-gyro acted as a clock enabling the onboard computer to determine which rockets have fired—they were single-shot only—and allowed the miniature vehicle to rotate past the spent rockets. Additional rockets were used to prevent the miniature vehicle developing "wobble" due to the firings. The ensuing high speed collision destroyed the target. The energy of such an impact is akin to hitting a satellite with a shell from a battleship's main gun.[23] A direct collision at such high velocity was simpler than fusing and exploding a warhead.

In principle any F-15 could have been adapted to carry the antisatellite weapon. Carrier-based F-14s or midair refueling of the F-15 would have enabled the antisatellite weapon to attack almost any position in the world.[24] This would have allowed the U.S. to target all of the low-orbit satellites along with the highly elliptical orbit satellites known as Molniya satellites, possessed by the Soviet Union.

The first flight test occurred on 21 January 1984, when an ASAT booster, without a MHV aboard, was launched against a point in space. A second test in November was targeted against an infrared emitting body (a star) to test the ability of the MHV to distinguish between its target and the background infrared emission of space. Both of these were considered to be successful. The third, and most important, test took place on 13 September 1985; in this test, the complete system was launched against a target satellite. The MHV successfully intercepted the target.[25] The miniature vehicle was destroyed by direct collision with the target at 45,000 feet per second (13,716 mps).

The F-15-launched antisatellite missile was a two-stage solid-fuel rocket 17.75 ft (5.4m) long and weighed 2632 lb (1194 kg). The first stage, 17.6 in (6.9 cm) in diameter, was based on the Boeing Short Range Attack Missile (SRAM). At the base are two small fixed fins and three large movable fins which control the vehicle during atmospheric ascent.[26] The second stage had an Altair III rocket motor of the kind used as the fourth stage on the Scout launch vehicle. It was specially strengthened for its antisatellite role and was fitted with small hydrazine thrusters for attitude control. The second stage was 19.76 in (7.8cm) in diameter. At its forward end was the miniature vehicle, with its spin table and subsystems (such as the inertial reference unit, computer and cryogenic tank for cooling the infrared sensor). An inertial guidance unit provided control during powered flight until a specific point in space was reached.[27] At this point, the miniature vehicle begins to search for its target. After second-stage burnout, it spins up and the target satellite was acquired.

The F-15 launch aircraft itself required certain modifications. An electronic package replaced the 20mm ammunition container. There were wiring charges and a special centerline pylon which included a microprocessor, a communications line between the missile and aircraft, a back-up battery, electrical connections, and a gas generator ejection system. The pilot's launch duties were minimal as he receives steering commands via the cockpit head-up display. For most attack profiles, the ASAT was launched while the F-15 was in subsonic, straight, and level flight. For satellites in higher orbits, a supersonic climb would be used. This added speed to the ASAT and avoids the need for a sharp pullup which might overstress the missile. The launch was automatic with a ten to fifteen second window.[28]

The F-15 ASAT has a number of advantages over a more conventional system. An F-15 could be flown to wherever necessary to accomplish an interception. A fixed-based ASAT, dependent on a large rocket, lacked such flexibility. As long as there are F-15s, ASAT missiles, supplies, and means to function in comparison with a fixed-base ASAT, the air-launched ASAT would be a candidate for attack during the early stages of an escalating war.[29] It was economically feasible to build enough of the weapons to cope with a high enemy launch rate.

In the mid-1980s Congress began constraining the U.S. ASAT program. This was due to the difference in ideology with regard to the weaponization of space between the Democrat majority and Republican minority. The fiscal year 1986 appropriation procurement money was significantly slashed and in fiscal years 1987 and 1988 Congress denied procurement funds completely. On 19 December 1985 a Congressional ban prohibited any further tests of U.S. ASATs in space until and unless the Soviets tested its ASAT again. In fiscal years 1987 and 1988 Congress continued the ban.[30] Indeed, an Office of Technology Assessment report highlighted the complexity of the ASAT issue:

> In choosing between ASAT weapon development and arms control, one wishes to pursue that course which makes the greater contribution to U.S. national security. This is often characterized as a choice between developing a capability to destroy Soviet satellites while assuming U.S. satellites will also be at risk, or protecting U.S. satellites to some extent through arms control while forfeiting effective ASAT weapons. The better choice could, in principle, be identified by comparing the utility which the United States expects to derive from its military satellites with the disutility which the United States would expect to suffer from Soviet MILSATs during a conflict. Such a compariso although—possible in principle—is made exceedingly difficult by the number of conflict scenarios which must be considered and by the lack of consensus or official declaration about the relative likelihood and undesirability of each scenario.[31]

During the latter part of the Reagan administration Congress was unable to be convinced of the deterrent value of an ASAT. The influence on Congress of the earlier Soviet initiative for banning weapons in space and the moratorium on testing of their own ASAT system cannot be discounted. In February 1988, Secretary of Defense Carlucci announced the cancellation of the Air Force's F-15 ASAT program citing the negative impact of the Congressionally mandated ASAT test ban.[32]

The Soviet ASAT Program during the Cold War

The first indication that the Soviet Union was seriously developing an ASAT capability came in 1963-1964 with the formation under the PVO-Strany air defense branch of a special antispace defense detachment called PKO (Protivo Kosmicheskaya Oborona).[33] The mission of this unit was to repel any attack emanating from outer space.

The Soviet Union continued to proceed with an ASAT program despite the cancellation of the United States Army ASAT program in 1966 and the Air Force ASAT program in 1970. The motivation for the Soviet antisatellite program can be seen from its doctrinal concept of "anti-space defense." The Soviet Union in 1965 defined this concept in the following manner:

> The main purpose of anti-space defense is to destroy space systems used by the enemy for military purposes, in their orbits. The principal means of anti-space defense are special spacecraft and vehicles (for example, satellite interceptors), which may be controlled either from the ground or by special crews.[34]

The Soviet view of the requirement for a satellite negation capability was similar to that of Generals White and Gavin for a U.S. ASAT program.

The Soviet ASAT weapons used a "hot-metal kill" weapons which was essentially an explosion in the vicinity of the target satellite which produced a spherical cloud of shredded metal expanding evenly in all directions.[35] The use of a high-explosive warhead, as opposed to a nuclear circumvented the Outer Space Treaty. However, the use of conventional means meant the ASAT had a narrow miss distance and had to pass closer to the target satellite for a successful kill.

From October 1968 the Soviet Union had tested twenty satellite intercepts against Russian target spacecraft. In sixteen of these tests the intercept distance was deemed close enough for the mission to be termed a success.[36] The interceptor vehicle was able to close in on the target satellite within one or two orbits which demonstrated a quick reaction capability. The SS-9 boosters which launched the antisatellite payloads were able to be wheeled from their shelters at the Tyuratan site and prepared for launch in less than ninety minutes.[37]

The intention of the series of Soviet satellite testing starting in 1968 only became known after six months had elapsed and the first full interceptor test had occurred.[38] On 19 October 1968 Cosmos 248 was put into orbit and on the following day Cosmos 249 was placed into an orbit that equated with the orbital plane and apogee of Cosmos 248. Indeed, within four hours a close high-speed "flyby" took place. What was more significant was that Cosmos 249 was destroyed after the flypast. Though this was not the first occasion that Soviet satellites had been exploded in orbit its occurrence with the interception of another satellite was enough to suggest the initiation of a new type of activity.[39] This was confirmed with the launch of Cosmos 252 on 1 November 1968 when it performed almost identical maneuvers to Cosmos 249, and exploded after passing close to Cosmos 248.

The reason for the destruction of the interceptor was not clear. There were however two possible theories:

> The explosions of these two payloads could mean that they carried instrumentation and other devices the Russians did not want to leave in orbit for some future generation of curious inspectors of another nationality to find; or they could have been exercising the destruct mechanism, presumably at a safe distance so as not to destroy their own target.[40]

Not until the 1983 edition of Soviet Military Power was official light shed on the matter. According to the report the Soviet ASAT detonates a pellet warhead near the target to effect a kill by damaging vital satellite components.[41]

A two-year cessation followed until on 20 October 21970 Cosmos 373 was launched from Tyuratam into an unusual orbit with a high apogee. This orbit was subsequently modified into a circular orbit similar to the first target satellite Cosmos 248. Three days later Cosmos 374 was launched from Tyuratam; this interceptor satellite was maneuvered to match the orbital altitude of Cosmos 373 at its perigee and a high-speed fly pass occurred.[42] However, Cosmos 374 apparently conducted an unsuccessful two-revolution interception with Cosmos 373.[43] The interceptor was then detonated. A week later the exercise was repeated using the same target satellite, but a new interceptor Cosmos 375 was used.[44]

In 1971 the satellite interception tests began to differ from the previous tests in a number of ways. The target satellites were launched from Plesetsk in the northwest of the Soviet Union instead of from Tyuratam, and were at a new inclination of 65.8 degrees. The launch vehicle, a modified SS-5 intermediate-range ballistic missile indicated that the target was significantly smaller than the earlier ones.[45] The new series of tests began with Cosmos 394 the target satellite, launched on 9 February 1971 and the interceptor satellite Cosmos 397 launched from Tyuratam sixteen days later.[46] The interceptor, initially in low orbit, maneuvered to a higher altitude to undertake a similar perigee-matching exercise with Cosmos 394. The interceptor satellite was detonated after the intercept. Unlike the previous intercepts, the intercept satellite was not used again for a second interception as was the case for all subsequent target satellites which were deemed successful.

On 19 March 1971 a new target satellite Cosmos 400 was launched into a circular orbit, approximately 1,000km, using a SS-5 booster from Plesetsk. The interceptor satellite, Cosmos 404, was launched from a SS-9 from Tyuratam sixteen days later. This maneuvered into a circular orbit similar to Cosmos 400. At the start of Cosmos 404's second revolution it was less than three minutes ahead of its target, and by the end of the third it was only one minute behind. With their orbital elements and hence their orbital velocities similar a much slower flyby was achieved which suggested that this mission was to test inspection equipment.[47] Instead of being detonated Cosmos 404 was deorbited back to earth. Whereas the previous five ASAT tests had ended with the interceptor maneuvering to a higher orbit and then exploding, Cosmos 404 performed a braking maneuver and reentered the earth's atmosphere.

On 29 November 1971 Cosmos 459 was launched from Plesetsk into the lowest ever orbit by a SS-5 launcher at approximately 250km at a 64.8 degree inclination. On 3 December 1971 Cosmos 462 was launched from Tyuratam into an unusual orbit and completed the familiar high-speed interception at their respective perigees.[48] The interceptor satellite Cosmos 462 was detonated after the flyby. This interception was more demanding owing to the lower altitude, which due to the higher drag of the earth makes the prediction of the speed and the likely position of the target satellite more complex. This was the last test until they resumed in 1976.

This first phase of testing demonstrated that the Soviet Union had a rudimentary yet significant antisatellite capability that threatened an important category of U.S. satellites. As one analyst observed:

> Within a period of eleven months the Russians had demonstrated their ability to place hunter spacecraft in the vicinity of targets with orbits

> characteristic of [U.S.] electronic ferrets, meteorological and navigation satellites and photo-reconnaissance payloads.[49]

The first four tests of the Soviet antisatellite system had produced a 50 percent success rate which was not bad for the initial test phase of a major new weapons program. The three successful tests in the following year raised the success rate to over 70 percent and probably signaled a Soviet ASAT initial operational capability. The 1971 tests more importantly demonstrated new characteristics, particularly a flexibility in attack geometry.[50]

The Soviet antisatellite system compared with the U.S. Thor-based system had several superior capabilities. The system had considerable flexibility in its intercept trajectory, allowing attack from a number of directions and hence making countermeasures more difficult.[51] The non-nuclear warhead eliminated any possible collateral damage from a nuclear detonation which was used in the U.S. system. The reach of the Soviet system had demonstrated that U.S. military satellites in orbits below 1,000 km were vulnerable. The Soviet ASAT used the SS-9 as a launcher which was probably chosen because there was an abundant supply since it had become out of service. This was deployed in large numbers in the southern part of the Soviet Union which meant that many U.S. satellites could have potentially been negated in a short space of time.[52] Although refitting the payloads would not have been that easy as the ASAT SS-9 needed to have special facilities.

The Soviet ASAT system did possess some significant limitations. During the tests the interceptors had been placed in orbits coplanar with their targets which meant that an ASAT could be launched at a specific target only twice each day from a given launch site.[53] The flight time of the interceptors was in excess of three hours which could allow the target satellite an amount of time to deploy countermeasures. A further constraint of the coplanar attack was the inability to intercept satellites in inclinations below forty-five degrees, which ruled out attacks on U.S. manned spacecraft and other NASA satellites.[54] Finally, most U.S. satellites were in orbits above 1,000km including the early warning and communication satellites.

The Soviet antisatellite tests entered a self-imposed moratorium coincident with the birth of detente and the signing of the SALT I accords. Although at the end of September 1972 Cosmos 521 was launched from Plesetsk into an orbit characteristic of a target satellite for a future ASAT test, it was never intercepted.

The Resumption of Soviet ASAT Testing

The Soviet decision to resume ASAT testing in 1976 was multipurpose. The show of resolve displayed by the testing might have brought the United States back to the bargaining table with new concessions, as the SALT II negotiations were underway, especially since the United States' ASAT system had been dismantled. Also, if the SALT II process was abandoned with a consequent rise in international tension a Soviet operational antisatellite system might be required. The four-year cessation in testing had also allowed Soviet engineers time to design new ASAT hardware and operational options.[55] These would have to be tested before being adopted into a fully established system.

On 12 February 1976 a target satellite Cosmos 803 was launched from Plesetsk on a SS-5 into an orbit at an inclination of 66 degrees. Four days later Cosmos 804, the interceptor satellite, was launched from Tyuratam into a more eccentric orbit at an inclination of 65.1 degrees. After several maneuvers its orbit was changed and its inclination altered to that of Cosmos 803, with the interception taking place over the Soviet Union.[56] However, this test was deemed to have been a failure since the miss distance between the satellites was around eighty nautical miles and the interceptor satellite was unusually brought back to earth. Cosmos 803 was again used as a target satellite on 13 April 1976 when Cosmos 814 was launched from Tyuratam within four minutes of Cosmos 803 passing over the launch site. Tracking data showed the Cosmos 814 interceptor in an initial 297 by 72-mile orbit, which was lower than the target's 385 by 340-mile orbit. This lower orbit meant that Cosmos 814 gained on its target. Once it had caught up in this manner, Cosmos 814 fired its onboard engine and assuming an elliptical orbit made a fast flyby.[57] From launch to interception had taken forty-two minutes. The appearance of the "Pop Up" profile required less than one orbit from launch to interception and provided a fast reaction capability. Between 1976-1977 the new technique was tested in a variety of circumstances. It was tested against a target in a medium-altitude orbit, a highly elliptical orbit, and a low elliptical orbit. Each test imparted different demands on the interceptor.[58] The Soviets had demonstrated a significant new enhancement of the system with the time from launch to intercept was cut in half. Thus an intended target would receive less warning time of an attack and might not be able to employ countermeasures.

On 8 July 1976 Cosmos 839 was launched but was placed in a much higher orbit than previous target satellites. The lowest point of the orbit was nearly 1,000km above the Earth's surface, while the apogee reached an altitude of 2,100km. An interceptor satellite Cosmos 843 was launched on 21 July but it was deemed to have failed to have reached the required height and reentered the atmosphere afterwards. However, it was possible that it may not have been a failure and that the interceptor could have maneuvered close to the target shortly after launch and been recovered in less that one revolution.[59]

The Soviet Union reverted to the rapid flypast interception followed by the destruction of the interceptor satellite. This took place on 9 December 1976 with the launch of Cosmos 886, the target satellite and Cosmos 886 the interceptor satellite launched on 27 December of that year.[60] There had been four attempted intercepts in 1976, although some of them may have been failures it was the highest number of tests in any one year. A further four tests beginning in May were conducted in 1977. Further information regarding the Soviet satellite interceptor came to light. Its dimensions were between 15 to 20 feet in length, 5 feet in diameter, and weighed around 2.5 tons. It had two main boosters for maneuvering in space. It was noted that the Soviets had been experimenting with a new guidance system. Whereas previous interceptors used a radar homing system, a new optical infrared sensor was used for the Cosmos 880/866 intercept on 27 December 1976 possibly in anticipation of U.S. countermeasures.[61]

The antisatellite interceptors prior to Cosmos 886 used a radar seeker to acquire and to track the target satellite as they moved in to simulate the intercept. Cosmos 886 used a new sensor which relied on reflected sunlight or possibly the infrared emissions of the target satellite to serve as the homing device.[62] There were two principal advantages of an acquisition and tracking sensor of this type. Optical-thermal sensing systems are typically much lighter and compact and require less electrical power than radar. More importantly, optical-thermal sensors are harder to counteract. Radar seekers can be jammed by a range of electronic techniques whereas decoys are often required to fool sensors which operate in the visible or near-visible portion of the spectrum.[63]

The April 1976 test was reported by *Aviation Week and Space Technology*. This article gave readiness details of the system. It reported that between 1972 and 1975 observations had been made of ground exercises which included SS-9s with antisatellite payloads.[64]

On 19 May 1977 Cosmos 909 was launched from Plesetsk into a highly elliptical orbit at an inclination of 66 degrees. Four days later Cosmos 910 the interceptor satellite was launched from Tyuratam into an orbit with the same inclination. Instead of a fast flyby interception occurring the interceptor satellite returned to earth within one revolution. This was initially interpreted as a failure. However, when on 17 June 1977 another interceptor, Cosmos 918, was launched against the previous target, Cosmos 909, a new method of interception was apparent.

Cosmos 918 was initially launched into 197 by 124 km orbit at the same inclination as the target satellite, but in a rapid maneuver, the interceptor suddenly "popped up" to pass the target satellite at its apogee.[65] In the same movement, the interceptor returned to earth. This demonstrated a greater degree of flexibility in the use of the Soviet antisatellite system and a capability to intercept satellites at higher altitudes.[66] This method was again used against the target satellite Cosmos 959 on 21 October 1977. Cosmos 961 was launched five days later and within three hours performed a low-orbit demonstration test of the high orbit pop-up technique at an altitude of 150km.[67]

The back-to-back tests of Cosmos 918 and 961 further expanded the capabilities of the Soviet ASAT. The new orbital intercept extremes of a maximum of 1,575km and a minimum of 150km easily covered U.S. low-altitude satellites. In addition, one test demonstrated a two-revolution intercept while another fulfilled its intercept in just one revolution. This flexibility would have made U.S. decisions of what countermeasures to employ and when to activate more difficult. Countermeasures employed to combat a two-revolution intercept would be inadequate if the ASAT arrives after one orbit. Equally if the activation of the evasive maneuvers or decoys against an anticipated one-revolution intercept, then the intercept occurs an hour and a half later. The decoys may have either dispersed beyond effective limits or may have exhausted their energy sources.[68]

The Soviets then reverted back to the earlier intercept method followed by the detonation of the interceptor vehicle. On December 13, 1977 Cosmos 967 was launched from Plesetsk with the interceptor Cosmos 970 following on 21 December. On this occasion a slow flypast was completed after the original orbit of the interceptor had become circular. The interceptor vehicle was destroyed afterward. On 19 May 1978 Cosmos 1009 was launched from Tyuratam and maneuvered for a close inspection of Cosmos 967 before returning to earth. This was the last test in the series before the first round of antisatellite arms control negotiations in Helsinki.[69] Testing resumed after it became apparent that the limitation talks would not continue after the Soviet Union had invaded Afghanistan in 1980.

Since 1968 there had been three distinct types of satellite interception: the fast flypast, the slow flypast, and the "pop-up" technique. While U.S. satellites in low earth orbit were considered vulnerable, the Soviet system had not demonstrated an ability to attack geostationary orbits which contained the early warning satellites and communication satellites.

The Soviet ASAT program moved into an engineering and development testing proceeding at the rate of one flight per year during 1978-

1982. The original radar-guided ASAT interceptor was capable of intercepts to about 5,000km using a one- or two-revolution trajectory.[70] The primary Soviet difficulty focused on the development of the optical-thermal guided weapon. This device was tested between 1978 and 1982 against targets in roughly circular orbits of 1,000km altitude, and all four appear to have been unsuccessful. On 18 April 1980 Cosmos 1174 intercepted Cosmos 1171 which had been launched on 3 April. This test was deemed a failure since the interceptor did not pass closer than the 8km which was considered to be the lethal radius of its shrapnel warhead.[71] The test in 1981, Cosmos 1243, against the target satellite Cosmos 1241 indicated that there had been a possible close encounter but there was reason to believe that the intercept was not completely successful. A month later a new interceptor Cosmos 1258, believed to have been radar-guided, made an intercept against the same target, Cosmos 1241. No target had been engaged twice when the original attempt had been successful. The reversion back to a radar-guided ASAT probably reflected the consternation after the four failures with the optical-thermal system.[72] The Cosmos 1258 intercept was deemed a success.

The June 1982 ASAT test was the twentieth Soviet orbital testing in fourteen years. The target satellite Cosmos 1375 was placed in a circular orbit of 1,000 km the same as the previous five tests. On 18 June Cosmos 1379 the intercept satellite was launched on a two-revolution intercept. Despite the initial accurate orbital maneuvers the fuse failed to fire on time and the intercept failed.[73] The significance of this test was that Cosmos 1379 was part of a simulated exercise during which front-line strategic and tactical weapon systems were tested. It included ICBM, SLBM, and IRBM firings, and also ABM engagements against dedicated targets. Also, the command, control, and communications (C3) networks were tested in a simulated wartime environment along with the support radars (Hen House, Dog House, Cat House, and Try Add). In the space sector of this exercise the launch of two Soviet satellites, one photo-reconnaissance from Tyuratam and one navigation from Plesetsk, was made between the launch of Cosmos 1379 and its attempted intercept of Cosmos 1375.[74] Prior to this no space launch had occurred during an ASAT test or from Tyuratam. The space launches may have imitated the orbiting of replacements for those destroyed by the United States during the simulated conflict.[75]

The Soviet ASAT system was operational in 1971. This was not confirmed until 1984, as prior to this it was believed to have become operational in 1977.[76] There were attempts to link operational intentions to the fact that since 1971 Soviet ASAT tests occurred at an inclination of 65.8 degrees and hence were aimed towards Chinese satellites. The case was made since Chinese satellites are flown nearer this inclination than U.S. satellites, and the first Chinese satellite appeared in 1970. Indeed, one commentator has argued that the Soviet interceptor tests followed both of the first two Chinese launches of satellites in April 1970 and March 1971. In addition the inclination of the interceptor was similar to that of Chinese satellites, suggesting that the intended target was the Chinese satellites.[77] However, the inclination of 68.5 degrees was a consequence of launching the target from Plesetsk (Tyuratam no longer had the facility to launch the SS-5 derived space vehicle), the launching of the interceptor from Tyuratam (until 1977 Plesetsk did not have a facility to launch the SS-9 derived space vehicle), and certain range and safety intercept restrictions.[78] The Soviet ASAT performed coplanar intercepts and subsequently the targets and ASATs had to orbit the Earth at the same inclination. The highest inclination launch from Tyuratam was 73.4 degrees and the lowest inclination launch possible from Plesetsk was 62.8 degrees, so the ASAT inclination had to fall within this.[79] The only common inclinations flown from each site have been 62.8 degrees, 65 degrees and 65.8 degrees. However, no characteristic of the Soviet ASAT was dependent upon orbital inclination, that is the launch azimuth, since this factor does not affect the intercept geometry. Therefore, the linkage between the Soviet ASAT and the Chinese 'space threat" was misleading.[80] In addition, the Soviet ASAT program was developed and tested before the first Chinese satellite flew.

The Search for ASAT Arms Control

The first notification that the Carter administration was seriously considering ASAT arms control and had proposed the issue with the Soviet Union came at a press briefing by President Carter on 9 March 1977 where he announced:

> I have proposed both directly and indirectly to the Soviet Union, publicly and privately, that we try to identify those items on which there is relatively close agreement—not completely yet, because details are very difficult on occasion. But I have for instance, suggested we forego the opportunity to arm satellite bodies, and also to forego the opportunity to destroy observation satellites.[81]

The issue was raised again by Secretary of State Vance on his visit to Moscow in March of that year. Although not the primary focus of the visit, both the Arms Control Disarmament Agency and State Department had prepared briefing papers that outlined a range of antisatellite arms control options. At the press conference following the meeting on 30 March Secretary of State Vance announced that both sides had agreed to set up working groups to discuss specific areas of arms limitation, including one for antisatellite weapons.[82] Prior to the meeting in Moscow, President Carter had issued Presidential Review Memorandum PRM/NSC-23 that directed the recently created NSC Policy Review Committee to review existing policy and formulate overall principles to guide U.S. space activities.[83]

The Policy Review Committee worked on long-term issues and was comprised of cabinet-rank officials from the relevant departments. However, due to the sensitive nature of the antisatellite issue an ad hoc Antisatellite Working Group made up of representatives from the State Department, DOD, CIA, JCS, and ACDA and chaired by Walter Slocombe (Principal Deputy Assistant Secretary for International Security Affairs) was set up. This group was separated from the main PRM-23 group to discuss ASAT-related issues.[84] The ASAT Working Group, as a result of President Carter's interest in antisatellite arms control, discussed U.S. negotiating strategy and its relationship to the U.S. ASAT program. None of the group wanted to curtail the program, yet neither did they support a crash program. Instead the group favored the development of the U.S. program in an orderly way that would facilitate the arms control process with the Soviet Union.[85] The group formulated the policy that the prospect of a U.S. ASAT capability would provide an incentive for the Soviet Union to negotiate, and would provide leverage during the negotiations. In addition, if an acceptable agreement proved elusive, the United States would have an ASAT capability.

The question of what form of limitations the United States should pursue caused the most disagreement within the Working Group. The Department of Defense initially favored the complete dismantling of the Soviet ASAT system, but as a result of either growing skepticism about the verifiability of a comprehensive ban, or a desire to maintain some ASAT capability for the United States it favored reaching a "rules of the road" agreement that would ban hostile acts in space.[86] However, the State Department and ACDA were more optimistic of a ban on testing and deployment. On September 3, 1977 the ASAT Working Group presented a range of arms control options to the President and on 23 September President Carter indicated his preference for comprehensive limits in the PRM/NSC-23 Decision Paper. The new Director of Defense Research and Engineering, William Perry, summarized the directive at the defense budget hearings in 1977:

> The PRM/NSC-23 Decision Paper dated September 23, 1977, requires that we seek a comprehensive ASAT agreement prohibiting testing in

> space, deployment and use of AST capability . . . To reduce the possibility of a future space conflict, the President has directed that we seek an effective and adequately verifiable ban on antisatellite systems with the Soviets. As a consequence of this decision an interagency group—of which DOD is a part—has been making the necessary preparations for negotiating with the Soviets.[87]

The Presidential Directive's national security components remain classified, although the press release gave some indication of what had been decided:

> The United States finds itself under increasing pressure to field an antisatellite capability of its own in response to Soviet activities in this area. By exercising mutual restraint, the United States and the Soviet Union have an opportunity at this early juncture to stop an unhealthy arms competition in space before the competition develops a momentum of its own. The two countries have commenced bilateral discussions on limiting certain activities directed against space objects, which we anticipate will be consistent with the overall U.S. goal of maintaining any nation's right of passage through and operations in space without interference. While the United States seeks verifiable comprehensive limits on antisatellite capabilities, in the absence of such an agreement, the United States will vigorously pursue development of its own capabilities. The U.S. space defense program shall include an integrated attack warning, notification, verification and contingency reaction capability which can effectively detect and react to threats to U.S. Space Systems.[88]

The press release was an offer of further U.S. ASAT restraint in return for reciprocal action from the Soviet Union. There was also a threat of a U.S. space defense program if the Soviet Union failed to conform.

Once President Carter had expressed his preference for comprehensive limits on antisatellites with PRM/NSC-23 the NSC began preparations for the negotiations with the Soviets. An Antisatellite Negotiating Working Group was established, although the departments represented were the same as the previous ASAT Working Group and as a result its membership was virtually identical. However, although PRM/NSC-23 had called for comprehensive limits on ASAT testing and deployment it had not specified how this was going to be achieved. The most important problem that arose was what activities and devices were to be prohibited. There was a large grey area over what systems constituted an antisatellite weapon. Electronic jammers and dual capable systems such as ABMs and ICBMs could all be used as a potential ASAT weapons. The Soviet Galosh exoatmospheric ABM system had a rudimentary ASAT capability.[89] A further important issue was how could a treaty prohibiting antisatellite weapons be verified. As the discussions continued the group became divided. The Defense Department became convinced that a comprehensive agreement would not be possible nor desirable. The principal coalitions were ACDA and the State Department favoring a comprehensive prohibition and the Defense Department and the Joint Chiefs of Staff against such an agreement.[90]

The Defense Department believed that the Soviets' dedicated ASAT weapon would be impossible to verify since the SS-9 booster was used for other missions, notably for launching ocean reconnaissance satellites. The argument that the Soviets would not have confidence in using a covertly deployed ASAT system because it had not been tested was countered by the fact that there were ways to disguise an ASAT test under the cover of activities such as spacecraft docking.[91] The State Department and ACDA on the other hand believed that the benefits of reaching an agreement which would curb antisatellite systems outweighed the risks of covert Soviet ASAT deployments. However, by March 1978, President Carter appeared to have become impatient with the negotiating group's division and decided to initiate formal discussions with the Soviet Union.

On 8 June of that year, talks began in Helsinki in the search for a comprehensive ban on ASAT weapons. During the first round of talks the U.S. delegation was headed by ACDA director Paul Warnke, whose position was to explore the extent of Soviet interest and thinking on the issue of ASAT arms control. The United States began the negotiations by proposing a complete prohibition of antisatellite weapons. However, it appeared that the Soviet delegation had not given serious thought to antisatellite arms control prior to the talks and subsequently asked for more time to consult with Moscow.[92] In addition to the prohibition of antisatellite weapons, the U.S. delegation explored various interim agreements which included a moratorium on the testing of antisatellite systems and a "noninterference" agreement. The Soviet delegation, headed by Oleg Khlestov, Head of the Treaty and Legal Affairs division of the Foreign Ministry wanted a guarantee from the United States that the space shuttle would not be used as an antisatellite weapon. However, the United States delegation had been ordered in advance to keep the space shuttle as a nonnegotiable subject.[93]

The next set of talks began on 16 January 1979 in Berne. The United States delegation sought from the Soviet delegation the range of possible agreements. It became apparent that the Soviets were willing to discuss a moratorium on antisatellite testing. They were not prepared to discuss the dismantlement of their antisatellite system. This position would have left the Soviets with their antisatellite capability intact while the United States would not have been permitted to develop its own system on a par with the Soviet system. It was therefore unacceptable to the United States' delegation. The only common ground was a nonuse agreement.[94] However, there were problems with this too. The Soviet position was that the nonuse would apply only to U.S. and Soviet satellites leaving allied satellites which were vital to NATO vulnerable. The Soviets also persisted with their objections to the space shuttle.

The third set of talks began on 23 April 1979 in Vienna and subsequently turned out to be the final talks. The combination of the Soviets" unwillingness to dismantle their satellite interceptor and the Defense Department's opposition to a comprehensive agreement, led the U.S. delegation to compose a two-stage strategy. The United States would seek a no use agreement possibly combined with a moratorium on antisatellite testing in the short term to be followed in the long run with an agreement to prohibit the hardware.[95] Progress was made during the talks of a no use treaty and a test moratorium was discussed, with the United States in favor of a short term moratorium and the Soviet Union in favor of a longer term one for reasons discussed above. However, further progress was prevented in the redrafting of a treaty regarding no use by the Soviets" repeated objections to the space shuttle and their desire to restrict a no use agreement to only U.S. and Soviet satellites. In addition to this, the Soviets also reserved the right to circumvent a "no use" agreement if "hostile or pernicious" acts by a foreign satellite infringed their national sovereignty. This was interpreted as a Soviet wish to prevent the potential use of direct broadcasting satellites for propaganda purposes.[96]

This round of talks was adjourned with the prospect of a fourth to be held in the autumn. However, further talks were delayed by the pursuit of SALT II discussions which were occurring and became the overriding priority of the Carter administration. Some officials in the Carter administration felt that the Joint Chiefs of Staff's support for SALT II might be at stake if they pushed too hard for an antisatellite agreement. The ensuing delay to the negotiations and the Soviet invasion of Afghanistan in December 1979 meant that any notion of an ASAT agreement was thwarted. There were a number of attempts within the administration in 1980 to reconvene the negotiations, mainly from within the State Department and ACDA and the Soviets also informally showed some interest in the resumption of talks. However, with Soviet ASAT testing resuming on 3 April 1980 the Carter administration gave up any hope of an agreement before the U.S. presidential elections in that year. The subsequent election of President Reagan brought U.S. interest in an ASAT arms control treaty to an end.

The U.S. Antisatellite Program since the End of the Cold War

The demise of the Soviet Union did not seem to have a corresponding effect on antisatellite proposals in the United States. Proposals in the early 1990s were argued from the Cold War premises which had dominated the debate since the issue arose in the Kennedy administration. These premises were founded on the 'space as a sanctuary" argument, that antisatellites would undermine strategic stability and the argument that an arms race in space would occur. The flaw in these premises was that the arms race in space issue combined with strategic stability were inextricably linked with a fully fledged adversary to maintain this relationship; with the disintegration of the Soviet Union this relationship disappeared. The Gulf War in 1990-1991 also changed the equation with the realization of the importance of space in warfighting during the campaign, and the possible effects if these assets were threatened.

The strategic arguments that had dominated the earlier ASAT debates began to dissipate in the post-Cold War and post-Gulf War, except in the purist position of supporting space as a sanctuary. However they were replaced by other concerns. The Clinton administration let its opposition to military space programs be known both in words and actions.[97] ASAT proponents, including retired Air Force General Charles Horner and the Secretary of the Air Force, attempted to raise the ASAT issue as one that needed addressing.[98] This was met with considerable opposition from the Clinton administration which followed the space sanctuary view and did not support the notion of a requirement for ASAT weapons. In particular, the Clinton administration resisted the Army's Kinetic Energy Antisatellite (KE-ASAT).[99]

However strong Congressional support, through Senator Bob Smith, has backed military space programs and kept some of them in existence in the face of opposition from both the Clinton administration and intraservice ambivalence. For example, Congress approved $30 million in 1996 for funds for KE-ASAT but this funding was rescinded by President Clinton. Congress rejected that action on 9 June 1996 by witholding money from some of the administration's favored projects.[100] However with the FY1998 budget Clinton vetoed specific programs from the budget which included the KE-ASAT, and cut $38 million from the project. Congress however managed to keep the KE-ASAT program going and in May 1998, KE-ASAT scientist Mark Fisher stated that "If there's money available we could conduct a proof of principle flight within 18 months. I would need $65 million to do two flight tests."[101] There were funds available in 1999 but this was from the previous year's funding. A request for an infusion of $41 million for the FY00 budget was requested to keep the program going although this was subject to political opposition.[102]

The Mid-Infrared Advanced Chemical Laser (MIRACL) in existence at White Sands testing range in New Mexico is perhaps closer to deployment than the KE-ASAT. It was originally an SDI antimissile program, but is in the process of being adapted into a laser for use against satellites. In addition to MIRACL the Pentagon is working on both excimer and free-electron lasers as ground-based ASAT systems.[103] These directed energy systems are able to respond in a more timely manner than kinetic energy systems. On 17 October 1997 the U.S. Army Space and Missile Defense Command used the Mid-Infrared Advanced Chemical Laser (MIRACL) ground-based laser to illuminate the MSTI-3 (Miniature Sensor Technology Integration) satellite in what was a test of satellite vulnerability.[104] The target satellite the MSTI-3 which was in a 265-mile circular polar orbit carried a mid-infrared, near-infrared, and visual focal plane array with a telescope and had finished its intended mission. The MIRACL used various power levels on the target satellite when it was 60-70 degrees above the horizon. The satellite and its sensors were not damaged since the intention was to test the level at which the laser caused the degradation of the sensor.[105] The MIRACL used excited deuterium fluorine molecules to produce 3.8 micron wavelength light for good atmospheric transmission. The power output is around 2 megawatts. The beam was aimed by the Hughes Sea Lite Beam Director.[106]

Defense Department Officials have been reluctant to provide information regarding what was obtained from the test firing, which included lasings by MIRACL and a low-power chemical laser.[107] The test cost about $2 million, with MIRACL operations running about $6,000 per second. Two bursts from the laser struck a sensor array on the MSTI-3 satellite. One burst was an initial one second firing to calibrate the laser's location on the satellite's body. The second beam was a 10 second burst, which triggered the sensors and relayed data back to the ground tracking and monitoring stations.[108] The Army experienced problems with the test which curtailed its effectiveness. Telemetry from MSTI-3 that was supposed to provide information about the test was never received. This information was to identify the power levels at which the MSTI sensors were blinded. The aim was not to damage the sensors but to temporarily blind them. A further problem that occurred during the testing was a shockwave in the laser cavity that damaged the MIRACL during its operation.[109] The satellite lasing was one of several initiatives the Army was considering in 1997. It is also conducting simulations to determine the effectiveness of other antisatellite weapons.

The MIRACL testing became the fulcrum of the debate on the issue of space control. The goal of space control has long been a part of the United States National Military Strategy, however, that did not include an antisatellite capability. The Pentagon under the Clinton administration did not consider the development of antisatellite weapons a priority. This test therefore was extremely controversial. The test was designed to measure the vulnerability of U.S. satellites to laser attack, but at the same time it was able to measure MIRACL's potential use as an emergency antisatellite weapon. Indeed, it has been claimed that MIRACL and its associated beam director has had an ASAT mission since the mid-1980s and has had a contingency mission to negate satellites harmful to U.S. forces.[110]

The testing which followed the lasing of the satellite has been focused on the Sea Lite Beam Director (SLBD) which is designed to track targets and help the laser beam target them. The SLBD was originally designed to track tactical targets such as aircraft and missiles, but improvements have increased the beam director's accuracy to enable it to track space objects. Although, the testing has not involved firing the MIRACL laser it has been oriented toward improving the overall system performance and operability. Indeed recent tests have been conducted on the task of keeping a laser focused on a target in space. In order to solve this problem, a target with the correct type of reflectors was required to gauge the effectiveness of the tests. The only available target with the required infrared "retroreflectors" is a U.S. satellite, the Low-Power Atmospheric Compensation Experiment (LACE). This is a "dead" satellite which enables the beam to track it.[111]

The beam director uses a technique known as a 2-D conical scan (Conscan) which involves moving the laser beam in a circle until it reflects light off the target back to the ground. Once the target is located, the beam director's boresight loop enables operators to keep the laser pinpointed on the target for as long as required. The Conscan experiments are designed to verify that the beam director can assist with reliable initial positioning and maintenance of a focused spot on an object. On 24 March 1998 the Army conducted its first active control scan boresight corrections using a satellite target which involved the beam director and the Low-Power Chemical Laser, a satellite tracking beam. This was referred to as the Data Collection Experiment (FY98 DCE).[112] The beam director tracked the LACE satellite at a distance of 550 kilometers and propagated the low-power laser beam (around 32 watts). The return energy was detected above 50 degrees in elevation, the lower elevation limit of the return off the LACE corner cube reflectors, and a Conscan track loop was closed.

A U.S. Defense Department directive (DOD I 3100.11) is the driving force behind the world's satellites being evaluated for their vulnerability to lasers. The work is being undertaken by the Satellite Assessment Center of the Air Force Research Laboratory's Directed Energy Directorate. The work is being undertaken in response to the new Defense directive which reflects two factors: there is an increasing number of satellites in space and some of these are particularly vulnerable to laser radiation.[113] The Satellite Assessment Center compiles detailed satellite intelligence coupled with laser effects testing on actual spacecraft components and materials to build high-fidelity computer models of foreign and domestic satellites. Using these models, the safe levels of laser illumination for a particular satellite are determined.[114] Another factor which is measured is the operation and orientation of particular satellites in relation to the proposed laser scenario. To help minimize costs the center is developing software upgrades that will provide U.S. Space Command the ability to screen satellites in-house. This software includes a centrally developed satellite vulnerability database that can perform predictive avoidance analysis as situations arise.

A further potential antisatellite system is the Airborne Laser. This is a modified Boeing 747 that will have the ability to fire directed energy at potential targets. A latent capability exists in using the Airborne Laser as an antisatellite weapon. The primary problem in using the ABL as an ASAT weapon arises from the use of infrared technology to track targets and cue the laser.[115] This requires a bright infrared reflection from the target. To use the ABL in an ASAT mission role an active system such as radar would have to be used to detect the satellites. There is also a difference of opinion whether the deconfliction system in the development for the ABL would be able to be incorporated in an ASAT role. The deconfliction process is used to ensure that the long-range radar does not intentionally hit an aircraft or satellite in front of or behind the target. At present Pentagon officials are not interested in developing the technology required for the ABL to be able to operate as an ASAT weapon. However, Air Force and aerospace industry officials believe that in the future the ABL may be given the task of intercepting satellites within 200 miles of the Earth's surface. It can be assumed that the ABL could destroy most low-Earth orbit satellites given its ability to deploy to a precise location that the satellites must fly over. The ABL is seen as a competitor to the congressionally supported Army program that is developing a ground-based ASAT capability designed upon an advanced kinetic-kill vehicle.[116]

The internal prioritization given to these programs was initially not high. The particular importance given by the military's policy and programs can be determined by whether or not they appear in the Five Year

Development Plan (FYDP) from which the services plan and what organization takes the lead. When funds are unrequested by DOD or the individual services it can be assumed that the programs are rogues rather than mainstream priorities. In this instance the programs were advocated from Congress, in particular the Senate, rather than the services themselves.[117]

The rationale behind the acquisition of a U.S. ASAT weapon system is that obtaining a proved means of disabling a satellite will discourage other countries from relying on them too heavily. The testing of an ASAT system would allow the military the confidence that it would be able to control the use made of space by future adversaries. It is this argument that weighs heavily in the thinking of the U.S. military and is vital for its future military operations.

Russian ASAT Activities since the End of the Cold War

The attitude to ASAT weapons in Russia has often been categorized as a response to U.S. ASAT developments combined with a response to U.S. ballistic missile defense efforts. Whether this is just rhetoric or is part of a wider development for Russia to continue to develop its ASAT capabilities is hard to determine. What can be said with some certainty is that Russia has carried out some activities with regard to ASAT weapons as the following demonstrates.

There have been reports of testing in Russia of a high altitude weapon which fired off an electromagnetic pulse or EMP that is similar to bursts caused by nuclear blasts.[118] This has the ability to disrupt a satellites' functioning. This test was seen as part of Russia's efforts to improve its antisatellite weapons technology. However due to the indiscriminate nature of EMP, directional weapons need to be used. Other activities in Russia are related to reports of a Russian air launched ASAT capability similar to the U.S.-developed F-15 miniature homing vehicle developed in the late 1980s. It was reported that a Russian Mikoyan MiG-31 was observed to be carrying an antisatellite weapon on its center under fuselage stores position.[119] The MiG-31 which was primarily designed as a high-altitude, long-range interceptor was modified slightly for its role as an ASAT carrier. Although these two reports do not constitute a concerted ASAT development plan, combined with the previous rigorous ASAT development they highlight the fact that Russia is still concerned with the issue of ASATs.

Conclusion

This chapter has highlighted the Soviet ASAT development of its co-orbital attack capability. The rigorous ASAT development and testing enabled the Soviet Union to have a reliable operational capability probable from the mid-1970s onwards. Indeed, the Soviets tested their ASAT capability on over twenty occasions against target satellites in varying orbits and inclinations and operated numerous attack profiles. There can be little doubt that the intended targets for this capability were U.S. and NATO satellites. It is possible that Russia could quickly operationalize the direct ascent co-orbital ASAT capability. It is however difficult to put a timeframe on how quickly they could operationally this. Since the latter stages of the Cold War and indeed since the collapse of the Soviet Union, Russia has shown some interest in an ASAT capability, of most note being the possible adaptation of the MiG-31 in an ASAT carrier role. Whether this interest will be developed upon is dependent upon the perceived threat Russia feels in response to the United States' missile defense and ASAT plans.

The different approach taken by the Soviet Union and the United States toward the development of an ASAT capability can be explained by timing and how seriously each country considered the issue. At the time of Soviets" interest in developing an ASAT the air-launched system was not technically viable. Also, the Soviets wanted a robust ASAT system which was provided by the coplanar space intercept. The U.S. on the other hand during the Cold War did not want to develop such a robust ASAT system, and merely wanted a limited system which the air-launched system provided.

The United States development of its ASAT capability saw the U.S. Army and Air Force compete for the mission. The initial U.S. ASAT policy utilized the ASAT Program 505, the NIKE-ZEUS anti-ballistic missile and was under Army command. However, when Program 505 was phased out and Program 437, which used the intermediate range ballistic missile the Thor, received the ASAT mission, the Air Force took the mission from the Army. This program itself was terminated and it was not until the conception of the air launched ASAT that the Air Force continued to hold the ASAT mission. Since the demise of the Soviet Union and subsequent end of the Cold War, the Army has been at the forefront of ASAT efforts, both in terms of the Ke-ASAT and the MIRACL testing.

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