# Short History of US and Soviet ASAT Programs

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The last forty years has seen the United States and Russia in a parallel and oftentimes mutually reinforcing path towards militarizing space. Space's initial military use was reconnaissance; the response of the United States and Russia/USSR to space reconnaissance missions has transitioned from the hostile days of 1960, when a US U-2 spy plane over the USSR was destroyed by anti-aircraft missiles, to the acceptance of imaging satellites used to verify arms control agreements as an essential component of national security. This transition has been uneasy. At times, both the United States and Russia/USSR were heavily investing in anti-satellite (ASAT) technologies, but some key transparency measures and the recognition that anti-satellite weapons were not in either state's best interest slowed the drive towards deploying such weapons. This was manifested most notably by Congressional bans and voluntary Russian moratoria on ASAT testing. At present, space has even greater military value, as satellites perform essential communications and navigation functions in addition to reconnaissance and verification missions. However, the United States appears to have renewed its interest in ASAT weapons.[1]

## Early ASAT Systems

The Soviet and then Russian armed forces have had specific anti-ballistic missile (ABM) and space defense programs since 1963.[2] This was originally driven by the perceived threat of US reconnaissance satellites, which were developed when it became clear that the Soviet Union would eventually be able to deny overflights of American U2 spy planes.[3] Anti-satellite capabilities were developed as part of this program and were also residual capabilities of systems developed for other purposes. The United States also pursued ABM/ASAT systems, in part because of a perceived threat of Soviet "orbital bombardment systems"[4]. Because of the limitations of the guidance systems of the time, the early interceptors were nuclear-tipped, allowing a successful ABM/ASAT attack without precision guidance. Russia fielded in the 1960's (and still retains) a limited

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[1] The January 2001 report of the Commission to Assess United States National Security and Space Management and Organization, chaired by Donald Rumsfeld shortly before he became Secretary of Defense in the Bush administration specifically calls for anti-satellite technology, stating that "The U.S. will require means of negating satellite threats, whether temporary and reversible or physically destructive." The report is available at http://www.defenselink.mil/pubs/space20010111.html.

[2] The Soviet space defense program is discussed in detail in the 1993-94 edition of *Europe and Asia in Space* (Colorado Springs, CO: Kaman Sciences Corporation), Nicholas L. Johnson & David M. Rodvold, pp. 346-348.

[3] The Soviet Union began a diplomatic effort against US satellite reconnaissance by submitting a draft proposal to the United Nations Legal Subcommittee in June 1962, which states "The use of artificial satellites for the collection of intelligence information in the territory of foreign states is incompatible with the objectives of mankind in its conquest of outer space".

[4] As reported in Paul B. Stares' book *The Militarization of Space: U.S. Policy, 1945-1984* (Ithaca, NY: Cornell University Press, 1985), in a 1964 pre-presidential election speech, Lyndon Johnson announced that "To insure that no nation will be tempted to use the reaches of space as a platform for weapons of mass destruction we began in 1962 and 1963 to develop systems capable of destroying bomb carrying satellites."

missile defense of Moscow, which employs nuclear-tipped interceptors.[5] Although both systems would be usable against satellites, they have long been recognized as a poor ASAT option, in part because nuclear explosions in space are indiscriminate and would destroy all nearby satellites and disrupt many more. Their use would also have contravened the Partial Test Ban Treaty of 1963[6].

The United States was eager for its space reconnaissance mission to be seen as legitimate, and to protect itself from Soviet space weapons. The Soviets also saw that arms control in space was to their advantage, and were agreeable to the idea of a treaty. Conditions were right in 1967, as the United States had modified its position from the late 1950's, when their diplomatic initiatives centered around a ban on all military activity in *and through* space, which was seen by the Soviets as a ploy to slow down their superior long-range missile program. Despite the concerns of both superpowers that verification would be difficult, in 1967 they signed the Outer Space Treaty, which prohibits the stationing of weapons of mass destruction in space or on celestial bodies, and declares a spirit of cooperation in space ventures.[7]

**Russia's Main System: Co-Orbital ASAT**

Russia's main and only dedicated ASAT system is the Co-Orbital ASAT system, in which a missile armed with conventional explosives is launched when a target satellite's ground track rises above the launch site and the ASAT is placed into an orbit close to that of the target.[8] Within one or two orbits (between about 90-200 minutes), the 1,400 kg ASAT interceptor maneuvers close to the satellite, guided by on-board radar, and then "dives" toward the target satellite, detonating when within a kilometer of the target. The target satellite is intended to be destroyed with shrapnel fragments from the explosion. The system's initial testing phase (1963-1972) consisted of around twenty launches, including launches of both target satellites and interceptors; around seven interceptions; and five detonations.[9] The initial tests confirmed the system could work from orbital altitudes of 230 to 1,000 kilometers and the system was declared operational. The Soviets

[5] The United States also deployed a system using nuclear interceptors at Grand Forks, ND in 1975, but shut it down within months because of cost and lack of effectiveness.

[6] The 1963 Limited Test Ban Treaty prohibits nuclear weapons tests "or any other nuclear explosion" in the atmosphere, in outer space, and under water. The text of the treaty is available at http://www.dpi.anl.gov/dpi2/hist_docs/treaties/ltbt63.htm .

[7] The "Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space", signed by more than 90 countries, including the United States, bans weapons of mass destruction from space and stipulates that "The exploration and use of outer space…shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind…[and] shall be guided by the principle of co-operation and mutual assistance …" The text of the treaty is available here: http://www.oosa.unvienna.org/SpaceLaw/lpostxt.htm .

[8] During testing, the Co-Orbital ASAT interceptors were launched from the Baikonur launch site in Kazakhstan using the Tsyklon-2 booster. The assumed similarity of the Tsyklon-2 and Tsyklon-3 launch pads imply that the ASAT system could also be launched from the Tsyklon-3 pads in Plesetsk, Russia, 800 km north of Moscow.

[9] Detailed information about the testing program for the Soviet/Russian Co-Orbital ASAT program can be found in the article "IS Anti-Satellite System" by Anatoly Zak and the references therein, on http://www.RussianSpaceWeb.com.

ceased testing the system after signing the Anti-Ballistic Missile treaty in 1972 which required not only that "Each Party undertakes not to develop, test, or deploy ABM [anti-ballistic missile] systems," it prohibited interfering with the "national technical means of verification" of treaty compliance[10]. These means have been primarily reconnaissance satellites and the Soviet acceptance of these terms was viewed as a tacit acceptance of the legitimacy of such satellites.

The Soviets were also suspected of developing electromagnetic weapons, in particular lasers, to use against satellites. In October of 1975, five instances of anomalous "blinding" of infrared sensors on US satellites were generated by sources located in the western part of the Soviet Union. Although the official explanation was that the infrared source was a fire along the trans-Siberian pipeline, some observers remained convinced the Soviets had developed a laser-based anti-satellite system[12].

The Soviets resumed testing of the Co-Orbital system in 1976, reportedly as a response to the US development of the Space Shuttle, which was perceived by the Soviet military as a carrier of space-based weapons. The Soviets reportedly showed some success at extending the range to as low as 160 km and as high as 1600 km and minimizing the attack time by enabling the interceptor to maneuver to its target in a single orbit. Systems using optical and infrared sensor systems instead of on-board radar are thought to have had problems. At that time, the system was considered ready to operate.

From 1978 to 1982, testing of the Soviet Co-Orbital ASAT weapon continued, at a pace of about one intercept a year. This system is thought to be currently operational, although it has not been tested for many years.

Both the US and the Soviet Union appeared to be hedging their bets by pursuing anti-satellite arms control talks while pursuing anti-satellite technology, albeit at a low level.

**Second Generation: US and Russian Air-Launched Missile ASAT Systems**

In June 1982, the United States announced its intention to test a new-generation ASAT weapon, the Air-Launched Miniature Vehicle (ALMV). A two-stage missile would be launched from a high-altitude F-15 aircraft; the missile would directly ascend to a target satellite in low-earth orbit and attempt to destroy or disrupt the satellite by the force of impact. This kill mechanism is referred to as "kinetic kill" since the satellite is destroyed by the large kinetic energy of the high-speed collision. In response, the Soviets/Russians reportedly developed a similar ASAT weapon, launched from a MiG-31 aircraft. Such a system improved on the Co-Orbital ASAT system because it eliminated both the need to wait for an opportune launch time and significantly reduced the time between ASAT launch and target destruction.

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[10] Text of the treaty can be found at http://www.defenselink.mil/acq/acic/treaties/abm/abmtoc.htm.

[12] Stares, *The Militarization of Space: U.S. Policy, 1945-1984*, (Ithaca, NY: Cornell University Press, 1985), p. 146

In the spring of 1983, President Reagan gave his "Star Wars" speech, announcing that he intended to focus US resources on developing a large-scale missile defense system. The missile defenses were expected to contain several types of space-based missile interceptors. The Soviet Union responded to this announcement by restarting in earnest research on its own missile defense systems. The Soviets also made diplomatic overtures, proposing a ban on space-based weapons and declaring a moratorium on testing ASAT systems.[13]

The US ALMV system was tested twice in 1984, firing interceptors but not against targets. Its first and only test against a satellite was performed on 13 October, 1985, when it destroyed an aging Solwind satellite in a 555 km orbit. The US Air Force continued to pursue this program aggressively, scheduling a number of tests for the following year. However, in December 1985, the Democratic-controlled House and the Republican-led Senate included in its budget authorization bill a ban on testing the ALMV on a target in space.[14] This decision was made only a day after the Air Force sent two target satellites into orbit for its next round of tests. The Air Force continued to test the ASAT system in 1986, but stayed within the limits of the ban by not engaging a space-borne target.

The ban on testing the ASAT system was renewed in 1986 and the Soviets continued to observe a voluntary moratorium on ASAT testing.. In November, 1987, the White House and Congress negotiated a compromise on arms-control provisions in the authorization bill which extended the ban on ASAT testing but allowed the ban to be suspended should the Soviets resume their ASAT tests. The political opposition to pursuing the ASAT system appeared entrenched, and the Air Force, unable to perform its final tests, dropped development of the ALMV system.

The Soviets did honor their moratorium, although they continued pursuit of some missile-defense technologies. Rumors circulated that the Soviets were developing a MiG-launched ASAT weapon similar in scope to the ALMV, but this was not confirmed. In 1987, a Soviet mission to launch what was reportedly a test platform for a future "space battle station" failed when the craft failed to reach orbit and fell into the Pacific Ocean.

**Third-Generation ASAT Systems: US MIRACL Laser & KE-ASAT and Soviet Laser**

In April, 1988, the two Democratic chambers of Congress voted against extending the ASAT ban, but also eliminated the $100 million Department of Defense request for development of a ground-based ASAT system. The Air Force began plans for other ASAT programs, in particular a ground-based laser system. Both kinetic-kill and laser ASATs have relative advantages and disadvantages. The kinetic-kill vehicle systems provide an easily verifiable "kill" of a satellite and can be used in any weather; the ground-based lasers, while susceptible to poor weather, produce less space debris and

[13] Soviet President Yuri Andropov said Moscow would impose a "moratorium on such launchings for the entire period during which other countries, including the United States, will refrain from stationing in outer space anti-satellite systems of any type." "Andropov Says Nyet To Star Wars Weapons," by John Iams, *UPI*, 18 August 1983

[14] The ALMV testing bans are included in Public Laws: 99-145, 99-661, 100-180

also allow for a covert satellite strike. The Army began speeding up plans for its own ground-based ASAT systems: a kinetic-kill vehicle launched from the ground (the kinetic-energy ASAT, or "KE-ASAT"[15]) and a ground-based laser system. The Army and Air Force's ground-based laser work converged around the Army's MIRACL laser, a megawatt-class chemical laser located at the White Sands Missile Range in New Mexico.

Intelligence reports at this time suggested that the Soviets had developed a working anti-satellite laser system, and was able to pose a significant threat to satellites and ballistic missiles. The Soviets success was given as motivation for further ASAT development; the ASAT system centered on the MIRACL laser was developed largely in 1989 and 1990. In July, 1989, the Natural Resources Defense Council and the Soviet Academy of Sciences arranged for a US delegation to visit the Sary Shagan Laser-Ranging Facility in Kazakhstan, and from the consequent observations and discussions, it became clear that the Soviet laser ASAT project was not a significant threat and was certainly not near to being deployed as a space-based ASAT weapon.[16] Subsequently, in their defense appropriations bills for 1991-1995, Congress included bans against using the MIRACL laser against an object in space.[17]

Although the Department of Defense formally terminated the Army's ground-based KEASAT program in 1993 and has not requested funding since then, Congress resurrected the program in 1996, adding $30 million to the budget for the program. Congress continued to support the program, appropriating $50 million in 1997, which President Clinton used a line-item veto to eliminate, and $37.5 million in 1998. Despite governmental reviews that said the program was in disarray,[18] the support continued, although at much smaller levels of funding. In particular, although DOD did not request money for the program, Congress authorized $7.5 million in 2000 and $3 million in 2001. No funding for the program is included in the FY2003 budget and the strongest Congressional advocate for this program, Senator Robert Smith (R-NH), was not reelected in 2002. There appears to be scant interest in the program outside of the Army, and Air Force officials have been openly critical of the program, stating that the risks of damaging friendly space assets through use of the KE-ASAT outweigh the system's usefulness.[19]

The ban on using the MIRACL laser against space targets lapsed in 1996, when the new Republican Congress opted not to renew it. In October 1997, the Air Force commissioned a test of an ASAT system based on the MIRACL laser. The ASAT system was directed towards a satellite orbiting 420 km above the earth. The MIRACL laser

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[15] The Army's KEASAT program's program number is PE 0603892D.
[16] "A Visit to Sary Shagan and Kyshtym", *Science & Global Security*, Vol. 1, Nos. 1-2 1989, p. 165
[17] The MIRACL laser testing bans are included in Public Laws 101-510, 102-190, 102-484, 103-160, and 103-337.
[18] United States General Accounting Office Report "GAO-01-228R KE-ASAT Program Status", 5 December, 2000
[19] Air Force Gen. Ralph Eberhart, commander-in-chief of U.S. Space Command and the North American Aerospace Defense Command, told reporters that the damage that could be inflicted inadvertently on U.S. and friendly satellites by a kinetic energy anti-satellite (KE-ASAT**)** weapon may outweigh its usefulness. "Space Command Chief Questions Value of KE-ASAT", by Kerry Gildea, *Defense Daily*, 29 March, 2001

apparently had technical difficulties, but the results of the test were startling. A lower power (30 watt) laser intended for alignment of the system and tracking of the satellite was the primary laser source used during the test, and it appeared that this lower power laser was sufficiently powerful itself to temporarily blind the satellite, although it could not destroy the sensor.[20] That a commercially available laser and a 1.5 m mirror could be an effective ASAT highlighted a US vulnerability that had not been fully appreciated. Although the Pentagon described the test as defensive, i.e., to learn about the vulnerability of US satellites to laser attack, many--in particular the Russians--expressed concern about the offensive capabilities of this system and whether it constituted a breach of the ABM treaty,[21] and formally requested negotiations on an ASAT weapon ban.

**Current ASAT Capabilities**

The US armed forces and defense agencies have been directed to focus and reorganize their space control efforts. This has resulted in a number of bureaucratic changes, but as of yet, no new large-scale ASAT weapon initiatives have been mounted. There is likely still some residual ASAT capability from the previous generation of systems, however.

What the current capabilities are of the Air Force's ALMV systems is not clear, as testing was never completed. Air Force officials have expressed disinclination towards using destructive, debris-generating ASATs, and even DOD advisors in favor of developing ASAT capabilities view nonreversible ASAT weapons as a last resort[22]. Although the Air Force has traditionally been the armed service most involved and interested in anti-satellite technology, it has not expressed interest in reviving this particular program.

The December 2000 GAO assessment of the Army's KE-ASAT system reported that considerable work and funding would be needed to make the system ready for flight-testing. Following the DOD's recommendation, the Army and its contractor Boeing have continued integration work and environmental compliance tests on three kill vehicles that consequently are to be placed in storage. Program officials believe the Bush administration and Republican Congress may be more supportive of the program, while acknowledging that there would likely be significant political opposition to flight tests of the KE-ASAT.[23] The officials have said that if they secured money and support for two

[20] John Donnelly, "Laser of 30 Watts Blinded Satellite 300 Miles High," *Defense Week,* 8 December 1997, p. 1.

[21] Russian Foreign Ministry Spokesman Gennadi Tarasov stated "The question arises of how compatible such work is with progress achieved on joint measures to ensure compliance with the ABM treaty…The creation of anti-satellite weapons could sharply change the strategic situation", "Russia Issues Warning After US Laser Test," by Paul Richter, *Los Angeles Times,* 7 October 1997, p. 5

[22] In "Science Board Urges Development of Anti-Satellite Capabilities," by Emily Hsu, *Inside Missile Defense*, 5 April, 2000, a report by the Defense Science Board is quoted: "The task force notes that the authority to employ systems for the 'physical' destruction of an adversary's satellite is not likely when other 'reversible' means for accomplishing the objective are at hand. Only under the condition where the permanent removal of an adversary's space mission capability is in the national interest would the United States destroy a space system, and only then when directed by the National Command Authority."

[23] "Possible Funding Boost in FY '04 Budget Could Lead To KE-ASAT Flight Test", by Kerry Gildea, *Defense Daily*, 17 December, 2002

flight tests, the system could have a contingency deployment capability within three years, although two of the three kill vehicles which had been built have been dismantled for use in other projects[24]. No funds have been allocated in the Presidential budget request or Congressional add-ons since 2001, and no funding was included in the FY2004 budget request.

The MIRACL laser ASAT system has not been tested again, and, although the Army occasionally fires the laser for routine power tests, the program has been facing financial difficulty and its directors are seeking other uses for the laser.

Basic electronic warfare ASAT technology, like jamming a satellite's uplink or downlink transmissions, is not particularly technically demanding and this capability is probably widely held. Such ASAT attacks also have the advantage of being relatively covert and do not add debris to the space environment, however, it is difficult to confirm the success of such attacks. Jamming for specific users only, or permanent disabling are more difficult and it is not known which specific capabilities the United States and Russia have, but it is likely both field electronic warfare techniques that are useful even out to geosynchronous orbit, especially against nonmilitary targets, which are relatively unprotected from such attacks.

The former Soviet republics continue to be invested in space, although military launches have decreased and commercial launches have increased. The existence of US reconnaissance satellites that drove Soviet ASAT capability development for many years is no longer perceived as a major threat, and the Russians are currently considering cooperating with the United States on aspects of missile defense. The ASAT weapon testing moratorium begun in 1983 continues to be respected.

**The Development of New Capabilities**

Although no new dedicated ASAT programs have been initiated by the United States, the Bush administration is currently increasing the funding for and widening the scope of research and development of space-relevant technologies, including improved tracking of space objects, new launch and propulsion technologies, and development of lightweight sensors and kill-vehicles. High-energy laser technology has also seen a large funding increase; supporting projects include development of the techniques necessary for propagating laser radiation through the atmosphere and an emphasis on decreasing the system weight to make the laser system more feasibly transported by airplane or launched into space.

Traditional satellite components are also being developed to be smaller and lighter. This may eventually permit launch of "parasitic" microsatellites,[25] i.e., small craft that track

[24] Emily Hsu, "Program Officials Trying to Rebuild Support for Army KE-ASAT System," *Inside Missile Defense*, 5 March, 2003

[25] For an overview of current technology and current and planned mini/micro/nano satellite missions, see the website maintained by the researchers at Surrey Space Center, UK: http://www.SmallSatellites.org

and follow other satellites; this technology could prove useful for ASAT missions if the microsatellite were able to maneuver close enough to the target satellite to disrupt or destroy it. Microsatellites could also perform defensive functions for satellites.

Development of most of these new technologies into deployable offensive or defensive systems will take a number of years. However, some of the systems the United States is currently developing to intercept ballistic missiles would have considerable inherent capability to be used as ASAT weapons, and could therefore significantly increase US ASAT capability.

Indeed, while the technologies being developed for long-range missile defenses may not prove very effective at defending against ballistic missiles, some could be much more effective against satellites, since in many ways attacking satellites is an easier task[26]. Satellites travel on predictable orbits that can be determined accurately by tracking from ground facilities, allowing the position of the satellite to be known at future times. The United States would have time to plan an attack, could choose the timing, and would have time to take as many shots as necessary to destroy it. In contrast, in a ballistic missile attack, the attacker would have the advantage of surprise and the defense less than 30 minutes to respond. In addition, an interceptor attacking a satellite would not have to deal with the severe countermeasure problem that would face a missile defense system. Current-generation satellites are not equipped to defend themselves. While future satellites might include defenses of some type, it will be difficult to overcome the advantages that an attacker has.

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[26] For a more detailed account, see D. Wright and L. Grego, "Anti-Satellite Capabilities of Planned US Missile Defense Systems," *Disarmament Diplomacy*, Dec. 2002-Jan. 2003, available at http://www.acronym.org.uk/dd/dd68/68op02.htm .