**Anti-ballistic missile**

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The Aegis Ballistic Missile Defense System. A RIM-161 Standard Missile 3 anti-ballistic missile is launched from USS *Shiloh*, a US Navy *Ticonderoga*-class cruiser.

An **anti-ballistic missile** (**ABM**) is a missile designed to counter ballistic missiles (a missile for missile defense). A ballistic missile is used to deliver nuclear, chemical, biological or conventional warheads in a ballistic flight trajectory. The term "anti-ballistic missile" describes any antimissile system designed to counter ballistic missiles. However the term is used more commonly for systems designed to counter intercontinental ballistic missiles (ICBMs).

**Current counter-ICBM systems**

There are only two systems in the world that can intercept ICBMs. Besides them, many smaller systems exist (tactical ABMs), that generally cannot intercept intercontinental strategic missiles, even if within range—an incoming ICBM simply moves too fast for these systems.

The Russian A-35 anti-ballistic missile system for defense of Moscow was established in 1971, has been improved since, and is still active. Presently it is called A-135 and it uses two missile types, Gorgon and Gazelle. They are themselves armed with nuclear warheads.

The U.S. Ground-Based Midcourse Defense (GMD; previously known as National Missile Defense – NMD) system has recently reached initial operational capability. Instead of using an explosive charge, it launches a kinetic projectile. The George W. Bush administration accelerated development and deployment of a system proposed in 1998 by the Clinton administration. The system is a dual purpose test and interception facility in Alaska, and in 2006 was operational with a few interceptor missiles. The Alaska site provides more protection against North Korean missiles or launches from Russia or China, but is likely less effective against missiles launched from the Middle East. President Bush referenced the 9/11 attacks and the proliferation of ballistic missiles as reasons for missile defense. The current GMD system has the more limited goal of shielding against a limited attack by a rogue state.

**US plans for Central European site**

*Further information: National missile defense Recent developments*

During 1993, a symposium was held by western European nations to discuss potential future ballistic missile defense programs. In the end, the council recommended deployment of early warning and surveillance systems as well as regionally controlled defense systems. During Spring 2006 reports about negotiations between the United States and Poland as well as the Czech Republic were published. The plans propose the installation of a latest generation ABM system with a radar site in the Czech Republic and the launch site in Poland. The system was announced to be aimed against ICBMs from Iran and North Korea. This caused harsh comments by then-Russia's President Vladimir Putin at the Organization for Security and Co-operation in Europe (OSCE) security conference during spring 2007 in Munich. Other European ministers commented that any change of strategic weapons should be negotiated on NATO level and not 'unilaterally' between the US and other states (although most strategic arms reduction treaties were between the USSR and US, not NATO). German foreign minister Frank-Walter Steinmeier expressed severe concerns about the way in which the USA had conveyed its plans to its European partners and criticized the US administration for not having consulted Russia prior to announcing its endeavors to deploy a new missile defense system in Central Europe. As of July 2007, a majority of Poles were opposed to hosting a component of the system in Poland.

**Current tactical systems**

Many short-range tactical ABM systems are currently operational, and three are most known: the U.S. Army Patriot, U.S. Navy Aegis combat system, and the Israeli Arrow missile. They are *not* capable of intercepting an ICBM, even if it is in range.

**United States**



United States Navy RIM-161 Standard Missile 3 anti-ballistic missile.

In several tests, the U.S. military have demonstrated the feasibility of destroying long and short range ballistic missiles. Combat effectiveness of newer systems against 1950s tactical ballistic missiles seems very high, as the Patriot Advanced Capability 3 (PAC-3) had a 100% success rate in Operation Iraqi Freedom.

U.S. Navy Aegis combat system uses RIM-161 Standard missile SM-3.

MIM-23 Hawk missile is not operational in the U.S.

These systems, as opposed to US GMD system, are not capable of intercepting an ICBM, even if it is in range.

A new system, scheduled for deployment during 2009, is U.S. Terminal High Altitude Area Defense (THAAD) system. It has a longer range, but it is not known if it will be able to intercept ICBMs.

**Russia**



S-300PMU-2 vehicles. From left to right: 64N6E2 detection radar, 54K6E2 command post and 5P85 TEL.

The Moscow ABM defense system was, or is, based on:

* ABM-1 Galosh (decommissioned)
* ABM-3 Gazelle
* ABM-4 Gorgon

Apart from the main Moscow deployment, Russia has striven actively for intrinsic ABM capabilities of its late model SAM systems.

* S-300P (SA-10)
* S-300V (SA-12)
* S-300PMU-1/2 (SA-20)
* S-400 (SA-21)
* S-500 ( In development )

**People's Republic of China**

**Historical Project 640**

Project 640 had been the PRC's indigenous effort to develop ABM capability. The Academy of Anti-Ballistic Missile & Anti-Satellite was established from 1969 for the purpose of developing Project 640. The project was to involve at least three elements, including the necessary sensors and guidance/command systems, the Fan Ji (FJ) missile interceptor, and the XianFeng missile-intercepting cannon. The FJ-1 had completed two successful flight tests during 1979, while the low-altitude interceptor FJ-2 completed some successful flight tests using scaled prototypes. A high altitude FJ-3 interceptor was also proposed. Despite the development of missiles, the program was slowed down due to financial and political reasons. It was finally closed down during 1980 under a new leadership of Deng Xiao Peng as it was seemingly deemed unnecessary after the 1972 Anti-Ballistic Missile Treaty between the Soviet Union and the United States and the closure of the US Safeguard ABM system.

**Operational Chinese system**

In March 2006, China tested an interceptor system comparable to the U.S. Patriot missiles.

Currently, China has acquired and is license-producing the S-300PMU-2/S-300PMU-1 series of terminal ABM-capable SAMs. China-produced HQ-9 SAM system may have some terminal ABM capabilities, but it is kinematically inferior to the imported Russian S-300PMU2 Favorite. PRC Navy's currently operating modern air-defense destroyers known as the Type 052C Destroyer and Type 051C Destroyer are armed with naval HHQ-9 missiles.

Surface-to-air missiles that supposedly have some terminal ABM capability (as opposed to midcourse capability):

* HQ-19
* HQ-18 ← A copy of S-300 (missile) and The reference doesn't confirm the ABM capability.

**Development of midcourse ABM in China**

The technology and experience from the successful anti-satellite test using a ground-launched interceptor during January 2007 was immediately applied to current ABM efforts and development.

China carried out a land-based anti-ballistic missile test on 11 January 2010. The test was exoatmospheric and done in midcourse phase and with a kinetic kill vehicle. China is the second country after US that demonstrated intercepting ballistic missile with a kinetic kill vehicle, the interceptor missile was a SC-19. The sources suggest the system is not operationally deployed as of 2010.

**France, United Kingdom and Italy**



Royal Navy Type 45 destroyers, and French Navy and Italian Navy *Horizon* -class frigates operate Aster 30 missiles

Main article: Aster (missile family)

Italy and France have developed a missile family called Aster (Aster 15 and Aster 30). Aster 30 is capable of ballistic missile defense. On 18 October 2010, France announced a successful tactical ABM test of the Aster 30 missile and on 1 December 2011 a successful interception of a Black Sparrow ballistic target missile. Royal Navy Type 45 destroyers and French Navy and Italian Navy *Horizon* -class frigates are armed with PAAMS, using Aster 15 and 30 missiles. Also France is developing another version, Aster 30 block II which can destroy ballistic missiles with a maximum range of 3000 km. It will have a Kill Vehicle warhead.

**Japan**



Japanese guided missile destroyer JDS *Kongō* (DDG-173) firing a Standard Missile 3 anti-ballistic missile.

Main article: RIM-161 Standard Missile 3

Since 1998, when North Korea launched a Taepodong-1 missile over northern Japan, the Japanese have been jointly developing a new Surface-to-air interceptor known as the Patriot Advanced Capability 3 (PAC-3) with the US. So far tests have been successful, and there are planned 11 locations that the PAC-3 will be installed. A military spokesman said that tests had been done on two sites, one of them a business park in central Tokyo, and Ichigaya – a site not far from the Imperial Palace. Along with the PAC-3, Japan has installed a US-developed ship-based anti-ballistic missile system, which was tested successfully on 18 December 2007. The missile was launched from a Japanese warship, in partnership with the US Missile Defense Agency and destroyed a mock target launched from the coast.

**India**



India's Advanced Air Defense (AAD) interceptor missile

Main article: Indian Ballistic Missile Defense Program

India has an active ABM development effort using indigenously developed and integrated radars, and indigenous missiles. In November 2006, India successfully conducted the PADE (Prithvi Air Defense Exercise) in which an Anti-ballistic missile, called the Prithvi Air Defense (PAD) an *Exoatmospheric* (outside the atmosphere) interceptor system intercepted a Prithvi-II ballistic missile. The PAD missile has the secondary stage of the Prithvi missile and can reach altitude of 80 km (50 mi). During the test the target missile was intercepted at an 50 km (31 mi) altitude.[26] India became the fourth nation in the world to acquire such a capability and the third nation to acquire it using in house research and development. On 6 December 2007 the Advanced Air Defense (AAD) missile system was tested successfully. This missile is an Endoatmospheric interceptor with an altitude of 30 km (19 mi). According to scientist V K Saraswat of DRDO, the missiles will work in tandem to ensure a hit probability of 99.8 percent.

**Phase I**

On 6 March 2009 India successfully tested an interceptor missile that destroyed an incoming missile. A Dhanush missile was launched from a ship about 100 km (62 mi) from the coast. It rose to a height of 120 km (75 mi) and as it began its downward trajectory, the interceptor was launched and successfully achieved a kill.

On 26 July 2010, India successfully tested an interceptor missile, bringing down an incoming target ballistic missile (a modified Prithvi) with 2,000 km range, at an altitude of 15 km over the Bay of Bengal.

On 6 March 2011 India successfully tested an indigenously built interceptor missile, bringing down an incoming target ballistic missile from Wheeler Island off the Orissa coast. The interceptor, developed under the Ballistic Missile Defense System, destroyed the target, a variant of Prithvi-II, mimicking an enemy missile, fired from launch complex-III of the Integrated Test Range (ITR) at Chandipur on-Sea in Balasore district, about 70 km from Wheeler Island across the sea, at an altitude of 16 km over the Bay of Bengal. The interceptor was fired five minutes after the target was fired. On 15 May 2011 it was reported that India has started working on a network of air-defense systems which would be able to shoot down any enemy missile with a distance of 5,000 km, before it can enter the Indian air space.

On 10 February 2012, India successfully tested its ABM capabilities. A modified surface-surface missile 'Prithvi' was used as a hostile missile. An interceptor Advanced Air Defense (AAD) successfully knocked down the hostile missile at an altitude of 15 km.

On 6 May 2012, Dr. V. K. Saraswat confirmed that Phase-I is complete and can be deployed to protect two Indian cities at a short notice. He also added that Phase-I is comparable to PAC-3 system. New Delhi, the national capital, and Mumbai, have been selected for the ballistic missile defense shield. This shield can destroy incoming ballistic missiles with have range of up to 2,000 km.

**Phase II**

As part of Phase II, the missile defense shield will be used to cover other major cities in the country, after successful implementation in Delhi and Mumbai. Two new high speed anti-ballistic missiles (AD-1 and AD-2) are being developed to intercept ballistic missiles with the range of 5,000 km (3,107 mi). Phase II is expected to be completed by 2016.

**Israel**

Main article: Arrow (missile)



An Arrow anti-ballistic missile interceptor

The Arrow project was begun after the U.S. and Israel agreed to co-fund it on 6 May 1986.

The Arrow ABM system was designed and constructed in Israel with financial support by the United States by a multi-billion dollar development program called "Minhelet Homa" with the participation of companies like Israel Military Industries, Tadiran and Israel Aerospace Industries.

During 1998 the Israeli military conducted a successful test of their Arrow missile. Designed to intercept incoming missiles travelling at up to 2 mile/s (3 km/s), the Arrow is expected to perform much better than the Patriot did in the Gulf War. On 29 July 2004 Israel and the United States carried out joint experiment in the USA, in which the Arrow was launched against a real Scud missile. The experiment was a success, as the Arrow destroyed the Scud with a direct hit. During December 2005 the system was deployed successfully in a test against a replicated Shahab-3 missile. This feat was repeated on 11 February 2007.

Main article: Iron Dome

Iron Dome (Hebrew: כיפת ברזל‎) is a mobile air defense system in development by Rafael Advanced Defense Systems designed to intercept short-range rockets and artillery shells. The system was created as a defensive countermeasure to the rocket threat against Israel's civilian population on its northern and southern borders. It is designed to intercept very short-range threats up to 70 kilometers in all-weather situations. It was declared operational and initially deployed on 27 March 2011 near Beersheba. On 7 April 2011, the system successfully intercepted a Grad rocket launched from Gaza for the first time.

Main article: David's Sling

David's Sling (Hebrew: קלע דוד‎), also sometimes called Magic Wand (Hebrew: שרביט קסמים‎), is an Israel Defense Forces military system being jointly developed by the Israeli defense contractor Rafael Advanced Defense Systems and the American defense contractor Raytheon, designed to intercept medium- to long-range rockets and slower-flying cruise missiles, such as those possessed by Hezbollah, fired at ranges from 40 km to 300 km.

**Development in Republic of China (Taiwan)**

Republic of China, commonly known as Taiwan, is also engaged in the development of an anti-ballistic missile system, based on its indigenously developed Tien Kung-II (Sky Bow) SAM system. Although reports suggest a promising system, the ROC government continues to be interested strongly in the American Terminal High Altitude Area Defense (THAAD) program.

**History of ABMs**

**1940s and 1950s**



Launch of an US Army Nike Zeus missile

The idea of destroying rockets before they can hit their target dates from the first use of modern missiles in warfare, the German V-1 and V-2 program of World War II. British fighters attempted to destroy V-1 "buzz bombs" in flight prior to impact, with some success, although concentrated barrages of heavy anti-aircraft artillery had greater success. The V-2, the first true ballistic missile, was impossible to destroy using aircraft or artillery. Instead, the Allies launched Operation Crossbow to find and destroy V-2s before launch. The operation was largely ineffective, and the V2s were eventually dealt with when the launch sites were overrun by the rapid advance of the Allied armies through Belgium and the Netherlands.

The American armed forces began experimenting with anti-missile missiles soon after World War II, as the extent of German research into rocketry became clear. But defenses against Soviet long-range bombers took priority until 1957, when the Soviet Union demonstrated its advances in intercontinental ballistic missile technology with the launch of Sputnik, the Earth's first artificial satellite.

In 1958, a topic of research by the U.S. was the test explosions of several low yield nuclear weapons at very high altitudes over the southern Atlantic ocean, launched from ships. The devices used were the 1.7 kt. boosted fission W25 warhead. When such an explosion takes place a burst of X-rays are released that strike the Earth's atmosphere, causing secondary showers of charged particles over an area hundreds of miles across. The movement of these charged particles in the Earth's magnetic field causes a powerful EMP which induces very large currents in any conductive material. The purpose was to determine how much the EMP would interfere with radar tracking and other communications and the level of destruction of electronic circuitry aboard missiles and satellites. The project's results are not known, although similar so-called 'effects tests' were a regular feature of underground tests at the Nevada Test Site until 1992. These 'effects tests' are used to determine how resistant specific warheads, reentry vehicles (RVs) and other components are to exoatmospheric nuclear explosions.

**Canada**

Other countries were also involved in early ABM research. A more advanced project was at CARDE in Canada, which researched the main problems of ABM systems. This included developing several advanced infrared detectors for terminal guidance, a number of missile airframe designs, a new and much more powerful solid rocket fuel, and numerous systems for testing it all. After a series of drastic budget reductions during the late 1950s the research ended. One offshoot of the project was Gerald Bull's system for inexpensive high-speed testing, consisting of missile airframes shot from a sabot round, which would later be the basis of Project HARP.

**The first operational ABM system – Moscow**

The first real and successful ABM hit-to-kill test was conducted by the Soviet PVO forces on 1 March 1961. An experimental V-1000 missile (part of the "A" ABM program) launched from the Sary-Shagan test range, destroyed a dummy warhead released by a R-12 ballistic missile launched from the Kapustin Yar Cosmodrome. The dummy warhead was destroyed by the impact of 16,000 tungsten-carbide spherical impactors 140 seconds after launch, at an altitude of 25 km (82,000 ft). The V-1000 missile system was nonetheless considered not reliable enough and abandoned in favor of nuclear-armed ABMs.

The first operational ICBM ABM system was the Soviet A-35 anti-ballistic missile system, designed to protect Moscow. It was initially a single-layer exoatmospheric (outside the atmosphere) design, using A350 (NATO name: AB1 Galosh interceptors). It became operational in 1971 and was deployed at four sites around Moscow.

A-35 was upgraded during the 1980s to a two-layer system, the A-135. The Gorgon (SH-11/ABM-4) long-range missile was designed to handle intercepts outside the atmosphere, and the Gazelle (SH-08/ABM-3) short-range missile endo-atmospheric intercepts that eluded Gorgon. The ABM-3 alone was considered to be technologically equivalent to the United States Safeguard system of 1975.

**American Nike-X of 1960s and plans of Sentinel**

The Soviet initial experiments were closely followed by United States Nike Zeus, a modification of then-existing anti-aircraft missiles. Nike Zeus proved unworkable, and so work proceeded with Nike X.

Nike X was a system of two missiles, radars and their associated control systems. The main missile was LIM-49 Spartan—a Nike Zeus upgraded for longer range and a much larger 5 megaton warhead intended to destroy enemy's warheads with a burst of x-rays outside the atmosphere. A second shorter-range missile called Sprint with very high acceleration was added to handle warheads that evaded longer-ranged Spartan. Sprint was a very fast missile (some sources claimed it accelerated to 8,000 mph (13 000 km/h) within 4 seconds of flight—an average acceleration of *90 g*) and had a smaller W66 enhanced radiation warhead in the 1–3 kiloton range for in-atmosphere interceptions.

The new Spartan missile changed the deployment plans. Previously, the Nike systems were to have been clustered near cities as a last-ditch defense, but the Spartan allowed for interceptions at a range of hundreds of miles. The experimental success of Nike X persuaded the Lyndon B. Johnson administration to propose a thin ABM defense, that could provide almost complete coverage of the United States. In a September 1967 speech, Defense Secretary Robert McNamara referred to it as Sentinel. McNamara, a private ABM opponent because of cost and feasibility (see cost-exchange ratio), claimed that Sentinel would be directed not against the Soviet Union's missiles (since the USSR had more than enough missiles to overwhelm any American defense), but rather against the potential nuclear threat of the People's Republic of China.

In the meantime a public debate over the merit of ABMs began. Difficulties that had already made an ABM system questionable for defending against an all-out attack. One problem was the Fractional Orbital Bombardment System (FOBS) that would give little warning to the defense. Another problem was high altitude EMP (whether from offensive or defensive nuclear warheads) which could degrade defensive radar systems.

When this proved infeasible for economic reasons, a much smaller deployment using the same systems was proposed, namely Safeguard (described later).

**The problem of defense against MIRVs**



Testing of the LGM-118A Peacekeeper re-entry vehicles, all eight shot from only one missile. Each line represents the path of a warhead which, were it live, would detonate with the explosive power of twenty-five Hiroshima-style weapons.

ABM systems were developed initially to counter single warheads launched from large Intercontinental ballistic missiles (ICBMs). The economics seemed simple enough; since rocket costs increase rapidly with size, the price of the ICBM launching a large warhead should always be greater than the much smaller interceptor missile needed to destroy it. In an arms race the defense would always win.

Conditions changed dramatically in 1970 with the introduction of Multiple independently targetable reentry vehicle (MIRV) warheads. Suddenly each launcher was throwing not one warhead, but several. The defense would still require a rocket for every warhead, as they would be re-entering over a wide space and could not be attacked by several warheads from a single antimissile rocket. Suddenly the defense was more expensive than offense; it was much less expensive to add more warheads, or even decoys, than it was to build the interceptor needed to shoot them down.

In summary, the MIRV made ABM economically ineffective, and practically non-workable.

**The Anti-Ballistic Missile Treaty of 1972**

Main article: Anti-Ballistic Missile Treaty

Technical, economic and political problems described resulted in the ABM treaty of 1972, which restricted the deployment of strategic (not tactical) anti-ballistic missiles.

By the ABM treaty and a 1974 revision, each country was allowed to deploy a mere 100 ABMs to protect a single, small area. The Soviets retained their Moscow defenses. The U.S. designated their ICBM sites at Grand Forks Air Force Base, North Dakota, where Safeguard was already under advanced development.

**Brief use of Safeguard in 1975/1976**

The U.S. Safeguard system, which utilized the nuclear-tipped LIM-49A Spartan and Sprint missiles, in the short operational period of 1975/1976, was a second counter-ICBMs system in the world. Safeguard protected only the main fields of US ICBMs from attack, theoretically ensuring that an attack could be responded to with a US launch, enforcing the mutually assured destruction principle.

**SDI experiments in the 1980s**

Main article: Strategic Defense Initiative

The Reagan-era Strategic Defense Initiative (often referred to as "Star Wars"), along with research into various energy-beam weaponry, brought new interest in the area of ABM technologies.

SDI was an extremely ambitious program to provide a total shield against a massive Soviet ICBM attack. The initial concept envisioned large sophisticated orbiting laser battle stations, space-based relay mirrors, and nuclear-pumped X-ray laser satellites. Later research indicated that some planned technologies such as X-ray lasers were not feasible with then-current technology. As research continued, SDI evolved through various concepts as designers struggled with the difficulty of such a large complex defense system. SDI remained a research program and was never deployed. Several post-SDI technologies are used by the present Missile Defense Agency (MDA).

Lasers originally developed for the SDI plan are currently in use for astronomical observations. Used to ionize gas in the upper atmosphere, they provide telescope operators with a target to calibrate their instruments.

**Tactical ABMs deployed in 1990s**

The Israeli Arrow missile system was tested initially during 1990, before the first Gulf War. The Arrow was supported by the United States throughout the 1990s.

The Patriot antiaircraft missile was the first deployed tactical ABM system, although it was not designed from the outset for that task and consequently had limitations. It was used during the 1991 Gulf War to attempt to intercept Iraqi Scud missiles. Post-war analyses show that the Patriot was much less effective than initially thought because of its radar and control system's inability to discriminate warheads from other objects when the Scud missiles broke up during reentry.

Testing ABM technology continued during the 1990s with mixed success. After the Gulf War, improvements were made to several U.S. air defense systems. A new Patriot, PAC-3, was developed and tested—a complete redesign of the PAC-2 deployed during the war, including a totally new missile. The improved guidance, radar and missile performance improves the probability of kill over the earlier PAC-2. During Operation Iraqi Freedom, Patriot PAC-3s had a nearly 100% success rate against Iraqi TBMs fired. However since no longer range Iraqi Scud missiles were used, PAC-3 effectiveness against those was untested. Patriot was involved in three friendly fire incidents: two incidents of Patriot shootings at coalition aircraft and one of U.S. aircraft shooting at a Patriot battery.

A new version of the Hawk missile was tested during the early to mid-1990s and by the end of 1998 the majority of US Marine Corps Hawk systems were modified to support basic theater anti-ballistic missile capabilities. MIM-23 Hawk missile is not operational in the U.S. service since 2002, but is used by many other countries.



Developed in the late 1990s, the Lightweight Exo-Atmospheric Projectile attaches to a modified SM-2 Block IV missile used by the U.S. Navy

Soon after the Gulf war, the Aegis combat system was expanded to include ABM capabilities. The Standard missile system was also enhanced and tested for ballistic missile interception. During the late 1990s SM-2 block IVA missiles were tested in a theater ballistic missile defense function. Standard Missile 3 (SM-3) systems have also been tested for an ABM role. In 2008 an SM-3 missile launched from a *Ticonderoga*-class cruiser, the USS Lake Erie, successfully intercepted a non-functioning satellite.

From 1992 to 2000 a demonstration system for the US Army Terminal High Altitude Area Defense was deployed at White Sands Missile Range. Tests were conducted on a regular basis and resulted in early failures, but successful intercepts occurred during 1999.

**Brilliant Pebbles concept**

Approved for acquisition by the Pentagon during 1991 but never realized, Brilliant Pebbles was a proposed space-based anti-ballistic system that was meant to avoid some of the problems of the earlier SDI concepts. Rather than use sophisticated large laser battle stations and nuclear-pumped X-ray laser satellites, Brilliant Pebbles consisted of a thousand very small, intelligent orbiting satellites with kinetic warheads. The system relied on improvements of computer technology, avoided problems with overly centralized command and control and risky, expensive development of large, complicated space defense satellites. It promised to be much less expensive to develop and have less technical development risk.

The name Brilliant Pebbles comes from the small size of the satellite interceptors and great computational power enabling more autonomous targeting. Rather than rely exclusively on ground-based control, the many small interceptors would cooperatively communicate among themselves and target a large swarm of ICBM warheads in space or in the late boost phase. Development was discontinued later in favor of a limited ground-based defense.

**Transformation of SDI into MDA, development of NMD/GMD**

While the Reagan era Strategic Defense Initiative was intended to shield against a massive Soviet attack, during the early 1990s, President George H. W. Bush called for a more limited version using rocket-launched interceptors based on the ground at a single site. Such system was developed since 1992, is expected to become operational in 2010 and capable of intercepting small number of incoming ICBMs. First called the National Missile Defense (NMD), since 2002 it was renamed Ground-Based Midcourse Defense (GMD). It was planned to protect all 50 states from a rogue missile attack. The Alaska site provides more protection against North Korean missiles or accidental launches from Russia or China, but is likely less effective against missiles launched from the Middle East. The Alaska interceptors may be augmented later by the naval Aegis Ballistic Missile Defense System, by ground-based missiles in other locations, or by the Boeing Airborne Laser.

During 1998, Defense secretary William Cohen proposed spending an additional $6.6 billion on intercontinental ballistic missile defense programs to build a system to protect against attacks from North Korea or accidental launches from Russia or China.

In terms of organization, during 1993 SDI was reorganized as the Ballistic Missile Defense Organization (BMDO). In 2002 it was renamed to Missile Defense Agency (MDA).

**US withdrawal from Anti-Ballistic Missile Treaty in 2002**

On 13 June 2002, the United States withdrew from the Anti-Ballistic Missile Treaty and subsequently recommenced developing missile defense systems that would have formerly been prohibited by the bilateral treaty. The action was covered by the ostensible reason of needing to defend against the possibility of a missile attack conducted by a rogue state.

The next day, Russian Federation promptly dropped the START II agreement, intended to completely ban MIRVS.