
# SDI: A Basis for a Multi-Layered Defense Against Ballistic Missiles

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**EXECUTIVE SUMMARY: The Strategic Defense Initiative (SDI, or Star Wars) program was developed in the US in the 1980s with the aim of providing a hermetic defense against Soviet intercontinental ballistic nuclear missiles. SDI did not reach final implementation and was canceled in 1993. It nevertheless created a basis for the development of a multi-layered theater defense against ballistic missiles. That defense was realized by Israel in its development of the Arrow ballistic missile interceptor system and other systems to defend against rockets and short-range missiles.**

Cold War-era tensions between the US and the USSR that began in the 1950s reached a peak in the early 1980s, surpassing even those of the Cuban missile crisis of 1962. In March 1983, President Ronald Reagan called the USSR the "evil empire" and declared the establishment of the Strategic Defense Initiative (SDI), also known as Star Wars. SDI had two purposes: to hermetically protect the US against Soviet intercontinental ballistic missiles (ICBMs) and bankrupt a USSR unable to afford an extremely expensive arms race.

The practical task of SDI was to find ways to neutralize Soviet ballistic missiles before they hit their targets. Methods included ground and space missile launch systems, lasers, and particle beam weapons, as well as systems that support the interceptors such as command and control systems, computers, radars, and other detectors. SDI aimed to deploy an extensive array of satellites and battle centers throughout the world to detect and destroy Soviet missiles in real time before they hit.

SDI explored various options for intercepting enemy ballistic missiles: during acceleration, when the missile's rocket engine is operating and its thermal

signature is very high but its speed is slow; in the middle of its track, when its rocket engine stops; and in its final phase, before it hits its target.

One of the first SDI projects was called Excalibur. Because a great many x-rays are released when a device containing a nuclear explosive in its center is detonated, Excalibur was designed to contain a large number of metal rods to be used as x-ray lasers. It was meant to be operated from space, in the absence of an atmosphere that could cause x-rays to diverge. The lasers were intended to hit a ballistic missile target even if the missile was thousands of miles away from the device. The large number of lasers in the device was also intended to allow the simultaneous destruction of dozens of ICBMs.

The first Excalibur experiment was performed on March 26, 1983 at an underground site, but its results were inconclusive. Regardless of the results of the test, the project was derailed by criticism of nuclear experiments in space.

Another SDI project was the Deuterium Fluoride (DF) laser, which was to operate as a "space-based laser". DF laser experiments conducted since 1970 indicated that it can store large amounts of energy within it yet be prevented from overheating. It could therefore be utilized for military applications, especially as a missile defense weapon.

The DF laser was first tested in 1980 and was later found to be capable of emitting a massive one megawatt of energy for up to 70 seconds. However, experiments simulating the use of the laser to intercept a ballistic missile were inconclusive.

In the fall of 1981, President Reagan instructed the Department of Defense to reexamine US defense plans against the Soviet ICBM threat. As a result of the development of new technologies, a multilayer strategic ballistic missile defense system was launched that included space interception satellites in addition to ground-based interceptor missiles deployed in US bases.

The space interception program known as "Brilliant Pebbles" (BP) was proposed in 1987. BP included thousands of small satellites, hundreds of which were to be placed over the USSR to detect Soviet ICBMs in flight and destroy them. Its sensor system was an array of "Brilliant Eyes" (BE) satellites, which were first launched in 1986.

BE satellites were designed to operate at an altitude of approximately 700 km and to detect ballistic missile launches. The system was intended to include 20 to 30 relatively small satellites equipped with sensors of near, mid-and far infrared spectra. The point of these satellites was to track the real-time, "horizon-to-horizon" flight of ballistic missiles, distinguish between warheads

and decoys, and provide a fairly accurate assessment of the location and time a ballistic missile would land. They were also equipped with detectors to spot ballistic missiles immediately upon launch using the "hotspot" detection capability of a launched missile over a 1,500 km range.

In the 1990s, BE and BP satellites were integrated into US-based space systems with satellite communications and without any need for land-based intervention. However, all three BP system trials conducted in 1990-92 failed. Because of these failures, and particularly in view of the end of the Cold War, the project was canceled in 1994. The BE satellites were integrated with ground-based missile defense systems.

SDI also included an Extended Range Interceptor (ERINT) program, which developed kinetic hit-to-kill technologies against ballistic missiles. These technologies were designed to launch interceptor missiles to destroy enemy missiles through head-on collision.

Four preliminary test launches were conducted by the US Army in 1983-84 in which Minuteman ICBMs were launched a distance of about 6,400 miles from a California base toward the Kwajalein Missile Range in the Marshall Islands Republic. Only the fourth test succeeded: the ICBM was intercepted while returning from space at a 160 km altitude and at a speed of 6.1 km/sec.

During the period between 1983 and the end of 1985, the USSR saw the SDI program as a threat to its physical security and argued that it could make nuclear war inevitable. While the Soviets might have feared that the SDI program was designed to protect the US against a Soviet counterstrike that might result from an American first strike, it is more likely that they understood that SDI was part of a campaign intended to burden the USSR's weak economy with military spending it could not afford.

SDI was indeed exceedingly expensive and stretched the US economy to the point of collapse, but it did contribute greatly to the end of the Cold War. The USSR was persuaded that it had failed in its arms race with America, and the ultimate result was the disintegration of the USSR.

But Russia is recovering. Under Putin's leadership, the arms race between Moscow and Washington is undergoing a resurgence. This is occurring at the same time the US is facing a new threat: North Korean nuclear weapons and missiles.

Although the SDI program ended in 1993, military tensions in many arenas have prompted the development and deployment of antiballistic missile defense systems around the world. In 1991, for example, during the Desert

Storm war with Iraq, Patriot batteries were deployed in Israel and Saudi Arabia as an initial means of defense against tactical missiles.

As the limitations of the Patriot became apparent, the US and Israel began to develop more sophisticated ballistic missile defense systems. The THAAD (Terminal High Altitude Area Defense) high-range missile was developed in the early 2000s to destroy short-range and medium-range ballistic missiles up to 2,000 kilometers using the hit-to-kill method. An operational THAAD battery was first deployed in Hawaii in 2009 to protect the islands from potential threat. In 2017, the US dispatched THAAD batteries to its North Korean assault defense.

As for Israel, it developed the Arrow interceptor system with the help of US funding and technology. The Arrow started as a part of SDI that the US decided to share with Israel. Arrow-1 tests conducted from 1992 to 1994 were successful and the missile's technology was proven.

The current Arrow system is based on the mid-range Arrow-2 and Arrow-3 two-stage interceptors. The Arrow-2 warhead is designed to destroy an enemy's ballistic missile by blasting when approaching it. Arrow-3, like THAAD, intercepts a missile via direct physical hit. The Arrow system's modularity enables the detection, tracking, interception, and destruction of ballistic missiles carrying a large range of warheads over wide terrain, through the atmosphere, and into outer space. It can thus provide total protection for sensitive facilities or populated areas.

Israel is currently developing the Arrow-4 missile, which is intended to intercept ballistic missiles equipped with multiple split warheads in outer space.

The multi-layer active defense system is critical to protecting Israel from missile attack due to its component parts: the Arrow-2 missile, which intercepts medium- and long-range ballistic missiles in the upper atmosphere; the Arrow-3 missile, which intercepts long-range ballistic missiles outside the atmosphere; David's Sling (its previous nickname was Magic Wand), which intercepts missiles in the lower atmosphere, including medium- and short-range cruise missiles and medium-and long-range rockets; and Iron Dome, which intercepts short-range rockets in the lower atmosphere.

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