Current U.S. Missile Defense Programs at a Glance

Fact Sheets & Briefs

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For more information on the European system, see European Phased Adaptive Approach (EPAA) at a Glance and for the Asia-Pacific Region, see U.S. and Allied Ballistic Missile Defenses in the Asia-Pacific Region.

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Executive Summary

According to Missile Defense Agency (MDA) estimates, Congress has appropriated over $200 billion for the agency’s programs between fiscal years 1985 and 2019. That total does not include spending by the military services on programs such as the Patriot system or the many additional tens of billions of dollars spent since work on anti-missile systems first began in the 1950s.
For nearly two decades, U.S. ballistic missile defense (BMD) policy has sought to protect the homeland against limited long-range missile strikes from states such as Iran and North Korea, but not major nuclear powers like Russia and China as that mission would pose significant technical, financial, and geopolitical challenges. The United States has also pursued programs to defend U.S. troops and facilities abroad, as well as some close allies, from attacks by ballistic missiles—and to a much lesser extent cruise missiles.

The overall U.S. missile defense effort enjoys strong bipartisan support in Congress. Additionally, many U.S. allies place a high value on missile defense cooperation with the United States.

However, the U.S. pursuit of effective missile defenses has been accompanied by intense debate about the technical capabilities of the system and realism of testing, the scope of the ballistic missile threat, the deterrence and assurance benefits of defenses, the cost-effectiveness of shooting down relatively inexpensive offensive missiles with expensive defensive ones, and the repercussions for U.S. strategic stability with Russia and China.

According to the Defense Department’s independent testing office, existing U.S. missile defenses have “demonstrated capability” to defend the U.S. homeland against a small number of intercontinental ballistic missile (ICBM) threats that employ “simple countermeasures.” The testing office assesses that defenses to protect allies and U.S. troops deployed abroad possess only a “limited capability” to defend against small numbers of intermediate-range ballistic missiles (IRBMs) and medium-range ballistic missiles (MRBMs). The capability of defenses against short-range ballistic missiles is labeled as “fair.” Apart from the point-defense Patriot system, no systems in the U.S. BMD arsenal have been used in combat.

Leaders of the U.S. missile defense enterprise have increasingly voiced concerns that the current U.S. approach to national and regional missile defense is unsustainable and that existing defenses must be augmented with emerging capabilities to reduce the cost of missile defense and keep pace with advancing adversary missile threats.

The Trump Administration

In May 2017, pursuant to direction from President Donald Trump and Congress, then Defense Secretary James Mattis formally announced the beginning of the department’s Ballistic Missile Defense Review, which is taking a wide-ranging look at missile defense policy and strategy. The review was finally released in February 2019, one year after its original completion target.

Broadly, the review proposes to expand the role and scope of U.S. missile defenses by focusing not only on ballistic missiles, but also other types of missile threats, such as regional cruise and hypersonic missiles. It also proposes placing greater emphasis on the importance of space and new technologies to intercept missiles during their boost phase when they are traveling at their slowest. The review also calls for integrating offensive attack operations more closely with missile defenses and to supplement the defense of the U.S. homeland with the Aegis Standard Missile-3 (SM-3) Block IIA interceptor.

The review also re-affirmed previously announced plans by the Trump administration to arm unmanned aerial vehicles with lasers to zap long-range missiles during their boost phase, expand the Ground-Based Midcourse Defense (GMD) system from 44 to 64 interceptors by 2023 (though this plan has since been indefinitely delayed), focus on “left of launch” capabilities to destroy a missile threat before it launches, and field a space-sensor layer to provide birth-to-death tracking of ballistic missiles and hypersonic glide vehicles. The review also called for 11 follow-up studies, which are detailed in the below section, The 2019 Missile Defense Review To-Do List.

Since President Trump’s inauguration, the administration has vowed to expand national and regional missile defense systems of every kind, and Congress has supported these efforts. In fiscal year 2018, Congress approved $11.5 billion for the Missile Defense Agency, an increase of $3.6 billion, or 46 percent, from the Trump administration’s May 2017 initial budget request. The appropriation is the largest Congress has ever provided for the agency after adjusting for inflation.
Congress approved another big increase for fiscal year 2019, approving $10.3 billion for the agency, an increase of $1.4 billion above the budget request of $9.9 billion.

Notably, the fiscal year 2020 request seeks $380 million over the next five years to develop and test by 2023 a prototype space-based laser weapon to destroy ICBMs during their boost and midcourse phases of flight.

For ballistic missile and missile defense basics, as well as the historical background of missile defense programs, please visit “Missiles and Missile Defense Systems at a Glance.”

Elements of the Current U.S. Ballistic Missile Defense System

The following charts provides a brief look at some of the major missile defense programs maintained by the United States. It contains information on what type of ballistic missile each defense would be intended to counter and at which stage of the enemy missile’s flight an attempted intercept would take place. Also included are the Pentagon’s estimates on when each defense may have an initial, rudimentary capability, as well as when it could be fully operational. For basics about missiles, missile defense systems and their various components, or the general history of the U.S. missile defense system and recently cancelled programs, visit the “Missile Defense Systems at a Glance” fact sheet.

GROUND-BASED MIDCOURSE DEFENSE

Program & Key Elements

• Key element: Ground-based missile interceptor (GBI) consisting of a multistage booster and an exoatmospheric kill vehicle (EKV).
• The EKV separates from the booster in space and seeks its target through radar updates and use of its onboard visual and infrared sensors.
• The EKV destroys its target by colliding with it. This process is referred to as “hit-to-kill” or “kinetic kill.”

Designed to Counter

• Goal: Intercept strategic ballistic missile warheads in midcourse -stage.

Status

• Initially fielded in 2004.
• As of the end of 2018, the total cost of the GMD system is estimated to be over $67 billion.
• MDA claims that the system has had 11 successful intercepts in 19 tests.
• The first test of the GMD system against an ICBM-class target with simple countermeasures took place on May 30, 2017, and was deemed successful.
• The first test which involved firing two interceptors against one ICBM target occurred in March 2019 and was deemed “successful.” In a real-world scenario, multiple interceptors would be fired at an incoming missile.

Capability / Schedule

• As of April 2018, the Pentagon deploys 44 ground-based interceptors (GBIs) – 40 at Fort Greely, Alaska, and four at Vandenberg Air Force Base, California. Twenty of the 40 interceptors deployed in Alaska are armed with an older CE-1 kill vehicle that has not had a successful flight intercept test since 2008. In 2017, the Trump administration announced its plan to deploy 20 more GBIs to be installed in a fourth missile field in Ft. Greely beginning in the FY 2021 timeframe. According to the Missile Defense Review, all 64 interceptors would be ready by 2023. These interceptors will be armed with the new, under-development Redesigned Kill Vehicle (RKV), which is intended to enhance the performance of the current EKV. But the RKV has been plagued by reliability and design problems, which led to the Pentagon stopping work on the program in May 2019 and, after a short review, terminating the program in August.
• The new timeline for expanding the GMD system to 64 interceptors is uncertain.
• The interceptors are supported by land- and sea-based radars upgraded to support the system. As of June 2018, upgrades at Vandenberg Air Force Base, California and at Fylingdales, the United Kingdom, Clear, Alaska. The less powerful, westward-facing COBRA Dane radar in the Aleutian archipelago, was also upgraded in February 2010.
• Former MDA Director Adm. James Syring told a Senate panel in 2013 that the MDA tests the GMD system “in a controlled, scripted environment based on the amount of time and money each one of these tests costs.” This means there are limits to the realism of the tests.
Following the May 30, 2017, test, the Pentagon's testing office updated its assessment, which had described the GMD system as having only a “limited capability” to defend the U.S. homeland from a small number of simple long-range missiles launched from North Korea or Iran. In a June 6, 2017, memo, the office said that the system has “demonstrated capability” to defend against a small number of long-range missiles threats that employ “simple countermeasures.” Concerned Scientists noted in a 2017 report that the only test of the GMD system against an ICBM-class target was “simplified in important ways that enhanced the test’s chance of success instead of challenging the system to work in a realistic way.”

**AEGIS BALLISTIC MISSILE DEFENSE (BMD)**

**Program & Key Elements**
- Key elements include: the RIM-161 Standard Missile-3 (SM-3) Aegis combat system.
- The SM-3 is a hit-to-kill missile comprised of a three-stage booster with a kill vehicle. There are three variations of the SM-3 missile: Block IA, Block IB, and Block IIA. Each variation will be deployed in different phases.
- The SM-6 is a hit-to-kill missile based on the SM-3 but offers extended range and firepower against cruise missile targets deep inland.
- As the Navy’s component of the missile defense system, the Aegis system is central to the defense footprint in Asia and the Phased Adaptive Approach to missile defense in Europe. Aegis is a sea-based system, with missile launchers and radars mounted on cruisers and destroyers but is adaptable to land systems as well.

**Designed to Counter**
- Geared toward defending against short-, medium-, and intermediate-range ballistic missiles during their midcourse phase with an emphasis on the ascent stage.

**Status**
- In 2005, the role of Aegis missile defense evolved from that of a forward sensor to include engagement capability.
- As of April 2019, the SM-3 has a test record of 40 intercepts in 49 attempts, comprising both the SM-3 and SM-6 missiles.
- Japan’s four KONGO Class Destroyers have been upgraded with BMD capabilities. Japan and the United States are co-developing the SM-3 block IIA.
- Under the fiscal year 2020 budget submission, by the end of fiscal year 2018, there are scheduled to be 39 Aegis BMD ships, and by the end of fiscal year 2024, there are scheduled to be 59 Aegis BMD ships.
- As of October 2017, thirty-three ships are currently deployed. Of these, 17 are assigned to the Pacific Fleet and 16 to the Atlantic Fleet.
- A land-based SM-3 block IB deployment occurred in Romania in 2016, and that same year, ground was broken in Poland on a site to house land-based SM-3 IIAs. The Polish site was originally scheduled to become operational in 2018 but has been delayed until 2020.
- The first intercept test of the new SM-3 IIA interceptor occurred in February 2017 and was successful. However, the second and third intercept tests of the missile failed to destroy their targets. There were two more tests before the end of 2018, both successful, with the December test particularly notable for being the first successful intercept of an IRBM target and using the ability to "engage on remote" using a forward-based sensor.
- The 2019 Missile Defense Review reaffirmed administration plans to test the SM-3 Block IIA missile interceptor against an ICBM-class target by 2020.

**TERMINAL HIGH ALTITUDE AREA DEFENSE (THAAD)**

**Program & Key Elements**
- Key elements include: 1) an interceptor missile comprising a single rocket booster with a separating kill-vehicle, 2) an advanced AN/TPY-2 radar unit to identify and discriminate between incoming missiles, and 3) an infrared seeker to home in on its target.
- The THAAD kill vehicle relies on hit-to-kill kinetic interception.
- THAAD batteries have four components: launcher, interceptors, radar, and fire control.
THAAD missiles are fired from a truck-mounted launcher. THAAD’s mission is to intercept short- and medium-range ballistic missiles at the end of their midcourse stage and in the terminal stage. Intercepts could take place inside or outside the atmosphere. As of April 2019, THAAD has succeeded in completing 15 interceptions in 15 tests since 2006. Four other THAAD tests, as of April 2019, have been classed as “no-tests.” (Note: A “no-test” occurs when the target malfunctions after launch so the interceptor is not launched.) On July 11, 2017, MDA executed a successful intercept test of the THAAD system against an air-launched intermediate-range ballistic missile (IRBM) target. The test was the first against an IRBM-class target.

**Capability / Schedule**

- The U.S. Army operates seven THAAD batteries, each comprising six launchers, are deployed in the Pacific: one in South Korea, one in Guam, and one in Hawaii.
- Production of the first THAAD interceptors began in March 2011. The Army received its 200th operational interceptor in August 2018.
- MDA is exploring development of an upgraded version of THAAD, known as THAAD extended range, which is designed to counter ultrafast gliding weapons.
- The U.S. and South Korea decided in July 2016 to deploy a THAAD battery in South Korea to counter North Korean threats despite strong objections from China. The battery began operating in April 2017. A THAAD battery was deployed to Guam in 2013 to counter potential North Korea IRBM threats to the island and U.S. military assets there. The first test of the THAAD system against an IRBM target occurred in July 2017.

**PATRIOT ADVANCED CAPABILITY-3 (PAC-3)**

**Program & Key Elements**

- Key elements include: a one-piece, hit-to-kill missile interceptor fired from a mobile launching station, which carries 16 PAC-3 missiles.
- The missile is guided by an independent radar that sends its tracking data to the missile through a mobile engagement control station.
- A blast fragmentation warhead kills the target.
- PAC-3 is designed to defend against short- and medium-range ballistic missiles at lower altitudes than the THAAD system.
- PAC-3s destroyed two Iraqi short-range ballistic missiles and a U.S. fighter jet. Earlier Patriot models also deployed to the region shot down nine Iraqi missiles and a British combat aircraft.

**Status**

- PAC-3 is now considered operational and has been deployed to Bahrain, Egypt, Germany, Greece, Israel, Japan, Jordan, Kuwait, the Netherlands, Saudi Arabia, South Korea, Spain, Taiwan, and the UAE.

The following is an overview of an early warning system to complement the missile defense systems listed above.

**SPACE-BASED INFRARED SYSTEM-HIGH**

**(SBIRS-HIGH)**

**Program Elements**

- Key Elements: 1) geosynchronous (GEO) satellites orbiting the earth; 2) geostationary (GEO) satellites in highly elliptical earth orbit (HEO).
- Primary objective is to provide early warning of theater ballistic missile launches.
- Provides data for technical intelligence and battle space awareness.
- Currently there are three SBIRS sensors mounted on host satellites.
There are four SBIRS satellites in geosynchronous orbit. GEO-1 was launched in May 2011, GEO-2 in March 2013, GEO-3 in January 2017, and GEO-4 in January 2018.

As of March 2018, the program is projected to cost $19.6 billion for six satellites—four times greater than its initial estimated $5 billion for five satellites.

**Major Issues**

- The first sensor in highly elliptical orbit—HEO-1—was certified for operations by U.S. Strategic Command in December 2008.
- The most recent sensor, GEO-4, was launched aboard an Atlas V rocket on January 19, 2018.
- Lockheed Martin is under contract to produce GEO-5 and GEO-6, which will be launched in 2021 and 2022, respectively.
- SBIRS originally called for two additional sensors, GEO-7 and GEO-8, but these were scrapped in favor of pursuing an entirely new SBIRS follow-on program. The successor program has yet to be identified or developed. Air Force Secretary Heather Wilson (who resigned in May 2019) suggested the new system will be "simpler" and more survivable to enemy attacks.

**The 2019 Missile Defense Review To-Do List**

The 2019 Missile Defense Review identified 11 issues that needed “follow-up” analysis to make a policy direction determination, which were scheduled to be completed within six months after the January 2019 review release date.

**Homeland Cruise Missile Defense**

Designating a service or defense agency with acquisition authority—by using the existing requirements-generation process—to find ways to defend the homeland against offensive cruise missiles.

**Worldwide THAAD Number Requirements**

The Army, the Joint Chiefs of Staff, and MDA will prepare a report that assesses the number of THAAD batteries needed to support worldwide deployments.

**Aegis Destroyers Fully-BMD Capable Timeline**

The Navy and MDA must determine how the existing Aegis destroyers can be converted to become fully capable against incoming missiles, including ballistic missiles.

**Homeland Missile Tracking and Discrimination**

MDA and Northern Command must prepare a plan to “accelerate efforts to enhance missile defense tracking and discrimination sensors, to include addressing advanced missile threats,” particularly focused on the homeland.

**F-35 Missile Defense**

The Air Force and MDA are working on how best to integrate the F-35 Joint Strike Fighter, including its sensor suite, into America’s missile defense networks for both regional and homeland defense.

**Aegis Ashore Test Center in Hawaii**

The Department of Defense is looking at the potential to operationalize the Aegis Ashore Missile Defense Test Center into a full-up missile defense site to counter potential missile launches from North Korea. MDA and the Navy will evaluate the option and develop a plan that could operationalize the site within 30 days, if needed.

**Study on Space-based Intercept Layer**

MDA will study development of a space-based layer capable of boost-phase defense, including the most promising technologies, estimated cost, and personnel requirements.

**More Efficient Acquisition and Development**

A big point of emphasis from officials talking about the MDR is that they wish to make the acquisition and development process more efficient and effective.
believe the acquisition and development of new technologies can and will go faster. To that end, the review calls for reviews of the current Warfighter Involvement Process, which determines missile defense requirements, in order to make sure commanders who will use the systems are involved early in the process of developing the systems and requirements.

Transregional Defense Integration

While the Pentagon divides the world into regional areas of responsibility, the nations capable of threatening American assets or allies with missiles do not necessarily. The chairman of the Joint Chiefs and the head of U.S. Strategic Command are therefore ordered to come up with a plan for “optimal roles, responsibilities, and authorities for achieving greater transregional missile defense integration.”

Left of Launch

Another requirement from the 2017 National Defense Authorization Act is for the designation of an office with acquisition authority specific to pre-launch attack operations—that is, someone who leads procurement of new technologies designed to destroy an enemy missile before it can take off. That agency must be identified within six months; after that happens, a larger review will begin to examine roles and responsibilities for updating operational doctrine.

Hypersonic and Cruise Missile Homeland Warning

And for a change of pace, the Pentagon will have nine months to research improvements for timely warnings on hypersonic and advanced cruise missiles launched at the U.S. homeland. At the completion of the study, the Office of Cost Assessment and Program Evaluation will initiate an analysis of alternatives for materiel solutions to provide early warning and attack assessment against these advanced threats and their integration into the nuclear command-and-control architecture.

Next Generation Efforts

The Missile Defense Agency is focusing its newest efforts to ensure the system stays ahead of developing foreign missile threats (see the below chart). Some of the advanced anti-missile technologies the Defense Department is pursuing, such as airborne lasers to zap missiles in the early stages of their flight, have been unsuccessfully pursued in the past.

**Multi-Object Kill Vehicle**

Three defense contractors (Boeing, Lockheed Martin, and Raytheon) have been awarded contracts to develop concepts to deploy multiple kill vehicles from one booster in order to destroy decoys and multiple warheads ejected from ICBMs. MDA had planned to begin fielding that kill vehicle in 2025, but the future of this effort is uncertain.

**Boost Phase Laser Defenses**

MDA is recommitting to research to determine how to develop laser beams that could destroy missiles in their boost phase. Inspired by the ABL program, the vision for the new system is to mate a powerful solid-state laser to drones. MDA aims to develop a laser demonstrator by 2020 or 2021 and a deployed capability by 2025. The MDR also called for a review of a new weapon for the F-35 fighter jet which could intercept an incoming ballistic missile in boost-phase.

**Left of Launch**

Left of launch is a proposed strategy that would be designed to counter missile threats before the missile is launched so as to reduce
expensive anti-missile interceptors to attempt to shoot down the missile. Tactically, the strategy would likely include the use of cyber-attacks and electronic warfare to achieve this goal. Despite much speculation in the press about the U.S. ability to hack North Korean missile tests, the data shows that North Korea’s missile tests are succeeding at a high rate and that failures are concentrated in new systems that had not been previously tested. The 2019 MDR reaffirmed the Trump administration’s plans to continue with this strategy.

**Space-Based Sensor Layer**

In August 2018, then MDA Director Samuel Greaves described a comprehensive space sensor layer. Such a layer could look like the Global Scanning system and could have a regional detection area that could go after targets that are currently harder to detect or in low Earth orbit. It could catch missiles in the boost or burnout phases of flight. The sensor would look at a missile’s flight by looking against the background of space and provide data directly to the ballistic missile defense weapon system for fire control. Finally, the sensor could also record towards the end of a missile’s trajectory whether an intercept against a target occurred or was missed.

**Space-Based Interceptor Layer**

According to the 2019 MDR, “Given the significant advantages of space-based interceptors, particularly for boost-phase defense, MDA will study the development of a space-based missile intercept layer capable of boost-phase defense and provide a report to USDR&E, and USDP within six months after the release of the MDR.”

The fiscal year 2020 White House budget requested $15 million for the new Space Development Agency to “develop a government reference architecture for a space-based kinetic interceptor layer for boost-phase defense.” It also requested $34 million for the 2020 fiscal year to develop and test by 2023 a prototype space-based directed-energy (laser) weapon for ICBMs during their boost phase. Over the course of five years, the program is expected to cost $380 million.

**Congressional Proposals**

In recent years, Congress has sought to encourage the expansion of the U.S. ballistic missile defense effort in the face of advancing adversary ballistic missile capabilities. These initiatives, which are summarized below, have been met with strong resistance from the administration.

**A Third National Missile Defense Site on the U.S. East Coast**

In the fiscal year 2013 National Defense Authorization Act, Congress required the Defense Department to conduct a study to evaluate at least three possible new long-range interceptor sites that could augment the GMD system, including at least two on the East Coast. The Defense Department announced in May 2016 that it completed a draft study of three possible locations in the eastern United States for a new ballistic missile defense interceptor site, but said it had no plans to actually build such a site. The three sites are: Ft. Drum, New York; Camp Ravenna, Ohio; or Ft. Custer, Michigan. The draft environmental impact statement, which was posted on the MDA website May 31, 2016, said that the Defense Department “does not propose and has not made a decision to deploy or construct an additional interceptor site.”

The Trump administration missile defense review noted the benefits of a new third GBI interceptor site in the eastern United States and noted that the Defense Department has already prepared an Environmental Impact Statement evaluating locations. Though the administration decided against building a third missile defense site on the East Coast in that review, on June 26 the Defense Department sent a letter to Rep. Elise Stefanik (R-N.Y.) announcing that Fort Drum, in her district, was selected as the new defense site, but that there was “no intent to develop one” based on a study earlier this year noting its cost due to environmental concerns.
Revising the 1999 National Missile Defense Act

The FY 2017 National Defense Authorization Act revised the 1999 National Missile Defense Act to remove the word “limited,” and the 2018 NDAA authorized expansions in the national missile defense program. Proponents of the change argue that the 1999 legislation has prevented the Department from adequately planning for the protection of the U.S. from the full spectrum of ballistic missiles threats, including those from Russia and China. The Obama administration strongly objected stating that the word “limited” is specifically intended to convey that the U.S. homeland missile defense system is designed and deployed to counter the strategic deterrence forces of Russia and China.

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