Airborne Laser

REAL PROGRESS TOWARD REAL CAPABILITY

Imagine a military airplane armed with a laser that zaps hostile ballistic missiles out of the sky. The laser beam travels so quickly — at the speed of light — that it can destroy targets while they are still over enemy territory.

Science fiction, right?

NOT ANYMORE.

The Airborne Laser (ABL), under development by the U.S. Missile Defense Agency and the industry team of Boeing, Northrop Grumman and Lockheed Martin, is making tremendous progress toward providing a rapidly deployable, precise, speed-of-light capability to destroy ballistic missiles in their boost phase of flight, or shortly after they are launched.

The achievements have been so monumental that the Airborne Laser is poised to conduct its first missile intercept test in just two years. The lethal demonstration will highlight ABL's potential to dramatically change missile defense — and warfare more broadly.

"We stand on the verge of fully demonstrating a revolutionary warfighting capability," said Pat Shanahan, vice president and general manager of Boeing Missile Defense Systems. "ABL technical risk has been substantially reduced as a result of previous investments by Congress and Democratic and Republican Administrations. We are on the cusp of demonstrating ABL's capability."

"Since 2004, the program has made continual and significant progress, which is an amazing achievement for a program of such complexity," said Greg Hyslop, Boeing's ABL vice president and program director. "The program remains on track to complete a missile shootdown demonstration in 2009 that will validate the unique contribution ABL can bring to an integrated ballistic missile defense system as a boost-phase element."

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PROGRESS

The Airborne Laser program is placing a high-energy, megawatt-class chemical oxygen iodine laser (COIL) and highly sophisticated beam control/fire control and battle management systems on a modified Boeing 747-400F aircraft to detect, track and destroy ballistic missiles in their boost phase of flight. ABL also can pass information on launch sites, target tracks and predicted impact points to other elements of the multi-layered global ballistic missile defense system. Boeing is the prime contractor for ABL. Lockheed Martin and Northrop Grumman are industry partners.

Boeing provides the aircraft and battle management and leads the overall systems integration and testing. Northrop Grumman supplies the missile-killing, high-energy laser, as well as the beacon illuminator laser, which measures atmospheric conditions between the aircraft and the target. Lockheed Martin provides the beam control/fire control system, which incorporates the beacon illuminator laser and ABL's other illuminator, the track illuminator laser, which tracks hostile ballistic missiles.

A large turret on the airplane's nose gives ABL its distinctive appearance. The turret points the laser beam at the target so the aircraft does not have to be turned to fire at a missile.

In late 2004, the program achieved two key milestones: "first light" of the COIL in ground testing, and "first flight" of the first ABL aircraft, YAL-1A, with the beam control/fire control system on board.

In July 2005, the program completed low-power system integration-passive, demonstrating the stability and alignment of the two beam control/fire control optical benches with the turret. That test also demonstrated the system's pointing and vibration control functions, as well as its ability to acquire targets as directed by the battle management segment.

The Airborne Laser recently visited Andrews Air Force Base, Md., and was toured by more than 200 members of Congress and their staff, senior Defense Department officials, foreign government representatives and news media.

In December 2005, the team fired the high-energy laser at lethal power and duration in ground testing. Lasing duration and power were demonstrated at levels suitable for the destruction of multiple classes of ballistic missiles.

In 2006 at Boeing's Wichita, Kan., facility, the two solid-state illuminator lasers were integrated onboard the ABL YAL-1A aircraft and underwent ground testing to demonstrate target acquisition, fine tracking, pointing and atmospheric compensation.

The YAL-1A then moved to Edwards Air Force Base, Calif., for 2007 flight tests of the beam control/fire control system, including the illuminator lasers, and later for installation of the high-energy laser, which has been removed from the system integration laboratory and is being refurbished before being installed in the YAL-1 aircraft.

In the current test phase, which is scheduled to be completed this summer, ABL will fire its two illuminator lasers at the U.S. Air Force's NC-135E "Big Crow" test aircraft to verify ABL's ability to track an airborne target and measure and compensate for atmospheric turbulence. On March 15, 2007, ABL fired the first of those two illuminators, the track illuminator laser, in-flight at the Big Crow airborne target for the first time.

Starting in the second half of 2007, the program will install the COIL in the ABL aircraft to prepare for high-power system testing, including multiple missile intercept tests. After laser installation is complete, the program will conduct a series of ground and flight tests building up to a lethal demonstration against a boosting ballistic missile target in 2009.

CAPABILITY

The Airborne Laser packs extraordinary capability into a 747. The back half of the aircraft will contain the world's largest mobile laser, which consists of six modules, each the size of a Chevy Suburban sport utility vehicle. The front half already contains the beam control/fire control system, which compares in size and sophistication to the Hubble Space Telescope.

"The COIL has already proved in ground tests that it can achieve the duration and power levels needed to destroy a ballistic missile," said Guy Renard, Northrop Grumman's ABL program manager. "In 2009, we will demonstrate this capability in the air against an actual boosting ballistic missile."

"The beam control/fire control system is the most sophisticated high-power electro-optical system that's ever been built," said Art Napolitano, Lockheed Martin's ABL program director. "We are making good progress and have achieved a series of never-been-done-before accomplishments."

Developing a cutting-edge system like ABL isn't easy. It requires plenty of innovation, and the timetable for invention isn't always predictable. But all major technology breakthroughs have been achieved, and the ABL team is now focused on completing the integration of key components into the aircraft.

"This is a highly advanced system, so challenges are not unexpected," Hyslop said. "But we've not encountered a problem that we couldn't work through."

ABL will complement other missile defense systems, including the Ground-based Midcourse Defense system, which a Boeing-led industry team and the Missile Defense Agency developed to intercept missiles in their midcourse phase of flight. With so much at stake in the event of an enemy missile attack, the Missile Defense Agency is deploying a layered set of defenses to address missiles in the boost, midcourse and terminal phases for maximum effectiveness in keeping our homeland, troops and allies safe.

While midcourse is the longest phase of flight, providing the most amount of time for an intercept, ballistic missiles are more vulnerable in the boost phase because their countermeasures have not yet deployed and because their rocket plumes make them more visible. ABL is the Missile Defense Agency's primary boost-phase intercept capability, providing the "first line of defense" against an enemy missile attack.

PATHFINDER

While ABL's main purpose is ballistic missile defense, it has significant potential for other missions, including destroying air-to-air, cruise and surface-to-air missiles. ABL's continued success will also open the door for developing other directed energy systems, including ground- and sea-based systems. As a result, ABL is considered a pathfinder for directed energy.

"The Airborne Laser aircraft is considered a prototype because no one's done this before," Hyslop said. "We're achieving a lot of firsts for directed energy weapons as we work through the development of ABL."

This promise is generating interest in ABL from key U.S. allies, including Japan. The Boeing-led U.S. industry team and Japanese industry are jointly studying potential ABL technologies they could cooperate on, such as sensor technologies and chemical laser-related areas.

"No other country is doing what the United States is doing with the Airborne Laser," Shanahan said. "Consequently, ABL and the technologies that result from its development will give the United States an enormous advantage on the battlefield."

Airborne Laser Accomplishments

- **Nov 2004:** First light of the high-energy laser
- **Dec 2004:** First flight of the passive mission payload (battle management and beam control/fire control systems)
- **Jul 2005:** Completed flight tests of the passive mission payload
- **Dec 2005:** Demonstrated lethal duration/power in ground tests of the high-energy laser
- **Oct 2006:** Integrated the two illuminator lasers into the beam control/fire control system onboard the aircraft
- **Mar 2007:** First in-flight firing of the track illuminator laser (TILL) at an airborne target
- **Upcoming flight tests:** ABL will fire the beacon illuminator laser (BILL), in conjunction with the TILL, to demonstrate compensating for atmospheric turbulence between ABL and the target. The aircraft then will complete the kill chain by firing both illuminator lasers and using a surrogate high-energy laser to simulate a target shootdown. Next, the program will install the actual high-energy laser in the aircraft, leading to the first intercept of a boosting ballistic missile in 2009.

Airborne Laser Engagement Sequence

Detect: Six infrared search and track sensors detect a missile launch

Acquire & Track: The beam control/fire control system acquires the target and fires its track illuminator laser to track the target

Compensate for Atmosphere: The beam control/fire control system fires its beacon illuminator laser to measure and compensate for atmospheric conditions

Kill: The high-energy laser destroys the missile

Airborne Laser Video Link

www.boeing.com/defense-space/military/abl/pics-clips/video.html

Airborne Laser: Major Employment Sites

(Boeing, Northrop Grumman, Lockheed Martin)

Edwards Air Force Base, Calif.	450
Redondo Beach, Calif.	200
Sunnyvale, Calif.	150
Seattle, Wash.	100
Wichita, Kan.	50
Albuquerque, N.M.	20

(Numbers are rounded)

"The Airborne Laser has demonstrated several of its key capabilities and has met many critical milestones. Because of the significant progress in this program and its tremendous potential as a defensive system, I believe Congress must provide the support required to reach the shootdown test of its full capabilities in 2009."

— Congressman Norm Dicks (D-Wash.), Vice Chairman,
House Defense Appropriations Subcommittee

"The threat to our nation from rogue nations is real, and the solution is clear. The Airborne Laser will be the best, and often only, solution to the uncertain and changing threats facing our nation."

— Congressman Todd Tiahrt (R-Kan.),
House Defense Appropriations Subcommittee

"Not since that time nearly 2,200 years ago, when Archimedes reflected the sun's rays to set the Roman fleet on fire off Syracuse, has the world seen a weapon that puts fresh meaning into the phrase 'in real time.'"

— Air Force Lt. Gen. Trey Obering
Missile Defense Agency director

An air-mobile system capable of generating a directed-energy beam powerful enough to destroy ballistic missiles at distances of hundreds of kilometers — the exact range of the Airborne Laser is classified — has the potential to revolutionize not just missile defense but warfare itself.

— Space News Editorial, May 21, 2007