

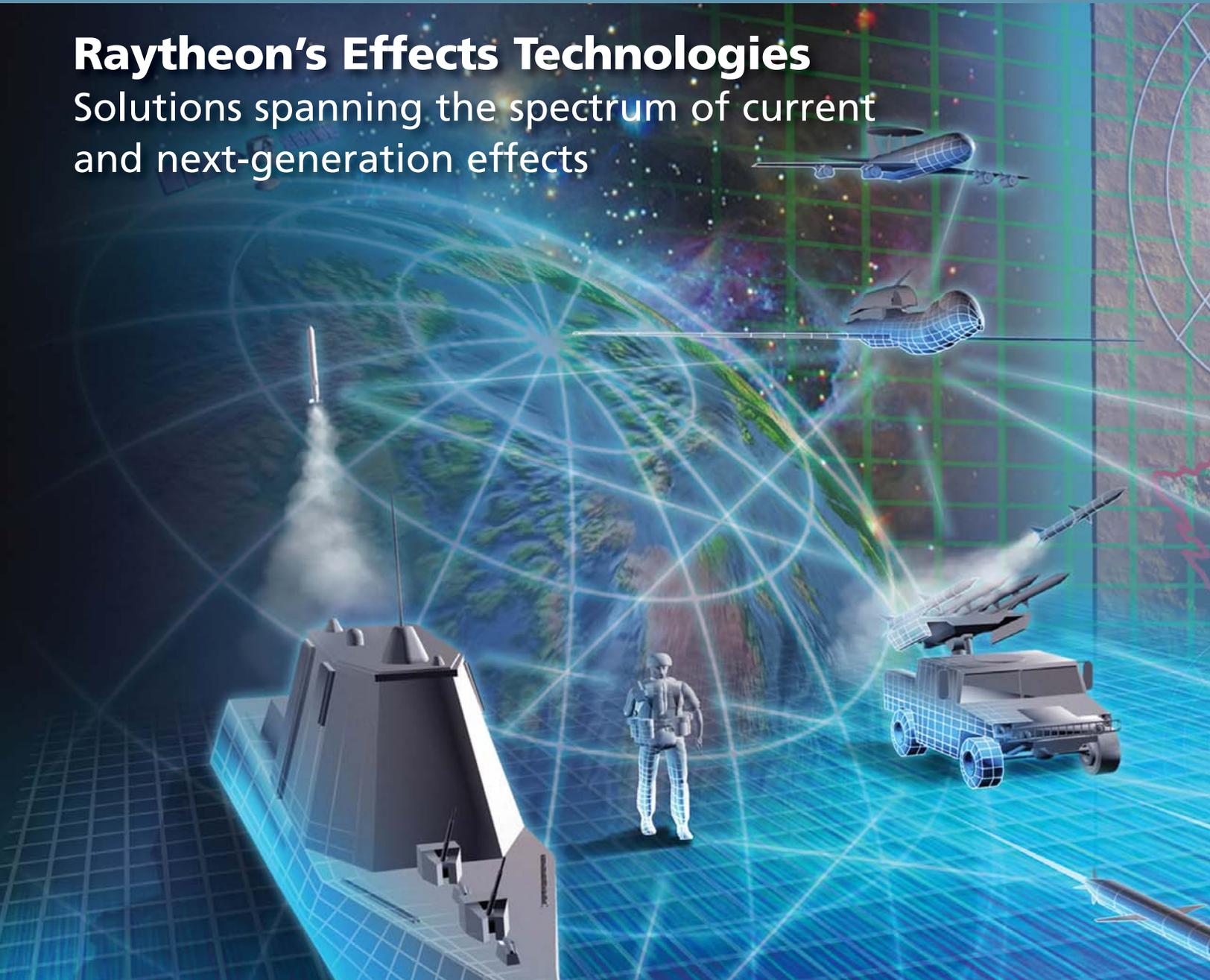
Technology **Today**

HIGHLIGHTING RAYTHEON'S TECHNOLOGY

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Raytheon's Effects Technologies

Solutions spanning the spectrum of current and next-generation effects



Raytheon

Customer Success Is Our Mission

Directed-Energy Systems are Raytheon's Latest Way to Put Energy on Target

While Raytheon leads the world in tactical missiles, its revenue from adjacent markets is growing rapidly. One of these key markets is directed-energy systems that can be placed on land, sea or air platforms.

These use electromagnetic energy to counter threats, instead of the chemical and kinetic energy used by missiles. They can precisely track fast targets and reach them instantaneously, thus defeating speed and evasive maneuvers as countermeasures. In addition, they can minimize collateral damage and rapidly reload.

Raytheon is among the leaders in several DEW disciplines: high-power radio-frequency (RF) systems, solid-state lasers, weapon system integration and production, and mission analysis. Engineering teams from Raytheon businesses are working with government laboratories in five main areas:

- Mission analysis: identifying targets, engagement profiles and kill mechanisms
- Lethality: characterizing effects of directed energy on targets and materials
- Laser and RF subsystems: generating very high output-power beams
- Beam-control subsystems: directing energy to the aimpoint on a moving target

- Weapon systems: integrating subsystems including sensors, targeting, power generation, beam generation and control, and thermal management

Raytheon has developed a range of solutions that generate laser or RF energy. For laser weapons, the near-infrared wavelength minimizes beam distortion and loss of lethal effectiveness resulting from nonlinear optical effects within the atmosphere. Internal research and development demonstrated that at this wavelength, solid-state lasers have characteristics that allow for increased lethality at lower average powers than previous longer-wavelength laser weapons. This short-wavelength advantage is greatest at low to medium altitudes, where Raytheon application efforts are focused.

"Speed-of-light weapons present a new set of challenges and opportunities for realizing lethality," explained Jay Stern, Raytheon Missile Systems Advanced Missile Defense and Directed Energy Weapons product line chief engineer. "The required engineering disciplines include very sophisticated electro-optical sensors, tracking algorithms, and automatic target recognition, as well as advanced thermal management techniques and the physics of laser/material interactions."

Laser Area Defense System (LADS)

LADS (Figure 1) combines radar, infrared and video trackers with a solid-state laser to destroy incoming mortars, rockets and missiles. The truck-transportable system rotates and tilts on a heavy-duty trunnion mount adapted from RMS' Phalanx shipboard close-in weapon system.

Electricity to power LADS can come from either a mobile generator or the grid. This capability makes it inexpensive to operate and gives it an almost unlimited ammunition supply.



Figure 1. This LADS prototype combines proven Phalanx weapon system capabilities with commercially available laser and optical components.

Since LADS uses existing technologies and systems, Raytheon and government engineers were able to take it from an idea to field tests in only six months. LADS is scheduled for shoot-down testing this fall.

Scorpion Aircraft Protection System

Raytheon's Scorpion (Figure 2) directed-infrared countermeasure system (DIRCM) will offer the lowest-cost way to protect helicopters and tactical aircraft from man-portable infrared guided missiles. It combines proven, fielded components, advanced multiband lasers, and two-color missile-warning sensors with the latest software and missile defense algorithms.

Scorpion uses the AIM-9X seeker, modified to include a laser pointer, to direct laser



Figure 2. Raytheon's Scorpion system protects aircraft from man-portable infrared-guided missiles.

energy into the attacking missile's seeker, thus diverting it away from the aircraft in seconds. Scorpion's slew rate and pointing

accuracy provide improved protection from multiple and short-shot engagements. A high-resolution infrared sensor controls the laser pointer to ensure responsive and reliable performance. Compared to currently deployed systems, the Scorpion pointer has almost twice the slew rate, half the cost, one-third the size, and 17 times the reliability.

The system's controller/processor has also been flight-proven in Raytheon's AIM-9X missiles. Scorpion's unique ability to integrate with a variety of solid-state lasers provides greater flexibility than other DIRCM systems. In addition, its demonstrated interoperability with both ultraviolet and infrared missile-warning systems adds flexibility to its platform applications.

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ENGINEERING PROFILE



Frank Brueckner

Senior Program Manager,
Advanced Missile Defense and
Directed Energy Weapons (AMD/DEW)
Raytheon Missile Systems

Dr. Frank Brueckner leads RMS' Directed Infrared Countermeasures (DIRCM) programs within the AMD/DEW product line. These systems protect fixed- and rotary-wing aircraft from shoulder-fired surface-to-air missiles, using laser energy to jam their infrared seekers and cause them to miss their targets. The proliferation of these missiles poses a significant threat to deployed troops.

RMS reuses guidance-section hardware and software technology from its missile systems to provide a smaller, lighter, more reliable DIRCM system. An air-to-air seeker acquires and tracks the incoming missile, and directs the DIRCM's laser energy onto the threat missile's seeker dome. "This innovative approach is a great example of RMS' Design 2010 initiative to reduce time-to-market and improve product affordability," Brueckner noted.

Due to extremely short mission timelines, defeating these missiles demands a speed-of-light effector. "Our DIRCM programs are one response to RMS' focus on developing directed-energy systems that address customer needs," Brueckner said. "Directed energy is solving problems where short timelines,

ultra-high precision, scalable effects, or the need for very large magazines cannot be met with kinetic solutions."

Previously Brueckner led RMS' high-energy laser-weapon programs. These included integrating a 20-kilowatt solid-state laser on a Phalanx Close-In Weapons System to demonstrate a way to protect forces from enemy mortars. Earlier he managed the Exoatmospheric Kill Vehicle Capability-Enhancement II program and several missile defense technology programs.

Brueckner has more than 20 years experience in weapon-system development, scientific research, and program management, spanning concept development through production. His technical background includes laser systems, missile-system engineering, precision pointing and tracking, and computational physics.

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Active Denial System

Another type of Raytheon directed-energy product uses high-power RF energy. The Active Denial System (ADS) provides a new approach to protecting forces and securing areas near critical facilities, such as embassies, petrochemical and power plants, ports, and airfields. The system repels aggressors without using deadly force or causing collateral damage, at distances beyond small-arms range.

“A short burst from ADS makes you want to leave the area instantly,” said Jay Stern. “It’s very effective at dispersing adversaries beyond useful small-arms range.”

The ADS has undergone extensive human safety testing and extended user evaluations in field conditions. Featured in the March 2 episode of *60 Minutes*, the ADS highlighted the potential benefits of this capability to be a “game changer.”

Raytheon is a world leader in ADS weapon system development, as the prime system integrator for Department of Defense configurations since 1998. Recognizing the

opportunity to extend this unique capability to other applications, Raytheon has been working with other federal agencies to develop solutions specific to their needs. One example is Raytheon’s Silent Guardian, a smaller, lower-cost ADS configuration. Another is the Active Denial System 2 that Raytheon delivered to the U.S. Air Force in September 2007 (Figure 3). It is designed for long-term operation with a self-contained generator.

Vigilant Eagle

Another RF technology is the Vigilant Eagle airfield-protection system (Figure 4). In 2006, Raytheon was awarded a Department of Homeland Security contract to provide data for an assessment of operation within the airport environment.

Vigilant Eagle identifies man-portable missiles at launch and illuminates them with a focused, precisely steered RF beam that diverts them away from aircraft. The ground-based system comprises:

- A subsystem of infrared sensors atop towers or buildings, which detects, discriminates and tracks missile threats

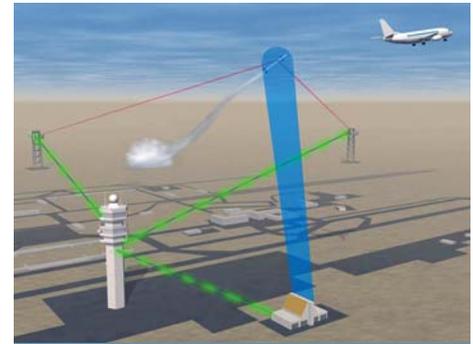


Figure 4. This drawing depicts Raytheon’s Vigilant Eagle system detecting a man-portable missile and diverting it away from an aircraft.

- A command and control system to identify the launch point, track missiles and direct the RF beam
- A billboard-size active electronically scanned array of antennas linked to solid-state amplifiers

The system has demonstrated an extremely low false alarm rate in tests. Transmitted electromagnetic fields are well within federal standards for human exposure and interference with aircraft electronic systems.

Installation at 35 airports would provide coverage for 72 percent of all U.S. takeoffs and landings, and more than 85 percent of overseas arrivals and departures. Compared with on-aircraft protection for commercial airlines, Vigilant Eagle is at least six times more cost effective to procure and 30 times more cost effective over a 20-year life cycle. In addition, Vigilant Eagle requires no aircraft modifications.

“We’re working on a lot more technology than can be discussed here,” concluded Mike Booen, Raytheon Missile Systems AMD and DEW product-line vice president. “I look forward to our numerous projects bearing fruit. These could open large new adjacent markets for Raytheon.” ●

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Figure 3. Raytheon’s ruggedized Active Denial System 2 includes a fuel supply and generator for long-term operation in remote areas.

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