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HIGHLIGHTING RAYTHEON'S TECHNOLOGY

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Raytheon

Customer Success Is Our Mission

the theory a reality: the first working laser. Huge amounts of research funding and government grants were poured into laboratories large and small across the United States in a race to be first.

But it was a lone physicist, Dr. Maiman, who created the first working laser. When he passed away in 2007, *The New York Times* described his approach of using artificial rubies as the active medium:

"Others had judged that rubies did not work and were trying various gases. Dr. Maiman found errors in their calculations. He also used pulses of light to excite atoms in the ruby. The laser thus produced only a short flash of light, rather than a continuous wave. But because so much energy was released so fast, it provided considerably more power than in past experiments. This first laser, tiny in power compared with later versions, shone with the brilliance of a million suns. Its beam spread less in one mile than a flashlight beam spreads when directed across the room."

Today, lasers are nearly ubiquitous — reading grocery barcodes, repairing damaged retinas, recording and playing CDs and DVDs, and performing countless other tasks that make our lives better and safer.

Future Issues: The Legacy Continues

As a recurring *Technology Today* feature, future "Legacy of Innovation" articles will examine additional breakthroughs that have made Raytheon a technology leader. Firsts such as the first gyro compass for use on a ship, and the first single-chip digital signal processor. Raytheon and its 72,000 employees are proud of its past, which has positioned the company well for an even more successful future •

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Sources and recommended reading:

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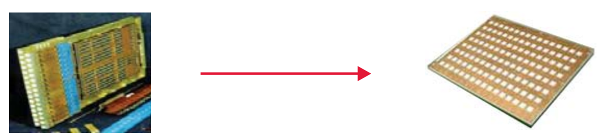
On the Ground and in the Air, **RF Panels are the Future of AESAs**

There are many challenges driving the development of the next generation of radar, communications and electronic warfare active electronically scanned arrays (AESAs). The ground- and surface-based applications must meet a broad range of requirements, from simple low-power radars for weather, surveillance and communications, to high-power radars for ship and missile defense. The airborne applications are additionally challenged by weight and volume constraints of the platform and, increasingly, by radar signature. Affordability, however, is a common challenge across all of the applications. AESAs applications have traditionally been limited to systems and platforms where the benefits could justify their higher price tag. The maturation of RF panel AESA technology is now beginning to change the cost–benefit paradigm.

performance within available cost, size, weight and power constraints.

AESAs have been a key subsystem in many production radars for nearly two decades (see Fig 1). The cost of AESAs is driven primarily by the high number of packaged components and interconnects associated with the several hundred to tens of thousands of transmit/receive (T/R) channels. The supporting structure/platform integration, thermal, power conditioning and control subsystems can also drive cost. Reducing the cost of an AESA requires a decrease in the number of devices, greater power efficiencies and advanced packaging. This decrease must be achieved within a modular structure that scales uniformly with size of the array.



- Large liquid cooled assemblies
- Discrete PWBs and beamformers
- Significant touch labor assembly
- MESFET and P/HEMT module technology

- Thinner modular/scalable assemblies
- Low power to high power applications
- Significant cost savings, surface-mount RF electronics
- Integrated cooling, power electronics
- GaN, RF CMOS, SiGe, RF MEMS technologies
- Digital beamforming

Figure 1. AESA Evolution and Revolution: more affordable, efficient and functional

Raytheon began investing in architectures and technologies several years ago to improve and streamline the affordability and integration of AESAs for a variety of platforms. Unfortunately, many times the desired capabilities are compromised because of cost and integration constraints. The challenge has been to develop affordable architectures and technologies that may overcome these constraints. The major challenge AESAs face is providing the required level of

Looking at the evolution of X-band AESAs from the early 1990s to today, we see a dramatic increase in capability enabled by key technology developments in microwave monolithic integrated circuits (MMICs), packaging and interconnects. These technology developments enable architectures that are focused on cost, scalability and modularity and more easily integrated into a wider variety of platforms and applications.

Continued on page 32

Continued from page 31

The production of AESAs for many military applications began in earnest in the early 1990s. Packaging the microwave electronic circuitry in most cases required hermetic environmental protection, and along with the corresponding interconnects, thermal control, etc., dictated the weight and volume of the AESAs. Today's AESAs have evolved to lighter, denser packages — some with hermetic packages and some exploiting alternative environmental protection technologies. This evolution, along with technology improvements in MMICs, interconnects, thermal control, etc., have realized a 50 percent savings in both weight and cost (see Fig 2).

Raytheon's next generation of affordable AESAs are enabled by emerging MMIC enabling solutions and capabilities that aren't available today.

Raytheon is leveraging maturing RF MEMS technology in order to realize low loss, low cost phase shifters in Active Electronically Scanned Lens Array (AESLA™) architectures for some applications. The AESLA architecture allows us to reduce the number of T/R modules compared with a traditional AESA by using a single higher power module. Each module drives a constrained lens of low loss phase shifters, thereby achieving the desired electronic scan and power aperture requirements more affordably.

Panel-based AESAs will not replace all radar arrays in the future. There will always be a need for brick architecture's replaceable assemblies for certain applications requiring mission-specific access for repairs. Also,

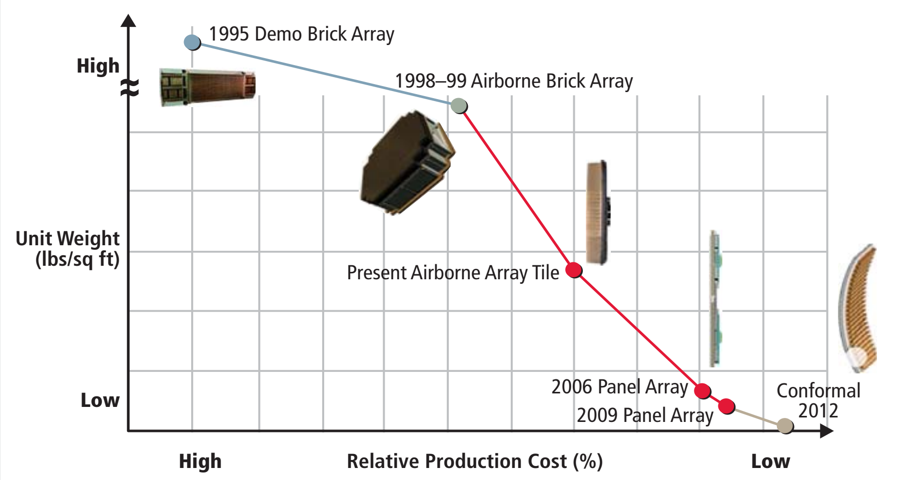


Figure 2. AESA panels arrays provide dramatic weight and cost improvements.

technologies capable of supporting higher RF power per unit area (e.g., gallium nitride) and those providing more functionality per unit area (e.g., RF CMOS and silicon germanium). Higher levels of circuit board integration/manufacturing; surface mount assembly (eliminating expensive interconnects); and environmental protection technologies (eliminating the need for hermetic packages) are enabling more affordable and lightweight panels as the major building block of the AESA. These architectural leaps are realizing significant savings in both cost and weight and panel architectures will not be used where the antenna's element spacing is limited due to power or frequency.

Summary

Raytheon's panel AESAs will revolutionize the way RF sensors are packaged and integrated, enabling new capabilities affordably across many applications from low-power ground-based, to high-performance low-observable airborne, to very large missile defense and surveillance sensors. •

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eye on Technology

Raytheon Mission Architecture Program (RayMAP) Provides a Foundation for System Success

More than ever, today's rapidly changing and increasingly complex systems demand quality architecture development. This benefits customers and developers by helping to define the problem space, validating needs and requirements, and providing a platform for sharing ideas. Architecture also aids in system development by concisely and comprehensively describing the system's structure to the developers and maintenance engineers, and it facilitates technology transfer by fostering reuse of domain architectural styles and patterns. Careful architecture development helps ensure that detailed design and implementation maximize requirements compliance, but minimize cost and schedule. Inadequate attention to architecture, however, can harm system performance and inhibit reusability, interoperability and other areas of customer concern. It makes sense, then, to maximize the effectiveness of a system's architectural foundation.

While Raytheon has embraced the architecture discipline for some time, Raytheon leadership also recognizes the need for a unified, cross-business approach to capture and leverage best architecture practices. A corporate-funded enterprise initiative that began in 2006 formally started the process of unifying architecture across Raytheon. The Raytheon Mission Architecture Program (RayMAP) is Raytheon's response to customer needs for architected solutions. Corporate Engineering will take over the sustainment of RayMAP starting in 2009. RayMAP includes the following six key elements, which collectively lay the foundation for solid, disciplined architecture capabilities across Raytheon.

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