Military Microwaves 2006 — Current Viewpoints on Air Defense Systems

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The editors of *Microwave Journal* and *Journal of Electronic Defense* interviewed some key executive and military leaders in the markets that we serve, both in the US as well as in Europe. Selected questions and answers from those interviews are presented below. We would like to thank the participants who took the time and effort to present their views. As expected there are significant differences in the US and European approaches to system development. We hope you find the responses to be informative.

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MWJ: *Looking at the air defense programs in Europe and the United States, what are the key areas of development?*

MH: Endwave Defense Systems is actively involved as an RF subsystem supplier on a number of current and future Air Defense Systems (ADS). These opportunities span a wide range of capabilities and platforms, from fighter jet aircraft, attack helicopters, unmanned aerial vehicles (UAV), and other airborne warning and surveillance applications. At a time when governments are struggling to dedicate the necessary funding required to secure the homeland and fight a long global war on terror, the Pentagon is pushing for "military transformation" – one that signals a shift away from large stove-piped defense platforms towards creating more agile, mobile forces that work in concert and are linked with advanced wireless communications networks. The fight today is, first and foremost, for communication superiority.

In the near-term, it is apparent from the QDR and US defense budget released earlier this year that major defense programs like F/A-22 Raptor, F-35 Joint Strike Fighter and Future Combat Systems are all continuing. Contracts favoring upgrades to extend the range or increase the payload of existing air defense platforms are more likely than replacing them with completely new systems – so adaptability is a common theme. Programs dedicated to only one military branch will be a distant memory as the resounding theme of interoperability within a joint "future force" is being voiced by the Pentagon. Key areas of development will shift the Department of

Defense's (DoD) attention from conventional fighting techniques to unconventional irregular warfare. Endwave sees tremendous opportunities for missiles and anti-missile systems, smart munitions, and UAVs for both surveillance and strike capability. Both manned and unmanned programs in Intelligence, Surveillance and Reconnaissance (ISR) applications abound. An excerpt from the QDR cited, "the ability of the future force to establish an 'unblinking eye' over the battlespace through persistent surveillance will be instrumental to conducting effective joint operations."

MWJ: *Describe how the development of wireless networking technology, such as data links, is making integrated ADS more effective and survivable.*

MH: Taking critical battlefield information from multiple sensors amongst a host of different platforms — and making that information available to all members of the joint future force, will create a "network-centric" military operation. As an example of the power of connectivity, many of the UAV missions conducted in the Middle East were flown remotely by pilots in Nevada, with real-time communications from forces on the battlefield to direct the mission. The enabler for such information connectivity lies in high capacity directional data links in order to put the right information real-time directly in the hands of combatant commanders. As such, these data links are deemed necessary in order for the United States' UAV strategy to pay off, which calls for a near doubling of the UAV coverage. Recently, tactical data links were used to demonstrate airborne interoperability between US Apache attack helicopters and Hunter UAVs, as further evidence that the network-centric military force is not so far away.

MWJ: *What changes in radar systems are needed to support the new generation of ADS?*

MH: Synthetic aperture radars (SAR) at millimeter-wave frequencies are being incorporated onto many UAV platforms in conjunction with optical imaging sensors to provide high resolution imaging around the clock or during harsh weather environments. Furthermore, phased-array radars are becoming an increasingly popular choice in ADS, due to their ability to steer the antenna beam in a near-instantaneous fashion — improving accuracy and precision, as well as the ability to track more targets simultaneously. These radars often use thousands of radiating antenna elements, each driven by a T/R module with precise control of gain and phase amongst elements.

There is certainly a trend towards the increased use of microwave and millimeter-wave frequencies — due in large part to their unique ability to carry large amounts of data, to provide higher resolution for radar systems, to penetrate certain structures and to provide solutions that are small, light-weight and high performance. In addition, we've seen numerous instances where millimeter-wave radars are necessary to see through sand storms in the Middle East for automatic landing guidance (ALG) systems on attack helicopters and other fighter aircraft in ADS.

MWJ: *Are there any applications for conventional antenna systems or will all new radars be phased array?*

MH: We see opportunities for both conventional and phased-array radars in future ADS. Given the DoD emphasis on budget trimming, each radar platform has a risk vs. reward analysis to be done. As a hardware supplier for a major development program in 2005, we witnessed a shift away from a phased-array approach used in the engineering development models to a more conventional radar-trading performance for a lower overall cost. But over time, as innovative technologies are introduced to lower the costs of these advanced radar systems, we believe phased arrays will be the predominant choice in the industry.

MWJ: *What advances in sensor fusion are required?*

MH: Sensor fusion refers to the ability to collect, distribute, process and quickly respond to intelligence data coming in from multiple sensors — all in an effort to aid decision-makers in battlefield coordination and to anticipate the actions of our adversaries. In future Air Defense Systems, the assimilation of sensor inputs will require access to intelligence data originating from both inside and outside of the battlespace — so a seamless integration of inputs from tactical, terrestrial and satellite communications sources will be necessary. Imagine being able to simultaneously strike thousands of enemy targets at remote locations around the globe, or the ability to instantaneously retarget cruise missiles and bomber payloads mid-flight while moving allied troops out of harms way. That's what the future air defense capability looks like. Given the large amount of data to be shared amongst many mobile combatant commanders, and the speed in which that information needs to be pushed down to this large group of users, products and platforms that enable secure wireless broadband data distribution will be in high demand.

MWJ: *What technologies will fuel the growth of ADS over the next five to 10 years and to what extent?*

MH: New threats require new battlefield tactics, and new battlefield tactics will require "disruptive" technologies to break through previous cost vs. performance barriers and allow system designers to pack more complex hardware into tighter form-factors than ever before. In high frequency subsystems, consistency and cost are two of the most common challenges encountered. Advances in both MMIC and MMIC-alternative technologies are paving the way for tuneless low cost T/R modules that form the heart of future radars and communication links. Multilithic Microsystems® (MLMS) is an advanced circuit technology using flip-chip and electromagnetic coupling methods to minimize expensive semiconductor real estate while eliminating lengthy interconnects and their related variability. MLMS moves passive circuitry onto an inexpensive proprietary substrate that processes with the ease of silicon, yet works past 100 GHz. Only the discrete active devices remain, which are then flip-mounted on top of the MLMS substrate. Mixed device technologies like SiGe, GaAs and InP can be utilized to increase functionality and optimize performance. The result is a true "system on a chip" with no bondwires in the RF path — and at 30% less cost than a MMIC-based solution.

With phased-array radars often employing thousands of T/R modules, the mechanical packaging associated with high frequency electronics is often a major contributor to the overall cost of ADS platforms. Conventional millimeter-wave thinking is rooted in the belief that module housings have to be fabricated utilizing costly machining and plating techniques. In contrast, Epsilon® Packaging is a multi-layer substrate and module package, all in one. It replaces costly and heavy weight metal mechanicals with metallized FR-4 and injection molded metallized plastics. The Epsilon Packaging approach includes revolutionary mixed technology integration, allowing chip-on-board and surface-mount technology components to co-exist, thus easing assembly and reducing cost. The end result is a package with no machined metal parts, making it light and mass producible, with efficient heat extraction.

In summary, the opportunities in fighter and surveillance aircraft, missiles, smart munitions and UAVs all demand technologies that aid the "lighter, cheaper, faster" requirements of these future Air Defense Systems. To learn more about Endwave's response to these challenges, please visit www.endwave.com.