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EXECUTIVE SPOTLIGHT: BRYAN GOLDSTEIN

Q&A with Military Embedded Systems: RF and Microwave Innovation Drives Military Radar and Electronic Warfare Application

In this Q&A with Bryan Goldstein, general manager of the Aerospace and Defense business unit at Analog Devices, he discusses how innovations such as gallium nitride (GaN) technology are driving the radio frequency (RF) and microwave market and, in turn, radar and electronic warfare designs. He also comments on the evolution in defense procurement. Edited excerpts follow.

MIL-EMBEDDED: Please provide a brief description of your responsibility within Analog Devices and your group's role within the company.

GOLDSTEIN: I am general manager of the Aerospace and Defense business unit at Analog Devices. The business unit focuses on innovation at the chip level all the way through the system level for aerospace and defense system designers. We have a portfolio of advanced differentiated component and system-level solutions focused on reduced size, weight, and power (SWaP), as well as development cost and time to market. At this division we specifically focus on radar, military communications, electronic surveillance/countermeasures, space, avionics for unmanned vehicles, commercial and military aircraft, and advanced munitions applications.

With the acquisition of Hittite Microwave, we have significantly expanded our RF and microwave portfolio such that we can now provide full RF, to bits and back, solutions to our customers. With over 50 years of system-level knowledge, ADI can provide the complete signal chain for most aerospace and defense electronic applications and can provide standard and custom solutions at the component, module, and subsystems level for the expected life cycle of the equipment.

MIL-EMBEDDED: What military applications are the best bets for RF and microwave suppliers?

GOLDSTEIN: There are a number of areas that are very exciting right now within aerospace and defense. Phased array antenna applications are exciting due to their large semiconductor volume requirements. Although phased array technology has been around for many years and

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is used on many high end military systems, the commercial availability of lower cost, simplified integrated solutions has enabled a whole new tier of customers and applications. Active collision avoidance systems on unmanned aerial vehicles (UAVs), next generation weather radar, and satellite and land-based communication systems all offer huge opportunities for RF and microwave devices and subsystems.

Electronic warfare—surveillance and countermeasure—systems also offer great potential, with significant activity in this market relying on high performance, next-generation devices to enable wide bandwidth capability. Solutions range from solid-state high power amplifiers and RF/microwave products to ultrahigh speed analog-to-digital converters (ADCs) and digital-to-analog converters (DACs).

MIL-EMBEDDED: As a designer of RF and microwave technology, what trends regarding military designs and applications in this niche did you see emerging at the International Microwave Symposium (IMS) held last spring?

GOLDSTEIN: The increased focus on phased array antenna, high frequency transceivers, and direct conversion receivers are all trends that were evident at IMS and are driving our customers' next-generation designs.

For example, in military communications there is a move to software-definable radio (SDR) architectures that will reduce the number of different radio platforms currently used by the armed forces. New configurable architectures and devices, using silicon germanium (SiGe) and complementary metal-oxide semiconductor (CMOS) processes, were on display and presented at the conference, which again continues to drive the goal to software-definable systems. Higher integration in SDR applications also enables cognitive functionality, antijamming, and encryption.

We also continue to see a trend toward higher frequency analog-to-digital converters, simplifying receiver architectures, reducing size and complexity by reducing frequency downconversion requirements while providing increased bandwidth.

In the areas of radar and electronic countermeasures, the increased development and acceptance of solid-state power amplifiers utilizing gallium nitride (GaN) technology was also apparent throughout the show. This is a significant area of investment for ADI, as the improvements that have been made in the efficiency, cost, and reliability of GaN devices and power combining methods are now starting to be actively implemented in military systems, replacing less reliable traveling wave tube amplifier technology.

MIL-EMBEDDED: RF and microwave technology fuels much of the radar and electronic warfare development in the military market, but the automotive radar market promises even larger growth. How is innovation in automotive radar driving military RF and microwave designs?

GOLDSTEIN: The dynamic here is actually very interesting. Clearly much of the original radar work and phased array technologies were developed and targeted for defense applications. The automotive market is making use of this work, but is now driving toward lower cost, higher volume, and more highly integrated solutions. Analog Devices is heavily involved in developing these solutions. The aerospace and defense industry looks to leverage these advancements made in the commercial market whenever possible. For example, the advancements in automotive radar are now feeding back into lower cost solutions in aircraft collision avoidance systems and radar imaging applications, completing the innovation circle and supporting advanced development activities, which previously would have been cost prohibitive due to the lower volume nature of these defense application areas.

Going forward, we see this synergy continuing as the defense industry continues to drive applications requiring higher levels of performance, which we may use in commercial applications having the volume to support the development and manufacturing infrastructure costs.

MIL-EMBEDDED: Do you see growth for RF and microwave technology use in military applications with the announced increases in the Department of Defense (DoD) FY 2016 budget or will this market remain flat like other military niches?

GOLDSTEIN: At first glance, the DoD FY16 budget and future initiatives show the defense industry growing, albeit at a moderate pace. Looking beyond the high level budget numbers, the trends toward upgrading technical capabilities of existing electronics platforms in this area point to a larger than average market growth for RF and microwave. Furthermore, activities such as the Defense Innovation Initiative, which look to identify investments in innovations to sustain and advance the DoD's military dominance, also look promising for these technology areas. Similarly, Defense Advanced Research Projects Agency's (DARPA's) projected funding is also increasing and a number of their key initiatives will drive long-term growth in this area.

From a specific applications perspective, missile defense, advanced munitions, communications, satellite, and space programs—as well as electronic surveillance and countermeasure systems—were all identified as target areas for funding; all of these heavily rely on RF and microwave technology. Comparing our own activities and engagements with the defense primes, driven by the defense budget, the continued drive toward more systems using phased array technology, advanced communications, and high efficiency solid-state power amplifiers indicates that the electronics content of these systems will grow significantly. Overall, it looks to be an exciting time for RF and microwave in the aerospace and defense arena.

MIL-EMBEDDED: Are you also seeing an increased demand for commercial-off-the-shelf (COTS) technology and commonality from your defense customers?

GOLDSTEIN: There is a significant push within aerospace and defense toward open architectures to enable system reuse, thereby reducing system development time and cost and creating increased competition through second sourcing. This is a divergence from past developments, which were based upon proprietary architectures that relied on sole-source development and provided limited competition. For example, recently the Navy Surface Electronic Warfare Improvement Program (SEWIP) Block III program demanded open architectures to enable subsystem competition to allow hardware reuse on other platforms. There will be many suppliers that will bid to be a part of this long running program; that competition will provide long-term benefits to the Navy.

Leveraging open architectures and COTS hardware gives both system designers and component designers more options when it comes to transferring technologies between platforms. The commonality provides a clear roadmap for product development and clarifies definitions for new products, minimizing investment risk. The companies investing in new products have clear definition and know that their products will be needed for very long life cycles.

There is also a shift in procurement philosophy at the DoD as it now expects industry to invest in new technologies more strongly on its own rather than always waiting for government funding. In turn, the government is engaging more deeply with industry partners, sharing product roadmaps so that all can understand the long-term scenarios for sustainment and obsolescence management. Industry seems to be getting on board with this philosophy; as a result, there is a tighter relationship between the suppliers and the government customers. Moreover, the number of partners that the customers wish to support is reducing. This type of procurement atmosphere will put more pressure on smaller firms that can't afford to invest on their own and don't have the breadth of technologies to be a broad partner. Suppliers such as Analog Devices have an advantage because of their breadth of portfolios, capabilities, markets, and the scale of their technology investments. Serving many markets allows the investment in technologies to be shared across multiple businesses and creates sales volumes that will ultimately reduce total system cost and speed the release of new technology.

MIL-EMBEDDED: Looking forward, what disruptive technology or innovation will be a game changer in the RF and microwave world? Predict the future.

GOLDSTEIN: There are several areas of disruptive technologies that we are focused on at Analog Devices. We continue to improve the efficiency and reliability of GaN power amplifier technologies and develop power-combining techniques that have allowed us to demonstrate power levels up to 32 kW at X-band. These improvements will continue and we will move quickly to Ka-band frequencies and beyond.

Phased array applications are pushing the developments of highly integrated SiGe core chips, which combine amplitude and phase control as well as digital and bias control onto a single silicon device. This technology has simplified the system and lowered the cost dramatically enough to finally create a viable high volume market. High frequency transceivers and high speed converters will change the communications, radar, and electronics surveillance/countermeasures markets dramatically.

Software-defined functionality will create cognitive, programmable systems that can be configured for multiple applications that are secure and impossible to jam. Direct conversion receivers and synthesizers will significantly simplify new architectures, while higher levels of integration at the chip, package, and subsystem levels will dramatically reduce the SWaP of future systems without negatively affecting system performance.

Lastly, there is an emerging offshoot from the traditional high reliability space market that requires a smaller, shorter mission life: low cost satellites. These communication constellations are envisioned to have thousands of satellites. Such systems require a new breed of RF and microwave components, which will require some level of radiation tolerance, a small amount of incremental environmental screening, and a level of configuration control.

About The Author

Bryan Goldstein, general manager of the Aerospace and Defense business unit of Analog Devices, is responsible for all aspects of the business as well as product and advanced technology development for ADI's modules, subsystems, and high reliability product domains. He has more than 25 years of experience in the aerospace and defense industry, with specific expertise in the design and manufacture of microwave modules and subsystems. Most recently, Mr. Goldstein served as vice president of the Modules, Subsystems, and Space business unit of Hittite Microwave Corporation—prior to its acquisition by Analog Devices. Before joining Hittite, Goldstein worked at Arcom Wireless; Sanders, a Lockheed Martin Company; and the Raytheon Missile Systems Division. Over his career, he has worked on the Patriot Missile system, the Longbow Missile program, and other key defense platforms. Goldstein holds a B.S. in electrical engineering from Northeastern University and an M.S. in electrical engineering from the University of Massachusetts.

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