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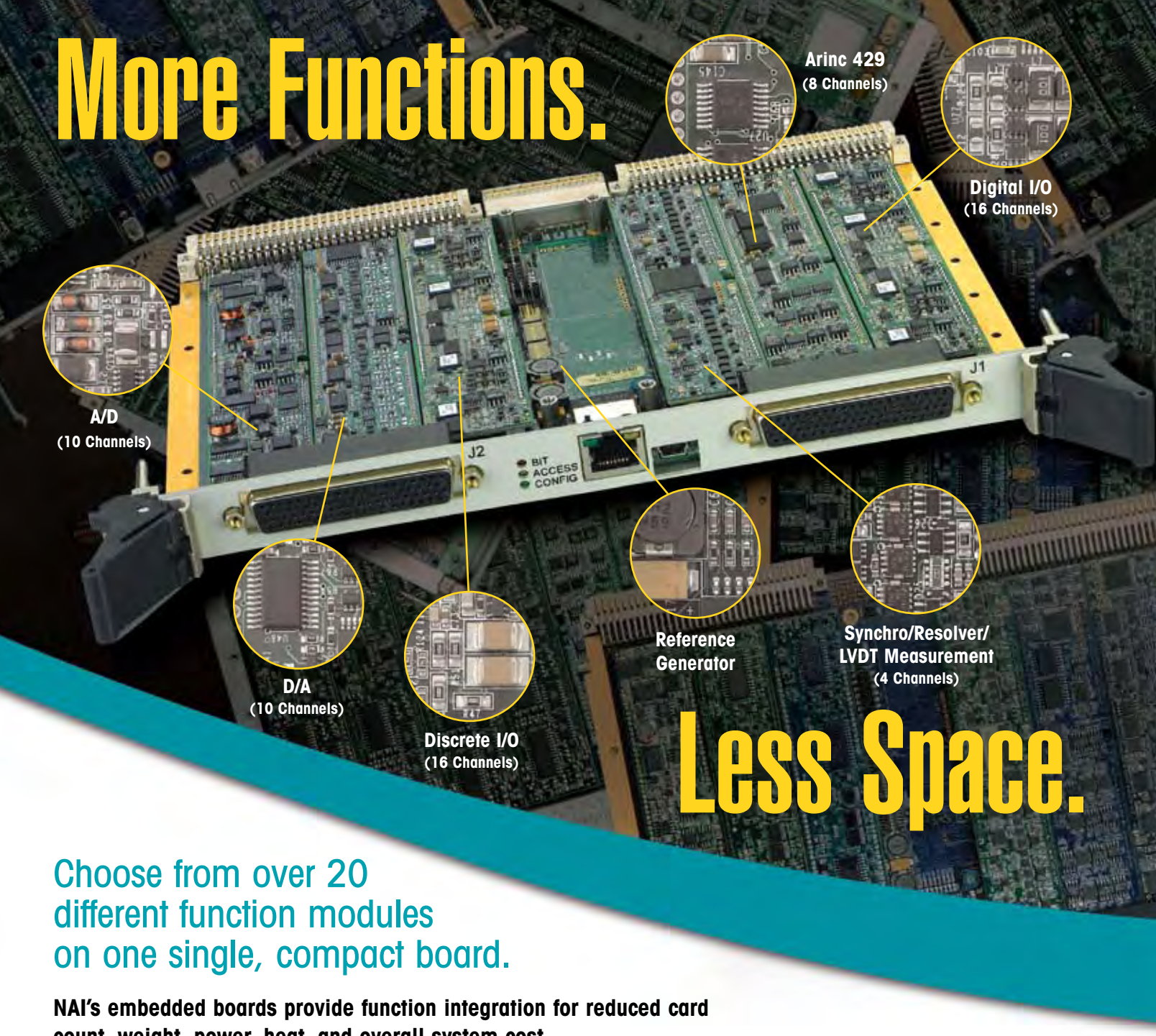

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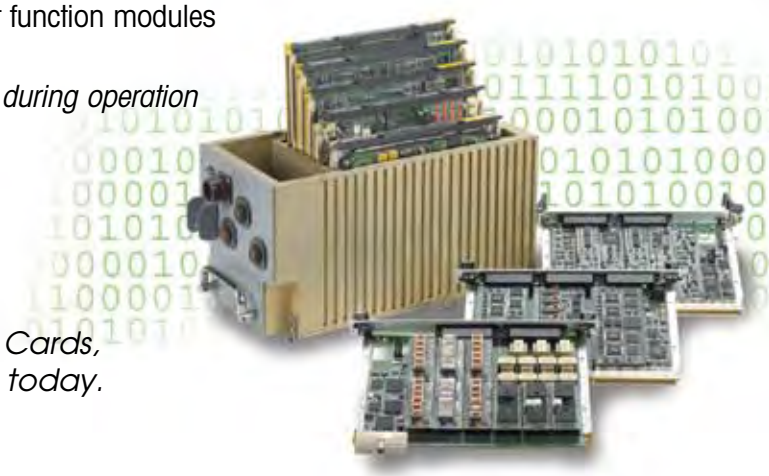

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Features

October 2008 Volume 10 Number 10

Special Feature

Analysts Assess the Military Market

Tech Recon

Payloads for Small UAVs

System Development

FPGA Boards & Configurable Computing

Technology Focus

Data Acquisition Boards

COTS (kots), *n.* **1.** Commercial off-the-shelf. Terminology popularized in 1994 within U.S. DoD by SECDEF Wm. Perry's "Perry Memo" that changed military industry purchasing and design guidelines, making Mil-Specs acceptable only by waiver. COTS is generally defined for technology, goods and services as: a) using commercial business practices and specifications, b) not developed under government funding, c) offered for sale to the general market, d) still must meet the program ORD. **2.** Commercial business practices include the accepted practice of customer-paid minor modification to standard COTS products to meet the customer's unique requirements.

——**Ant.** When applied to the procurement of electronics for the U.S. Military, COTS is a procurement philosophy and does not imply commercial, office environment or any other durability grade. *E.g., rad-hard components designed and offered for sale to the general market are COTS if they were developed by the company and not under government funding.*

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Market forecasters say that much of the DoD's emphasis going forward will be on defense programs that require increasing amounts of embedded computing—everything from advanced radar upgrades to smarter UAV payloads that enable greater mission autonomy. An MQ-1 Predator UAV shown here sits on the parking ramp at Balad Air Base, Iraq.

Courtesy: U.S. Air Force photo/Staff Sgt. Tony R. Tolley

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The Journal of Military Electronics & Computing

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Publisher's
Notebook

History's Prism and Its Agents of Change

It's amazing how three ingredients—an event, the times and individuals—sometimes converge to propel changes that have a lasting effect on the future. In such cases it seems like each of those ingredients have to come together at the exact right moment in time or the opportunity is lost and nothing happens. When that happens it often takes a long time to get a real clear vision of why the event was significant. The more time that passes, the clearer the vision becomes. Today, the Military is working through just such a convergence. I have four quick examples of the kind of historical convergence I'm talking about—along with some thoughts on where each now stands in the evolution of public opinion viewed thought history's prism.

Let's start with the birth of our nation as the first example. Certainly it's one for which the passage of time has enabled the event to be fully appreciated. At the time the event was happening, individuals like George Washington, Benjamin Franklin, John Adams, Thomas Jefferson and the others were considered heretics by most—as agents of change who placed America in a position to endure a certain disaster. Fast forward to today and ample time has passed so that today there's little question as to whether or not the Founding Fathers chose the correct path.

In contrast, a more recent event on the world scene still requires more time to pass before history appreciates the courage it required and the opportunity that it created. I'm referring to events initiated by Mikhail Sergeyevich Gorbachev in the Soviet Union in the late '80s. Gorbachev put in place reforms critically needed to enable the people of the Soviet Union to participate in the economic progress of the rest of the world. Today, you don't hear a lot about Mr. Gorbachev anymore and you don't see statues of him like we have of George Washington. He's not on the face of the ruble. He has no major monuments in Red Square. Quite to the contrary, Gorbachev is viewed by many in his own country as the person who destroyed their country.

Showing his commitment to military and acquisition reform, former SecDef Dr. William Perry supported our efforts to bring *COTS Journal* to life and participated in our inaugural issue (left). Today Dr. Perry (right) is very active in many organizations focusing on domestic and international initiatives, including working on the Nuclear Threat Initiative (NTI).

That said, the remnants of the Soviet Union—Russia, Georgia, Ukraine and so on—have had major problems in trying to restructure their governments and economies. In the meantime they're fighting op-

portunistic political and criminal elements within that have the ability to destroy the development of their countries. Even more so than the United States faced in the early 1800s, Russia likewise has had to deal with external elements—countries and individuals that were trying to exploit Russia's situation for their own benefit. History will probably show that one of the United States' great failings was that we did not implement a Truman-style Marshall Plan in the '90s for the ex-Soviet Union States.

So all this history is nice, but how is any of this relevant to the military embedded computing market? On a less dramatic scale we've had a very similar convergence occur within the DoD. And like America's separation from Britain and the disassembly and restructuring of the Soviet Union, there were and are persons and entities that see this change as heresy and a recipe for disaster.

The convergence I'm referring to is the confluence of an explosion of advances in technology, the end to the Cold War, the re-focusing of the military, and Dr. William Perry. All those ingredients came together in the early to mid-nineties to create one of these historic events: a revolutionary set of changes and reforms to military acquisition. Although acknowledged by Dr. Perry, he buried that critical event in the middle of a list of what he thought were his most important accomplishments while serving eight years in the Pentagon. His list contains: improving the lot to military personnel, developing an effective relationship with military leaders, instituting changes and reforms to military acquisition, managing the drawdown of the military, establishing close relationships with many foreign defense ministers, reducing the nuclear legacy of the Cold War, promoting the Partnership for Peace within NATO, and utilization of military image and strength in Haiti, Bosnia, Korea and the Persian Gulf. Dr. Perry's tenure in the Pentagon includes serving four years as undersecretary of Research and Engineering, one year as Deputy Secretary of Defense and three years as Secretary of Defense (SecDef).

Like Mikhail Gorbachev, William Perry is very active today in many organizations focusing on domestic and international initiatives. In fact, one thing that has him busy right now is his work with Senator Sam Nunn (ret.) on the Nuclear Threat Initiative (NTI), which is essentially a follow-on to his work as SecDef. At the time of this writing, Dr. Perry was in the Baltics with several other members of the NTI team. Just as some view Mr. Gorbachev as a saint and others as a devil, I fear that the situation is similar for Dr. Perry. As you can imagine, I see him more as a saint, at least with respect to his acquisition reforms. And I'm positive that over time history's judgment will concur. He was the right person at the time and he did the right thing for the military.

There's one more reason I have a lot of respect for Dr. Perry, and that brings me to my fourth example of a fortunate convergence of events, times and individuals. A little over ten years ago,

Dr. Perry spoke at *COTS Journal's* coming out party in January 1998. From left to right, Pete Yeatman, Brigadier General William Becker, former Secretary of Defense Dr. William Perry, *COTS Journal* Editorial Director Warren Andrews and RTC Group President John Reardon.

John Reardon and Warren Andrews approached me and asked if I thought that the military embedded marketplace needed a magazine to focus on the technology issues. In the process, Dr. Perry made himself available to meet with us. Warren and I met with Dr. Perry and discussed our plans. And in just another example of Dr. Perry's commitment to the military and acquisition reform, he agreed to support our effort to bring *COTS Journal* to life and even arranged to speak at *COTS Journal's* coming out party in January 1998. I'd like to say that Dr. Perry and I are on a first name basis, but I can't. I am on a first name basis with his office staff, and most appreciative of Ms. Gordon's work in conveying my messages as Dr. Perry's missions take him around the globe.

It's hard to believe that *COTS Journal* has been around for 10 years. When we started this publication there were just military program books. And there was *Military and Aerospace Electronics* magazine which, at the time, focused more on systems and programs than it does now. So, in our own small way we experienced our own convergence: the times, the market change and the people. And by "people" I don't just mean John, Warren and myself. It was all the people who saw the need for getting the latest technology to the military, along with Dr. Perry, that brought *COTS Journal* to life. We sincerely hope that in some small way this publication has helped you in navigating through the technology and acquisition changes that the military is currently undergoing, and we look forward to serving you for the next 10 years.

Pete Yeatman, Publisher
COTS Journal

The Inside Track

GD C4 Systems to Equip Stryker Brigade with New Land Warrior System

General Dynamics C4 Systems has been awarded a $70 million contract to equip the 5th Brigade, 2nd Infantry Division Stryker Brigade Combat Team (5/2 SBCT) with a new, lighter-weight version of the Land Warrior integrated fighting system. This order funds a Brigade-set of Land Warrior ensembles and vehicle integration kits. The Land Warrior system (Figure 1) provides command-and-control, computing, communication and position-location technologies that will digitally link the Stryker Brigade's infantry soldiers to the battlefield network while they are on missions, improving their situational awareness, survivability, mission speed and effectiveness.

The slimmer Land Warrior system now weighs 7.2 pounds, down from approximately 17 pounds in 2006. System improvements, including size, weight and power reductions, resulted from feedback received directly from soldiers equipped with a previous generation of Land Warrior in Iraq. Their suggestions helped guide a team working at the General Dynamics-sponsored EDGE Innovation Network to improve the "fightability" of the Land Warrior system. Based at Fort Lewis, Wash., soldiers of the 5/2 SBCT will be equipped with advanced warfighting technologies that include built-in text messaging capabilities; maps and imagery that can be changed by leaders while on the move; virtual "chem-lights" that identify known enemy locations; and acoustic sniper detection.

Figure 1

Land Warrior consists of a helmet mounted display, a small computer for situational awareness and navigation, and a headset with radio connectivity.

General Dynamics C4 Systems
Scottsdale, AZ.
(480) 441-3033.
[www.gdc4s.com].

L-3 to Deliver over 600 VideoScout-MC Laptops to U.S. Marine Corps

L-3 Communications announced today that its Advanced Products and Design unit has been awarded a $23.2 million delivery order to provide 600 VideoScout-MC mobile video exploitation and management systems to the United States Marine Corps. These systems enhance portable equipment currently in use by adding video imagery in real time, which improves situational awareness. Production of these units is underway, with deliveries expected in the fourth quarter of 2008.

The Marine Corps will be receiving the mobile VideoScout-MC laptop computer with integrated multiband receivers. VideoScout-MC captures video and metadata directly from Unmanned Aerial Systems (UASs), targeting PODs, intelligence feeds and other common sensors, and allows users to view, archive, annotate, georeference and disseminate relevant, actionable video intelligence to others. Video and metadata can also be paused, zoomed, annotated and recorded in real time to improve situational awareness. Video and metadata are stored and indexed automatically for subsequent search and retrieval.

L-3 Communications
Advanced Products & Design
San Diego, CA.
(858) 552-9500.
[www.l-3com.com/apd].

Parvus Supplies Common Mission Computer for Aurora UAV

Parvus announced a subcontracting agreement with Aurora Flight Sciences to supply common Mission Computers for Aurora's Unmanned Aerial Vehicles (UAVs) under several prime contracts. No financial terms were disclosed. Parvus has delivered Aurora Common Mission Computer (ACMC) units for use with the GoldenEye 80 Unmanned Aircraft System (UAS) (Figure 2), an advanced Vertical Take-Off and Landing (VTOL) aircraft designed to carry advanced sensor payloads for homeland security and battlefield operations.

Figure 2

Shown here on its first flight, the GoldenEye 80 UAV is an advanced Vertical Take-Off and Landing (VTOL) aircraft designed to carry advanced sensor payloads for homeland security and battlefield operations.

The ACMC computer is a small form factor rugged computing system based on Parvus' COTS DuraCOR 820 subsystem, designed to accommodate the environmental and physical requirements of Aurora's airborne vehicles. The computing architecture for this Parvus subsystem is based on a low-power mobile Pentium CPU, solid-state memory, Linux operating system, military-grade power supply, and various peripheral and network inputs.

Aurora Flight Sciences
Manassas, VA.
(703) 369-3633.
[www.aurora.aero].

Parvus
Salt Lake City, UT.
(801) 483-1533.
[www.parvus.com].

SAIC Subcontracts Quantum3D for Advanced Signal/Image-Processing Apps

Quantum3D will serve as a subcontractor to Science Applications International Corporation (SAIC) on the STAP Boy contract for the Defense Advanced Research Projects Agency (DARPA). As the prime contractor, SAIC will leverage Quantum3D's new LibertyVPX High-Performance Embedded Computing (HPEC) system for an advanced deployed radar, Signal Intelligence (SIGINT), Communications Intelligence (COMINT) and Imagery Intelligence (IMINT) processing research and development program.

The STAP Boy program pursues the deployment of teraflop computing power to field environments. STAP Boy

requires rapid, high-volume real-time processing so first responders and soldiers can use sophisticated high-resolution sensors, space-time adaptive radar systems, urban structure mapping and occupant tracking for their life-critical missions. The LibertyVPX HPEC systems combine a processing architecture with the unprecedented floating-point performance of GPUs and multicore CPUs. The result is a compact, open-architecture, ruggedized package that's both cost-effective and ready to be deployed in the field. The LibertyVPX HPEC system that SAIC will use provides FPGAs and mobile GPUs along with low-power, embedded Intel multicore CPUs. This entire solution is integrated in a high-performance, InfiniBand-based switch fabric architecture.

Quantum3D

San Jose, CA.

(408) 361-9999.

[www.quantum3d.com].

NASA's Orion Crew Exploration Vehicle Embeds Green Hills' RTOS

Green Hills Software announced that NASA is using Green Hills Software's Platform for Avionics, including the safety-certified INTEGRITY-178B real-time operating system, in safety-critical electronics—including the command computer—aboard NASA's Orion crew exploration vehicle. Lockheed Martin selected Green Hills Software's INTEGRITY and INTEGRITY-178B operating systems for use in the spacecraft's avionics systems, including the Flight Control Module (FCM), Spacecraft C3I Communication Adapter (SCCA) and Backup Emergency Controller. Green Hills Software was determined to be the most technically mature and offered a more economical commercial off-the-shelf solution.

Figure 3

The Orion crew exploration vehicle will transport a new generation of explorers to the moon, with crewed flights scheduled to begin in 2015. This artist's rendering represents a cut-away concept of the Orion crew exploration vehicle's crew module.

The Orion crew exploration vehicle (Figure 3) will transport a new generation of explorers to the moon, with crewed flights scheduled to begin in 2015. Orion is part of NASA's Constellation Program, the largest space initiative in 30 years, to send human explorers back to the moon and then onward to Mars and other destinations in the solar system. The new Orion and Ares space transportation system will carry crew and cargo to the International Space Station, rendezvous with landing modules for exploration of the moon and Mars, and serve as the return vehicle back to Earth.

Green Hills Software

Santa Barbara, CA.

(805) 965-6044.

[www.ghs.com].

The Military Embedded Market from Bottom to Top

Despite much uncertainty and turmoil in the DoD budget, the embedded segment of the military markets continues to ride a path of growth. Top industry analysts look at the multiple facets of this trend and forecast from bottom up and top down viewpoints.

Jeff Child,
Editor-in-Chief

If there's one thing certain these days about the Defense market it's that there's a lot of uncertainty. Evidence is mounting that the overall DoD budget will shrink in coming months and years. Changes to the political landscape as well as forces within the government are expected to drive that budget down, but the degree of that decrease depends on how the political and government changes fall. Throw in the recent financial crises that's shaking up the United States and the world, and it gets pretty difficult to read the tea leaves.

It's interesting to note, however, that over the long term such dips and rises in the overall DoD budget are commonplace. Over the past ten years, however, the electronics and embedded computer component of the overall DoD budget has been ramping up dramatically, and that trend continues to accelerate (Figure 1). The forces driving that increase have everything to do with what the DoD has been putting its focus on. That focus can be divided into three factors. First, a great deal of emphasis has been on defense programs that require increasing amounts of compute-density—everything ranging from sophisticated radar upgrades to advanced UAV payloads that provide more mission autonomy.

Next, there's the DoD's migration to Network-Centric Operations. The effect of making every vehicle, aircraft, ship, ground installation and soldier part of a network is ballooning demand for sophisticated compute-intensive radio and network nodes—each suited for a different environment, platform or user. And finally, the DoD continues to spend heavily on tech upgrades and tech refreshes of existing systems. There are significant cost benefits to upgrading the cockpit electronics and avionics on an older air-

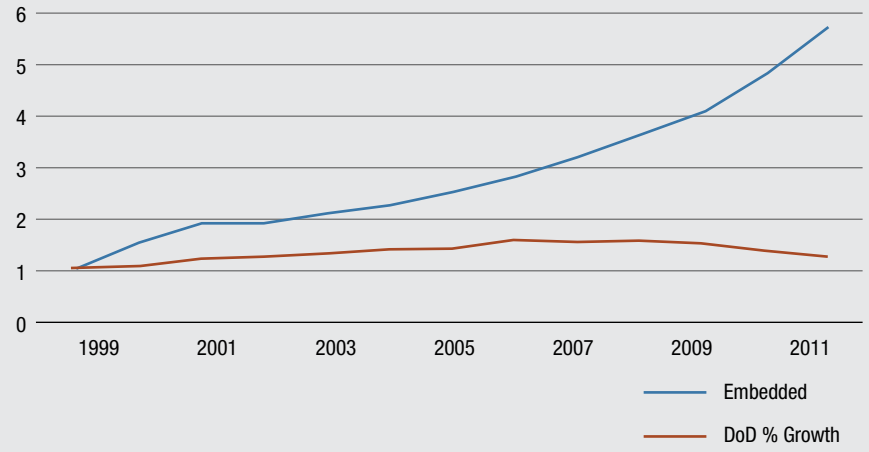

Figure 1

Using the overall DoD budget growth as an abstraction where 1 equals the total overall DoD budget growth, this graph illustrates how the electronics and embedded computer component of the overall DoD budget has been growing dramatically over the past decade and that trend continues to accelerate.

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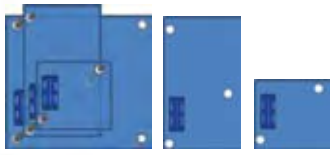

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frame instead of building new aircraft. Many of the large ongoing land, air and sea programs will continue, of course, but the trend seems to be shifting toward making cuts there, rather than in other areas.

Shedding Light on Uncertainty

To help shed some light on where the military embedded market is headed, this section provides reports from three top market analysis firms that cover this market: VDC Research Group, Frost & Sullivan and Jane's DS Forecast. And in keeping with *COTS Journal*'s penchant for covering military technology from the bottom up, we've structured this section to start with an analysis of the building block components and board form factors that are critical to the military embedded space, and move from there up to higher-level platform-specific market coverage. In his piece, Eric Heikkila, director, Embedded Hardware & Systems at VDC Research Group, analyzes and forecasts how specific embedded board form factor categories like cPCI, VME and others fit into the military embedded market's growth, as well as the impact of multicore processors on the standard form factor board arena.

Next, Lindsay Voss, senior consultant, Defense Electronics at Frost & Sullivan, tackles an important and fast growing segment of the defense market: The Unmanned Systems Market. In her article, Voss looks at the dramatic changes rocking the market. Last year, says Voss, saw the largest influx of unmanned aerial vehicles (UAVs), unmanned ground vehicles (UGVs), unmanned underwater vehicles (UUVs) and unmanned surface vehicles (USVs) to ever be deployed to the battlefield. She examines the what, when and where of those segments of the market with a look at where the opportunities are to supply hardware, software, sensors, communications and other subsystems.

Last but not least, a team of researchers from Jane's DS Forecast takes a top-level look at the Worldwide Military Electronics Market—a market they predict peaking at just under $100 billon by 2011. The Jane's team analyzes the market from a variety of perspectives including by technologies, functions platform types and international region. Since 2002, Documental Solutions (DS) has been tracking the defense electronics market from a bottom-up perspective. Six years later, and with over 26,000 defense electronic program opportunities tagged, DS has categorized and evaluated the market. The total Worldwide Military Electronics Market value will grow between now and mid-2011, when it could peak at just under the $100 billion mark. The story indentifies the pockets of high growth in the market and those that are effectively stagnant. The piece also looks at which subsystem types will have high demand for off-the shelf products and applications.

The market data provided in this section is of the caliber vital for proposals and design briefings. It's useful material to use over the next 12 months to verify system-architecture and business development choices. The editorial staff of *COTS Journal* is grateful to the analysts at VDC Research Group, Frost & Sullivan and Jane's DS Forecast for their participation in this special section. ▮▮

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VME and cPCI Maintain Tight Grip on Mil Embedded Market

Demands for greater compute density, advanced networking and better processing per-watt are fueling healthy demand for embedded computers in the market. CompactPCI and VME remain the dominant choice.

Eric Heikkila, Director, Embedded Hardware & Systems
VDC Research Group

The market for military embedded computer boards and systems today is both healthy and growing. VDC Research Group has been covering the embedded systems market for over twenty years, including the vital military/aerospace segment of this market. We have watched and carefully tracked the COTS transformation in the embedded market since General William Perry's memo in 1994. There are multiple factors contributing to the growth of this market.

First is the expansion and proliferation of military communications into other applications areas as military systems are going network-centric. Future Combat Systems and the latest military equipment link people with one another, and with vehicles, aircraft, ships and command centers. Many applications areas now require embedded computers to enable this communication. In addition, applications that previously made use of embedded computers now require new, more powerful systems to enable a higher level of communication and functionality, so these too will drive increases in shipments. The increase in military communications also creates a new requirement to process, route and if necessary store all of the new data that is created by having a greater number of connected elements in the military telecom/datacom network.

The second factor is the increased use of more complex military systems, such as UAVs, which require heavy processing capability. Systems such as these comprise a higher usage of embedded boards and systems, creating increased demand for these products.

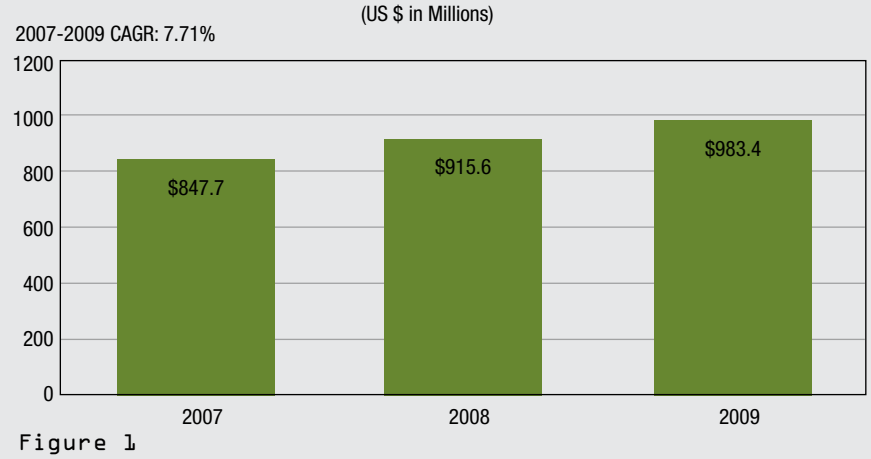

Figure 1

Driven by the rising demand for net-centric military communications gear plus and increased need for complex processing in platforms like UAVs, the North American and European Union military embedded boards and systems markets are growing at healthy rates.

EU Growth Rate Higher

Both the North American and European Union military embedded boards and systems markets are growing at healthy rates for the reasons outlined above. However, the EU market is projected to show slightly higher growth. European military spending, both internal and external to the European Union, is expected to increase as some of the old European powers—France, Germany and Russia—wish to play a larger part in ensuring the security of the world. In addition, certain Eastern European nations, after years of fast-paced economic growth, are beginning to have the wherewithal to invest in advanced military technology. Figure 1 shows the North American and European Union merchant Mil/Aero embedded boards shipments and projections for 2007 to 2009.

Passive backplane architectures currently comprise the vast majority of embedded boards consumed in military and aerospace applications. However, smaller form factor boards such as mezzanine cards, COMs, PC/104 family modules and other stackables are projected to command increasing shares over the next several years. Primary reasons for this trend are twofold.

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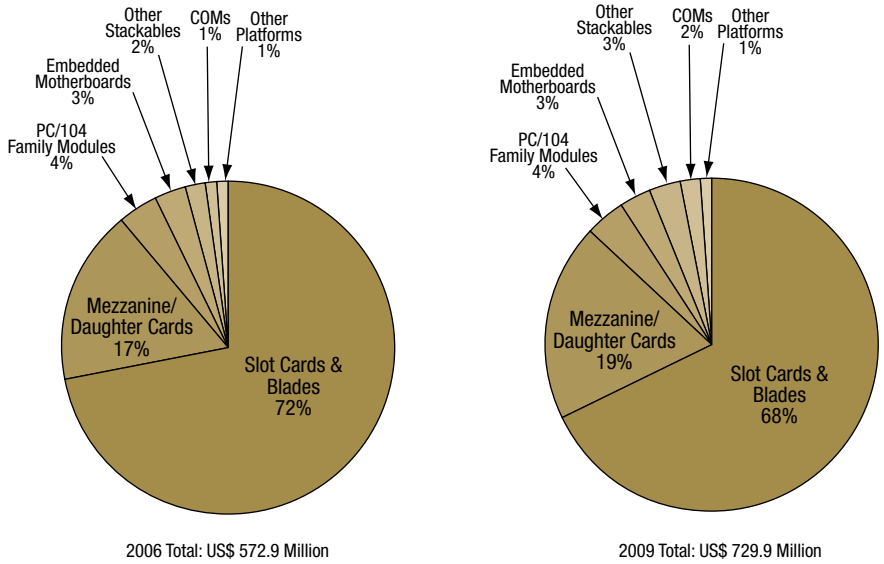

Figure 2

Smaller form factor boards such as mezzanine cards, COMs, PC/104 family modules and other stackables are expected to capture increasing market shares over the next several years. Such boards often boast superior processing power-per-watt and are less expensive than their passive backplane-based counterparts.

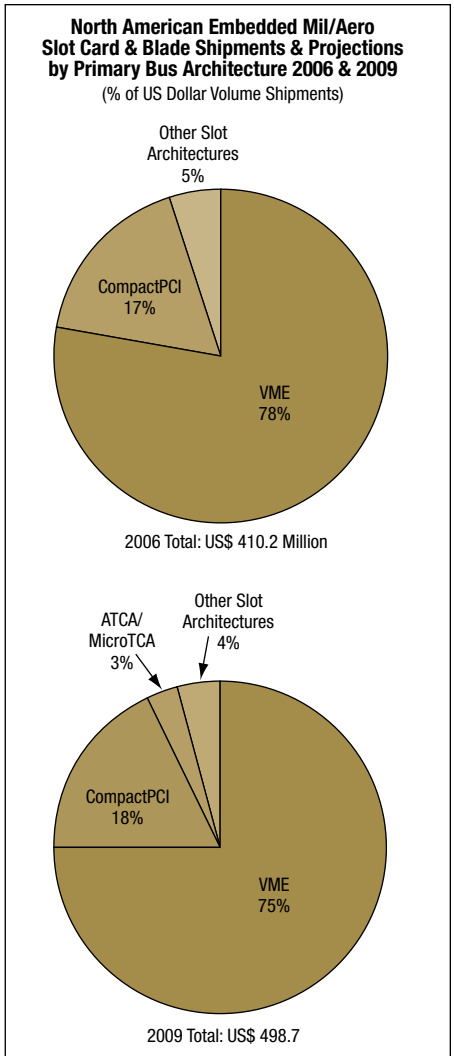

Figure 3

VME (including VITA 41 and 46/48) and CompactPCI are expected to experience healthy growth through 2011. Together they still remain the cornerstone standard architectures of the military embedded board market.

The first reason is the continued increase in processing power-per-watt, including gains offered by multicore processor architectures, coupled with higher bandwidth offered by modern serial technologies, are allowing suppliers to offer powerful board products in smaller form factors. In many—if not most—cases, these are less expensive than their passive backplane-based counterparts.

Meanwhile, modern warfare, including counter-insurgency and homeland security, is becoming increasingly dependent upon local, tactical computing systems rather than larger, more strategic ones. These are utilized

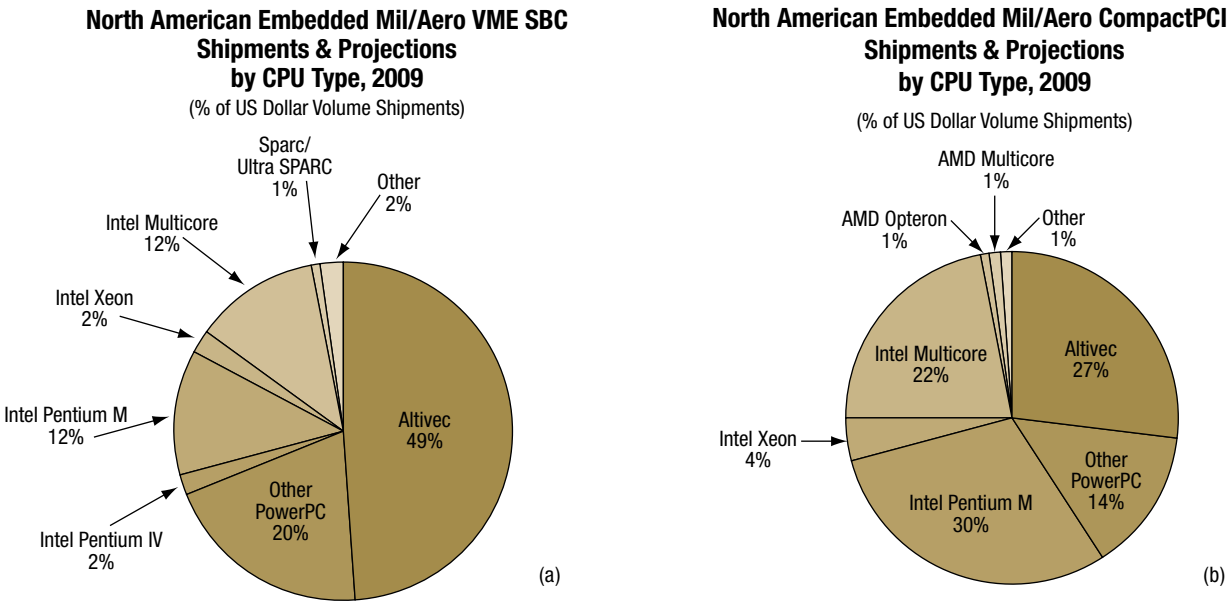

Figure 4

The trend toward multicore processors is evident in shipments of both VME (a) and CompactPCI (b) processing boards to the military. The movement to multicore processors is driven, in part, by power and heat considerations—a key factor in embedded military systems where systems are already at the bleeding edge of supportable power and heat budgets.

more to minimize civilian and friendly casualties and damage to the infrastructure than to provide large-scale destruction such as that present in early stages of a conflict. Smaller form factors allow such systems to be lighter and less bulky than passive backplane systems, facilitating their use by ground troops in limited engagements. Figure 2 shows North American Mil/Aero embedded board shipments and projections from 2006 to 2009 broken down by product type.

VME and CompactPCI comprise the cornerstone standard architectures of the military embedded board market. Both are expected to experience healthy growth through 2011. Although some have expected use of VME to decline and disappear, the architecture has proven to be tremendously resilient, and, once again, it has been "reinvented" with the new VXS (VITA 41) and VPX/VPX-REDI (VITA 46/48) standards. Both are switch fabric-enabled and VPX will effectively provide the first VME standard that extends into the small 3U form factor.

CompactPCI growth is primarily fueled by 3U as well. The small size makes these popular in an increasing number of military systems where space is tight. CompactPCI, which is basically a telecom/datacom architecture, is also very appropriate for military communications applications. Figure 3 charts the North American embedded Mil/Aero slot card and blade shipments and projections by primary bus architecture (dominated by VME and CompactPCI) from 2006 to 2009.

Multicore CPU Trend

The use of multicore processors in embedded military applications is another trend unfolding as many embedded processor boards with multicore processors are now shipping to military/aerospace customers. Microprocessors have become faster, denser, more powerful—and hotter. They have now reached the point where chip design is constrained by power dissipation considerations. The movement to multicore processors is driven, in part, by power and heat considerations. The situation is especially acute for embedded military systems, where current microprocessors, even including multicore processors, are at the edge of supportable power and heat budgets.

At the board level, the problem is getting the heat from these current generation processors off the board. Therefore multicore is certainly a big part of the future. Multicore trends are evident in shipments of both VME and CompactPCI processing boards to the military. Figures 4a and 4b chart the embedded Mil/Aero shipments and projections by CPU type for CompactPCI and VME respectively.

Embedded boards of various form factors and architectures continue to make inroads into military and aerospace applications on top of the long legacy that architectures such as VME have already built, continuing to make this one of the most important segments of the embedded boards and systems market. ▮▮

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Unmanned Systems Face a Changing Market

In contrast to the slower dynamics of manned platforms, the Unmanned Systems Market—including its air, ground and sea segments—is facing accelerated changes and significant growth.

Lindsay Voss, Senior Consultant, Defense Electronics
Frost & Sullivan

The future of unmanned systems is here and the market is rapidly changing. The last year has seen the largest influx of unmanned aerial vehicles (UAVs), unmanned ground vehicles (UGVs), unmanned underwater vehicles (UUVs) and unmanned surface vehicles (USVs) to ever be deployed to the battlefield. Increased spending for unmanned systems over the past five years has led hundreds of companies to enter the market not only to supply platforms, but also to provide software solutions, sensors, communications and other subsystems. However, now many companies are questioning the future of the U.S. unmanned systems market in the midst of a changing war environment in Iraq, increasing competition levels as well as potential program budget cuts and delays.

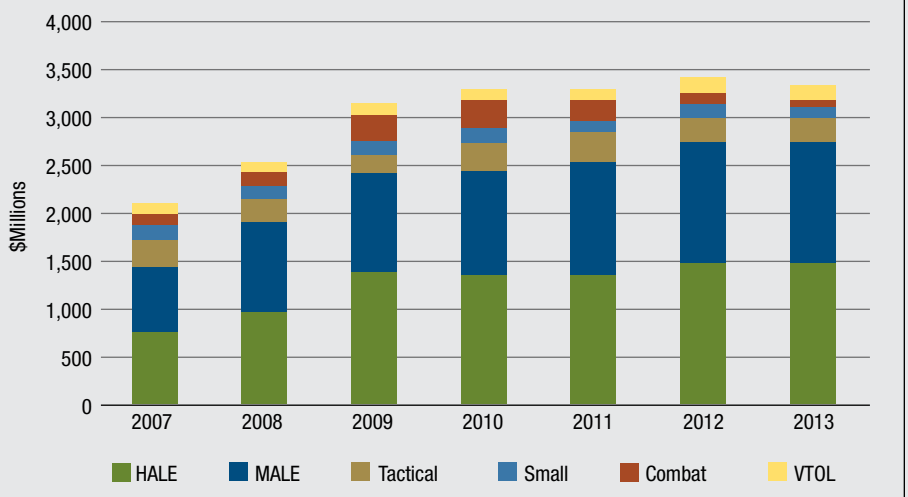

Figure 1

UAVs boast the largest and most mature segment in the unmanned systems marketplace with a market value of $2.2 billion last year. Today, intelligence, surveillance, reconnaissance (ISR) and precision strike are the two predominant UAV missions.

Unmanned Aerial Vehicles Market

With a market value of $2.2 billion in 2007 (Figure 1), UAVs represent the largest and most mature segment in the unmanned systems marketplace. Few military technologies have come as far in recent years as unmanned aircraft. These systems have evolved from drones used primarily for surveillance into advanced weapons capable of detecting, tracking and striking a target all while being controlled by a pilot and sensor operator stationed thousands of miles away. Currently intelligence, surveillance, reconnaissance (ISR) and precision strike are the two predominant UAV missions, but the DoD is closely working with industry to develop new capabilities that will greatly enhance these systems in the future.

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As the result of successful performances in Iraq and Afghanistan, UAVs that fly high and medium altitude long endurance missions have been the beneficiaries of the latest technologies and consequently received more than $1.8 billion in DoD funding in 2007. Eighty percent of this spending went to the U.S. Air Force's medium altitude long endurance (MALE) and high altitude long endurance (HALE) platforms. However, the USAF is not the only military service with these capabilities; the Navy's Broad Area Maritime Surveillance (BAMS) program will have a substantial impact on defense spending in addition to the Army's Extended Range, Multi Purpose (ERMP) aircraft. These two programs are expanding long endurance UAV capabilities across the military services.

Small and Tactical UAVs

In addition to MALE and HALE platforms, a surge in small and tactical UAV procurement has also been evident. DoD spending for these platforms totaled $367.7 million in 2007, paling in comparison to spending totals for larger UAV platforms. This smaller class of fixed-wing UAVs includes the RQ-11 Raven B manufactured by AeroVironment, Inc. and RQ-7 Shadow 200 system

Figure 2

The Fire Scout is the DoD's strongest funded Vertical Take Off and Landing (VTOL) UAV program with Navy and Army RDT&E and procurement spending totaling $139.7 million in 2007. Northrop Grumman's MQ-8B Fire Scout has successfully completed a shipborne takeoff and landing. The MQ-8B features a four-blade main rotor that reduces noise and improves lift capacity and performance. The MQ-8B is fitted with stub wings that serve both an aerodynamic purpose as well as an armament carriage location, with weapons such as Hellfire missiles, Viper Strike laser-guided glide weapons and APKWS rockets. The Fire Scout can carry up to 90 kilograms (200 pounds) of supplies.

Optional payload swapouts for the MQ-8B under consideration include a TSAR with Moving Target Indicator (MTI) capability, a multispectral sensor, a SIGINT module, the Target Acquisition Minefield Detection System (ASTAMIDS) and the Tactical Command Data Link (TCDL). The Army hopes to employ the Fire Scout to operate as an element of an integrated ground sensor network as well.

manufactured by AAI Corporation. The DoD's only major ongoing UAV competition is focused on a small tactical UAV and is being run through the Navy's Air Systems Command (NAVAIR). This program, known as Tier II STUAS, will provide small tactical UAV assets to both the Navy and Marine Corps. The Navy is currently defining system requirements, but a shortage of funding for the program has slowed progress.

Another UAV class in development and receiving strong DoD support is comprised of Vertical Take Off and Landing (VTOL) platforms. These systems offer improved capabilities over fixed-wing platforms in two particular settings: Urban warfare and shipborne operations. For instance, Honeywell's Micro Air Vehicle (MAV) has been deployed in limited quantities to search for improvised explosive devices (IEDs) in urban areas of Iraq, while Northrop Grumman's MQ-8B Fire Scout (Figure 2) has successfully completed a shipborne takeoff and landing. The VTOL market space includes aircraft such as the well-known Fire Scout in development with both the Navy and Army and other lesser-known platforms including Boeing's A-160 Hummingbird and Aurora Flight Sciences' ducted-fan GoldenEye family of aircraft. The Fire Scout is the DoD's strongest funded VTOL UAV program with Navy and Army RDT&E and procurement spending totaling $139.7 million in 2007.

Four Major Companies Dominating

Despite DoD funding in the billions of dollars, the UAV market can be challenging for new companies looking to enter as either a prime contractor or a supplier. Competition levels are at an all time high with four major companies dominating the market, which include Northrop Grumman Corporation, General Atomics Aeronautical Systems, Inc., AAI Corporation and AeroVironment, Inc. There is also increasing competition for Tier one and two suppliers in the UAV market, however, there is more opportunity for these suppliers than for companies offering a complete system. One area of particular growth has been in UAV cameras and thermal imaging systems with companies such as FLIR Systems, DRS Technologies and L-3 Communications recently increasing market share. With competition levels locking out many UAV companies seeking opportunity within the DoD, focus has shifted to potential civil and commercial applications. However, these markets have yet to emerge because of regulatory and liability issues.

The U.S. Unmanned Ground Vehicle (UGV) market (Figure 3) segment has exploded in response to the urgent needs by troops in Iraq and Afghanistan for autonomous ground assets capable of both detecting and defeating IEDs. High demand for these systems in the last two years has resulted in spending for Explosive Ordnance Disposal (EOD) robots to escalate beyond $200 million in 2008. The bulk of this spending is divided

among two major players in the UGV market: iRobot Corporation maker of the PackBot and Foster-Miller, Inc., a subsidiary of QinetiQ North America providing the Talon. EOD robots are driving spending in the near-term, but larger systems with a diverse range of capabilities are also being developed. Future UGV missions will include perimeter surveillance, logistics support, communications relay, and eventually, armed combat.

The PackBot and Talon have become invaluable in theater, and recent indefinite delivery, indefinite quantity (IDIQ) contracts for the systems potentially totaling more than half a million dollars are testament of their value. As a result of successful missions in Iraq, and strong troop support, not only are the PackBot and Talon being heavily procured, they are also becoming much more sophisticated. EOD robots are being upgraded with small gimbaled EO/IR cameras for surveillance, Joint Architecture for Unmanned Systems (JAUS) software to increase interoperability, chemical, biological, radiological, nuclear and explosives (CBRNE) detection sensors, and in some cases, small arms weapons. A smaller version of iRobot's PackBot, the Small Unmanned Ground Vehicle (SUGV) is being deployed as a part of the Army's Future Combat Systems (FCS) technology spinout.

In addition to EOD robots, the DoD is working on several larger systems that will be used for reconnaissance and surveillance, armed combat and logistics. These include the Multifunctional and Utility Logistics and Equipment (MULE) vehicle in development for the FCS program. The system has two variants, one of which will be armed and the other designed to carry equipment and supplies. In addition to logistics and combat, perimeter surveillance is also becoming a role for UGVs. The Mobile Detection, Assessment and Response System (MDARS) (Figure 4) from General Dynamics Robotics Systems is designed to autonomously patrol the perimeters of high-priority installations and inventory.

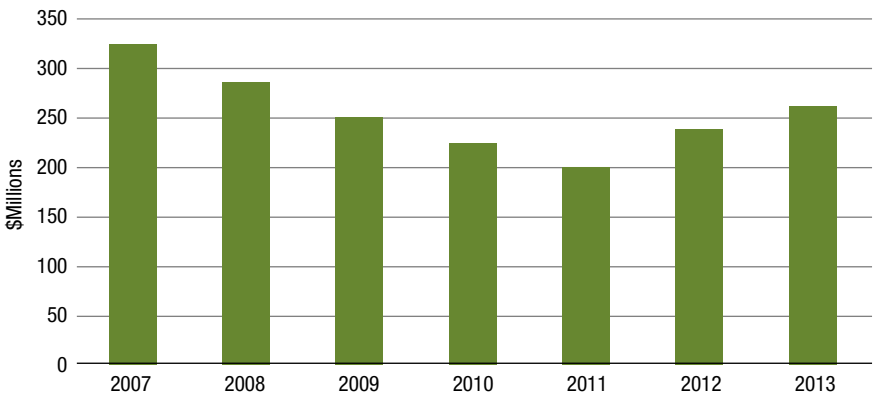

Figure 3

The U.S. Unmanned Ground Vehicle (UGV) market segment expanded rapidly to serve the urgent needs of troops in Iraq and Afghanistan as tools for detecting and defeating IEDs. This caused the Explosive Ordnance Disposal (EOD) robot segment to escalate beyond $200 million in 2008.

Non-EOD Robots

MDARS remains the only non-EOD robot to receive a significant DoD contract in 2008 potentially worth $40.0 million over five years. DoD spending on these larger UGVs has been significantly less than that for EOD-specific systems. While the market for the PackBot and Talon and other related UGVs has escalated into the hundreds of millions of dollars, spending for larger platforms has been much lower with 2007 spending totaling less than $30.0 million in 2007.

The IED threat and resulting supplemental spending to defeat the threat has influenced UGV spending more than any other unmanned systems market segment. While EOD robots are used by law enforcement, SWAT teams and bomb squads, the primary customer to date has been the DoD. With the level of violence in Iraq at its lowest level since the onset of the war, defense spending for UGVs, particularly with an IED detect and defeat mission, is expected to drop in the near term.

A drop in defense supplemental spending could significantly impact the UGV market, which has become accustomed to multimillion dollar contracts and large incoming orders for EOD robots. With IEDs being less of a concern, the UGV industry will have to increase its focus on transitioning these systems to take on more diverse and complex missions. This will include advancing imaging capabilities for improved surveillance, developing more compact and affordable systems, and increasing system interoperability.

Unmanned Maritime Systems Market

Unmanned Underwater Vehicles (UUVs) and Unmanned Surface Vehicles (USVs) make up the UMS market segment, and both technologies are still in their infancy. Unlike the UAV and UGV markets, unmanned maritime systems are being funded at much lower levels. Two companies currently supply the bulk of the Navy's UUVs. These are Bluefin Robotics and Kongsberg Maritime's recently acquired Hydroid, LLC. Both companies are involved with the majority of the Navy's major lightweight and man-portable UUV programs, with prime contractors such as Boeing and Lockheed Martin targeting the heavyweight UUV programs.

Figure 4

The Mobile Detection, Assessment and Response System (MDARS) remains the only non-EOD robot to receive a significant DoD contract in 2008 potentially worth $40.0 million over five years. Built by General Dynamics Robotics Systems, the MDARS is designed to autonomously patrol the perimeters of high-priority installations and inventory. The MDARS-E (Exterior) version will provide commanders at Army, Air Force, Navy and Defense Logistics Agency (DLA) facilities with the capability to conduct semi-autonomous, random patrols and surveillance activities, including barrier assessment and theft detection functions.

Another goal intended for the project is to develop a system that allows Small UAVs or UGVs to be launched, recovered and refueled from the vehicle platform. Other benefits are seen in the mission flexibility, which allows the UAV to be launched from one type of system and captured by another—such as launched from a USV and recovered by a HMMVW.

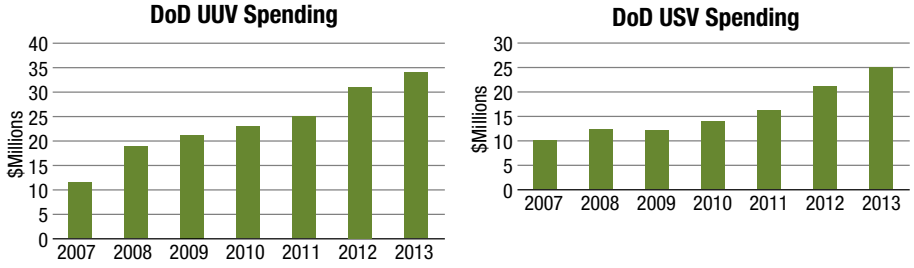

Figure 5

Still in their infancy, the Unmanned Underwater Vehicles (UUVs) and Unmanned Surface Vehicles (USVs), unlike the UAV and UGV markets, are being funded at much lower levels. In 2007, spending for the UUV market (a) totaled $16.9 million, with the USV market (b) lagging behind at approximately $10.0 million. That said, estimated growth in the coming years expects to be high.

DoD spending for UMS is almost incomparable to that for UAVs and UGVs. The UUV market is slightly more mature than that for USVs due to the commercial use of the systems by the off-shore oil and gas industry. In 2007, spending for the UUV market (Figure 5a) totaled $16.9 million, with the USV market (Figure 5b) lagging behind at approximately $10.0 million. While DoD spending for both segments has been low, estimated growth in the coming years expects to be high. It is this growth that has companies historically invested in UAV and UGV technologies entering the UMS market.

Unlike the UGV and UAV markets, the UMS market has an open competitive environment. Companies known for their work with UGVs and UAVs are now making acquisitions and positioning themselves to take advantage of this emerging market. For instance, iRobot Corporation and Foster-Miller, Inc. are both in the process of leveraging their strong backgrounds in unmanned systems development to find opportunity with UUVs and USVs.

Delays Because of LCS

Recently the UMS market has been restrained due to the delayed Littoral Combat Ship (LCS), which has requirements for multiple unmanned maritime systems including the underwater Remote Mine Hunting System (RMS) (Figure 6) and an unmanned surface craft. The current state of the LCS program has negatively impacted the UMS market in the near term. In the coming years, however, demand for unmanned maritime assets from agencies such as the U.S. Coast Guard will drive growth as these systems are valuable for both harbor surveillance and maritime interdiction.

With the Navy being slow to procure UMS technologies, companies are looking for different opportunities with other federal agencies such as the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA). There is also an emerging commercial market for these systems in the offshore oil and gas industry. However, this market is still in its infancy.

High Demand Expected

Despite challenges within the market, demand for unmanned systems is high and will continue to increase as the military services augment their fleets of autonomous platforms. The UAV segment will be the strongest funded segment, but will have the least opportunity due to entrenched competitors. The UGV and UMS market will see less funding, but will have more long-term opportunities for both prime contractors and suppliers.

Defense companies view the unmanned systems market as a major area of opportunity that is increasing compe-

tition levels across all three market segments. With competition increasing and market dynamics changing, companies invested in unmanned systems will have to be prepared to make adjustments as well. This will include staying ahead of the competition, looking beyond the DoD for new potential markets, and improving unmanned systems and subsystems to be prepared for more diversified missions. Those companies prepared for the changing unmanned systems market will ultimately find new opportunities while overcoming challenges.

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Figure 6

A Navy sailor aboard the guided-missile destroyer USS Bainbridge is shown here guiding a Remote Mine-hunting Vehicle into the Mediterranean. Lockheed Martin's Remote Minehunting System (RMS) is launched and controlled remotely from forward-deployed ships. This gives Carrier and Expeditionary Strike Groups an organic, real-time, over-the-horizon mine reconnaissance capability, significantly enhancing ship and crew safety. The unmanned, semi-submersible RMV tows a Variable Depth Sensor to detect, localize, classify and identify moored and bottom mines.

Other key elements of the system include line-of-sight and over-the-horizon real-time data links, a shipboard launch and recovery subsystem, and a software segment, which integrates AN/WLD-1(V)1 into the ship's AN/SQQ-89(V)15 Undersea Warfare Combat System. The Remote Minehunting System (RMS) will transition to the Littoral Combat Ship (LCS) as part of the Mine Warfare and ASW Mission Packages.

Opportunities Abound in the Defense Electronics Markets

With steady growth predicted between now and 2011, the Worldwide Military Electronics Market could peak at just under the $100 billion mark. This growth will be spread across a variety of technologies, functions and platform types.

Jane's DS Forecast Analyst Team
Jane's DS Forecast, a part of Jane's Information Group

In the past ten years, manufacturing and markets have changed to the point where the term COTS has moved from a catch phrase to an accepted part of the military electronics market. However, placing a value on the defense electronic market, let alone the COTS market, has traditionally been an almost impossible task.

Since 2002, Documental Solutions (DS) has been tracking the defense electronics market from a bottom-up perspective. Six years later, and with over 26,000 defense electronic program opportunities tagged, DS has categorized and evaluated the market. The total Worldwide Military Electronics Market value will grow between now and mid-2011 when it could peak at just under the $100 billion mark. This growth will be spread fairly evenly across the various technologies with small pockets of high growth in a market that is effectively stagnant. Some areas of high growth include man-portable equipment, vetronics, vehicle protection systems, unmanned sensors, integrated logistic C2 (Command and Control) and Intelligence, Surveillance, and Reconnaissance (ISR)-based C2 applications.

If the total Global Military Electronics market is examined by subsystem type it's clear that the market can be defined by subtechnologies, and if one is looking for market opportunities, some conclusions can be drawn. First, most of the listed areas in the worldwide military electronics subsystem market by subsystem type chart (Figure 1) have off-

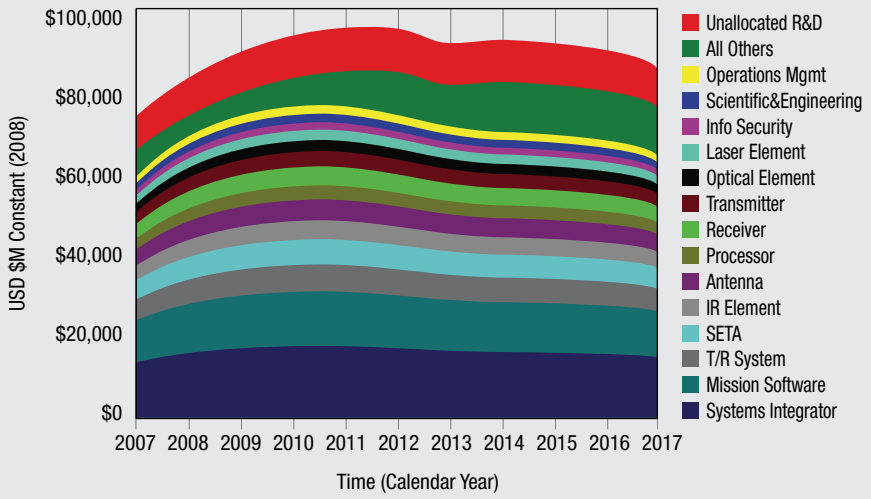

Figure 1

Although none of these market subsystems can be delivered entirely through an off-the shelf solution, many of the subsystems have requirements that can be met through off-the shelf products. Only the unallocated R&D and the system integrator elements will have a naturally low level of off-the-shelf requirements.

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the shelf requirements and applications. While none of these market subsystems can be delivered entirely through an off-the shelf solution, many of the subsystems have requirements that can be met through off-the shelf products. Only the unallocated R&D, our estimate for the levels of unidentified Research and Development within a market and/or country, and the system integrator elements will have a naturally low level of COTS requirements.

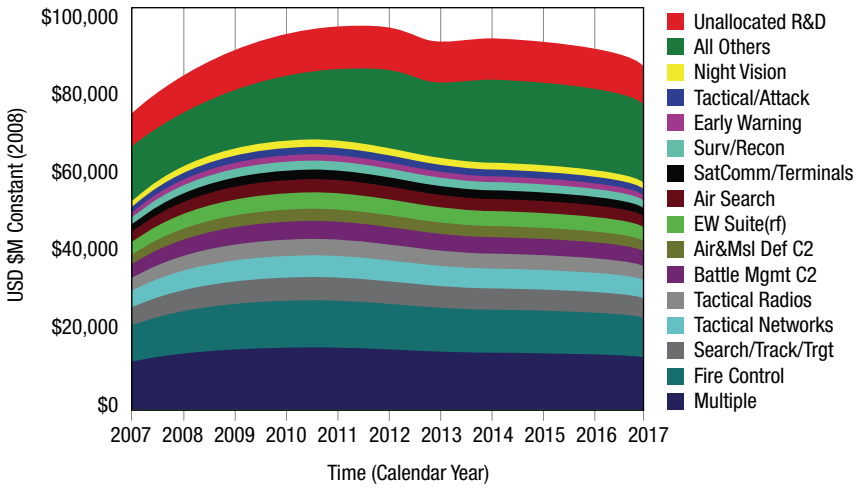

Figure 2

This chart of the total global military electronics market by functional segmentation shows that the market continues to be remarkably diverse in application requirements. No one single segment dominates the market, and the 15 top functional segments are even in size.

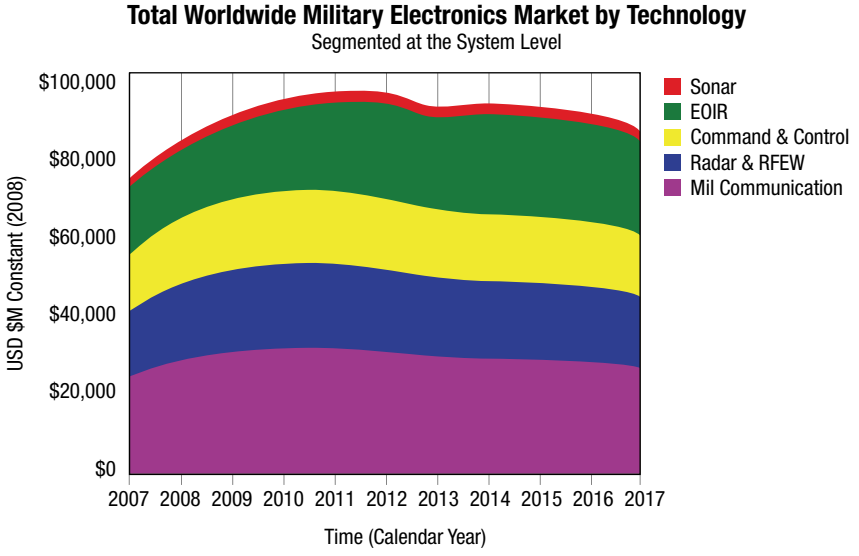

Figure 3

This breakdown of market technology areas shows the four leaders: Military Communications, Radar and RFEW, Command and Control and EOIR as fairly equal, and they are expected to remain so relative to one another over the next ten years.

With a value of $10 billion a year, the military mission software market has seen a dramatic change in the past ten years with a switch to open architecture technologies and an adoption of commercial standards. While much defense software will continue to be worked to custom specifications, there is an increasing use of applications, graphical information systems and structural tools. Processors is another area of high off-the shelf component and subsystem use and application; with the cost of commercial processing power falling dramatically over the past decade, the development of military-specific processing power has fallen significantly.

An examination of the total global military electronics market by functional segmentation (Figure 2), shows that the market continues to be remarkably diverse in application requirements. No one single segment dominates the market, and the 15 top functional segments are not only even in size, but none will see a significant rise or fall within the ten-year time frame. Even the two largest segments—"fire control" and "multiple"—are, by their nature, multifunctional in many respects and applications.

Mil Market by Technology

In terms of market technology areas (Figure 3) the four leaders: Military Communications, Radar and RFEW (Radio Frequency Electronic Warfare), Command and Control and EOIR (electro-optic infrared) are fairly equal and will remain relative to one another over the next ten years. Sonar will continue to play a minor role in the market compared to the other four technologies.

If we examine the total market by platform type (Figure 4), we can see that the market varies significantly as we examine each in turn. The aircraft (fixed wing and helicopter) market has very demanding requirements, and while commercial technologies are being used and adapted for the military aviation market, the market has the most demanding en-

vironmental specifications. This relatively low demand is unlikely to change over the ten-year forecast period. Although there will be opportunities as the UAV market grows, there is an increasing demand for smaller, low-cost units that will naturally endear themselves to commercial off-the-shelf products, including EOIR. Furthermore, as the total number of all UAVs increases, there is a proportional demand for increased numbers of ground control stations that don't have the same rigorous environmental demands as they would if they were mounted on aerial platforms.

The vehicles (artillery and ground vehicles) market traditionally had a low electronics component, however, this is currently changing very rapidly as requirements for vetronics are quickly ramping up. Vehicle management systems, tactical battle management systems, remote overhead weapon systems, observation screens and digital intercoms are all now using off-the-shelf elements. With the emergence of cost-effective new build and upgraded integrated vetronic systems, and their proven utility in Iraq and Afghanistan, the market is expected to grow strongly.

Advanced Vetronics Drives Demand

The next ten years the number of vehicles with advanced vetronics will rapidly increase from a minority to a majority. Furthermore, in the long term the market is set to accelerate again as vehicles are increasingly fitted with soft kill and hard kill protection systems that will have a significant electronic component. The Lebanon war demonstrated that there is a very strong requirement for these systems, although recent reports suggest that the market leader, Israel, is having problems getting a system into service.

The ships (ships and submarines) market is a strong market for commercial technologies with ever increasing demands for reduced cost, relatively large amounts of space, and fairly friendly operational environments

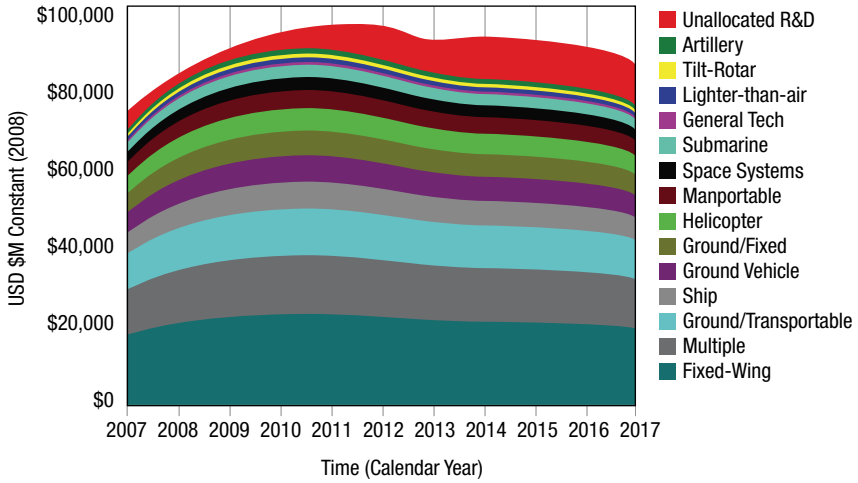

Figure 4

This examination of the market by platform type shows a lot of variation between each platform. Note that as the total number of all UAVs increases, there is a proportional demand for increased numbers of ground control stations. Those ground stations will have less rigorous environmental demands compared to systems mounted on aerial platforms.

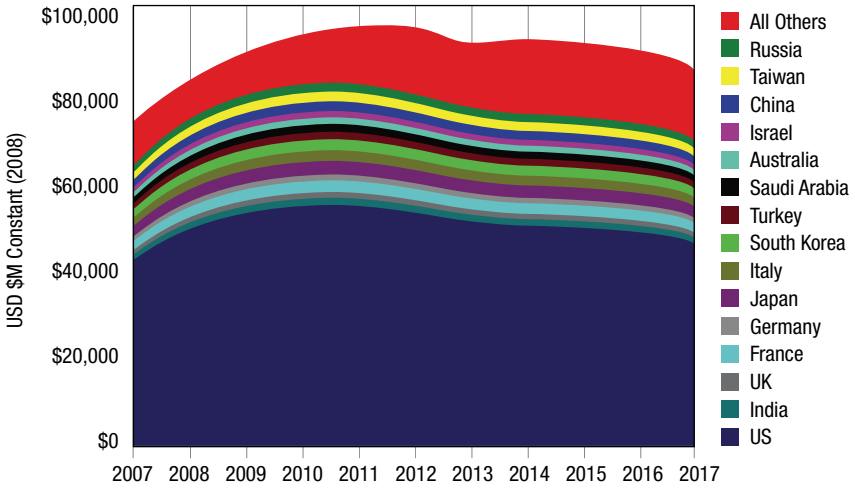

Figure 5

Not surprisingly, the market from an international perspective is dominated by the United States, which continues not only to spend the most on defense, but the highest portion of its budget on defense electronics. Some 30% of the total market is dominated by the rest of the top ten leaders in the global defense expenditure list. This is unlikely to change in the coming ten years although we will see significant growth from Turkey, India and China as they push their way upward in the market.

(bar vibration). Already large amounts of communication equipment for internal networks and broadcast equipment are commercial-based, and increasingly command system software and hardware is commercial-based. Radar and EOIR elements are perhaps the least commercial-based at the current time, but as these products become more interfaced with the combat management system, there is a greater opportunity for commercial-grade component implementation.

Non-Platform-Centric Segment

The Non-Platform-centric capabilities market includes a range of diverse capabilities encompassing man-portable, ground/transportable, ground/fixed and multiple platform segments. This area has the most opportunity for commercial-grade products, and while they support the warfighter, they do not require a ruggedized capability,

high shock or vibration specifications because of the environments they operate in. When there is a requirement for a degree of heightened environmental specifications, these can often still be met by enhanced or modified commercial-grade products.

Man-portable equipment is a harder place for non-custom components to flourish because it has higher specification requirements due to the forward battlefield environment. Good examples of where commercial products already have a high level of usage are combat support C2, logistics and information infrastructure programs. Off-the-shelf logistic software applications and RFID technologies have had a huge impact on this market over the past couple of years.

International Mil Market

Examining the market from a national perspective (Figure 5), it's very much dominated by the United States, which continues not only to spend the most on defense, but the highest portion of its budget on defense electronics. The result is that the U.S. spends far more on defense electronics than the rest of the world put together. Some 30% of the total market is dominated by the rest of the top ten leaders in the global defense expenditure list. This is unlikely to change in the coming ten years although we will see significant growth from Turkey, India and China as they push their way upward through the leadership board.

Much of this growth will come from an increased military budget, but a good portion of it will come from changes in actual spending and resource allocation from support and acquisition of traditional military platforms, weapons and hardware to an increased focus on electronic capabilities to enhance existing current and future platforms and capabilities.

The overall defense electronics market trend is one of slight growth despite competition for resources from operational funding requirements and social programs. However, amidst the large slow moving programs, pockets of growth remain with much of it driven and fulfilled by commercial technology advances and capabilities. Without major global investment in military R&D or a significant downturn in commercial R&D electronics this trend should continue over the ten-year forecast period. ▮▮

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Tech Recon

Payloads for Small UAVs

Small UAV Payloads Wrestle with SWaP Challenges

Although slower than their Large UAV counterparts to embrace standard form factor boards, Small UAV and Small UAV Payload developers are starting to look to box-level and board-level solutions that are able to meet their stringent size, weight and power requirements.

Jeff Child,
Editor-in-Chief

All branches of the DoD are investing heavily in UAV development and procurement. Within the Small UAV segment of that market the variety of platforms and volume of systems scheduled for purchase far exceeds that of medium and Large UAVs. This class of UAVs faces unique challenges as system developers cope with size, weight and power (SWaP) trade-offs while attempting to cram more functionality and autonomy into Small UAV payload systems.

In contrast to the larger classes of UAVs, Small UAVs and their payloads have been slower to embrace standard form factor boards. Backplanes crammed with VME and CompactPCI boards are well entrenched aboard platforms like the Global Hawk and Predator, but in Small UAVs the use of standard boards is far less consistent. Form factors like PC/104, COM Express and others are often used in the development phase, but few get deployed in the end product. That's beginning to change as Small UAV system developers seek to outfit UAVs with more mission autonomy and more powerful sensors. Meanwhile, complete compact box-level subsystems—often designed for a special payload function—are also having an impact in this market space.

Figure 1

An Aerosonde UAV being fitted to its car-top launch cradle.

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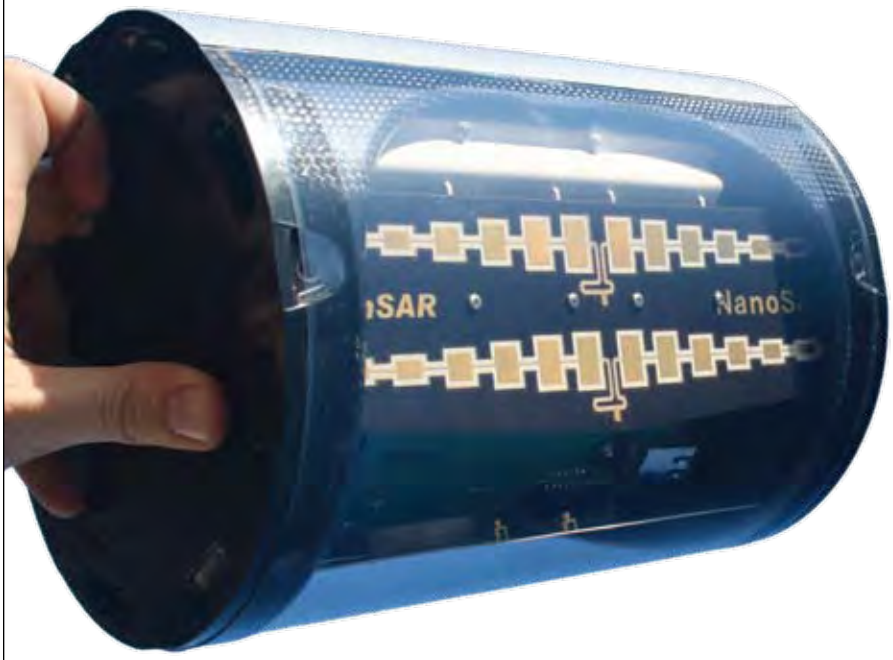

Figure 2

A NanoSAR (Synthetic Aperture Radar) sensor is shown here in a ScanEagle UAV payload bay container.

One example of a Small UAV design that relies on PC/104 technology is the Aerosonde (Figure 1), a small, low-cost UAV platform designed by a company of the same name. Aerosonde has been developing small UAVs for military, paramilitary and civilian missions for more than a decade. A typical Aerosonde payload includes a SatCom PC/104 processor card. This card applies selectable wavelet compression to images captured by the UAV's camera. The processor then adds aircraft metadata from an interface to the UAV's avionics computer, and controls data transmission between satellite and ground control station.

A recent example of a function-specific box-level payload is the NanoSAR, a Synthetic Aperture Radar (SAR) codeveloped by ImSAR and Insitu. UAV developer Insitu agreed to be purchased by its partner Boeing Integrated Defense Systems last month. Earlier this year, Boeing and its partners suc-

cessfully flight-tested NanoSAR, the world's smallest Synthetic Aperture Radar, aboard the ScanEagle UAV. During the 1.5-hour flight the ScanEagle, with ImSAR's NanoSAR payload installed, completed several passes over the target area at various altitudes and ranges. The targets included vehicles, structures and corner reflectors. Data collection on board the ScanEagle worked as planned, and SAR imagery was later created on the ground. The next step in flight testing will be to create imagery aboard the UAV in real time. The NanoSAR is a 2-pound system approximately the size of a shoebox. In contrast, the weight of standard SARs ranges from 50 to 200 pounds. Thanks to the reduction in weight, a UAV like the ScanEagle can carry both an electro-optical or infrared camera and a SAR payload at the same time.

Mobile UAV Video Capture

On the ground control side, Small UAVs have a nice advantage over their larger UAV counter-parts. Many small, tactical UAVs don't require a complete Ground Station. Usually some form of laptop system will suffice. Along just such lines is L-3 Communications VideoScout-MC, a highly portable video exploitation and management system with an integrated L/C- or L/S-band receiver to directly receive video and telemetry data from manned or UAV systems.

VideoScout-MC can receive data from L-band systems, such as the Dragon Eye, Raven and Pointer; S-band systems, including the ScanEagle and Silver Fox; and C-band systems, including the Predator, Shadow, Hunter and Litening Pod. Once the video has been received, warfighters can add "knowledge" to the captured video by annotating, extracting images, creating short clips and disseminating video anywhere across the battle space. ■■

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Tech Recon

Payloads for Small UAVs

Fabric-Based Strategy Doubles Up on UAV Payload Functions

Small UAV payloads call for very challenging size, weight and power restrictions. Fabric-based approaches like 3U VPX let military system designers double up payload functions.

Tim Klassen, Senior Engineer, Mil/Aero Products
GE Fanuc Intelligent Platforms

In recent years, the aerospace industry, particularly in the military market, has seen the proliferation of UAV in a variety of end-use applications. The applications now include everything from long range 30-hour flights at high altitude, to ultra short-range tactical vehicles launched from the shoulder. Concurrent with those advances, and in many cases preceding them, have been unmanned ground vehicles and marine vehicles. As might be expected, the demands on the payloads for these unmanned vehicles has grown exponentially in numerous ways including compute power, ruggedness, restrictions on energy dissipation, flexibility and size minimization. All of these demands tend to oppose each other, making the final solution that much more difficult. The result has been the need for novel approaches to solve the conflicting demands of this market.

Figure 1

GE Fanuc provides the electronics inside the electro-optic (EO) system aboard the Sperwer UAV, a widely used European UAV. GE Fanuc's board handles target detection and video tracking aboard the Sperwer. The Sperwer currently flying uses a relatively older product that's in a 3U VME format.

GE Fanuc provides the electronics inside the electro-optic (EO) system aboard the Sperwer UAV (Figure 1), a widely used European UAV. GE Fanuc's board handles target detection and video tracking aboard the Sperwer. The Sperwer currently flying uses a relatively older product that's in a 3U VME format.

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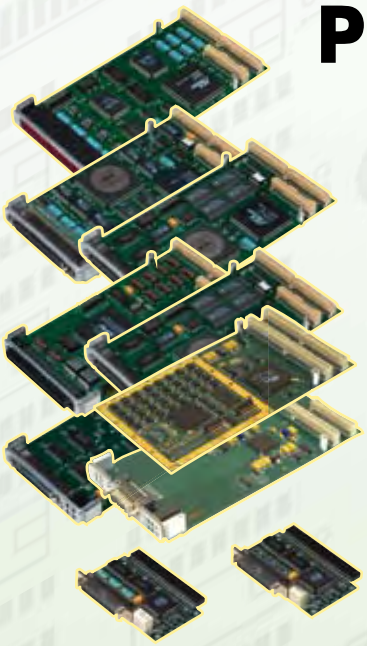

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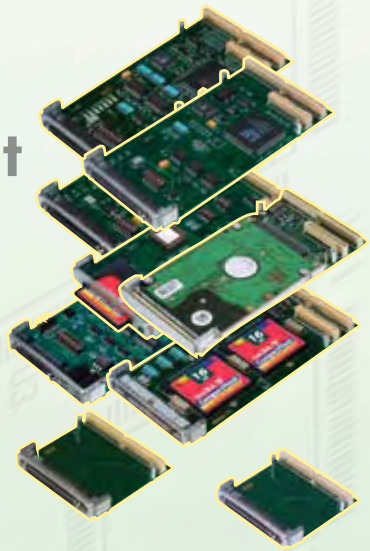

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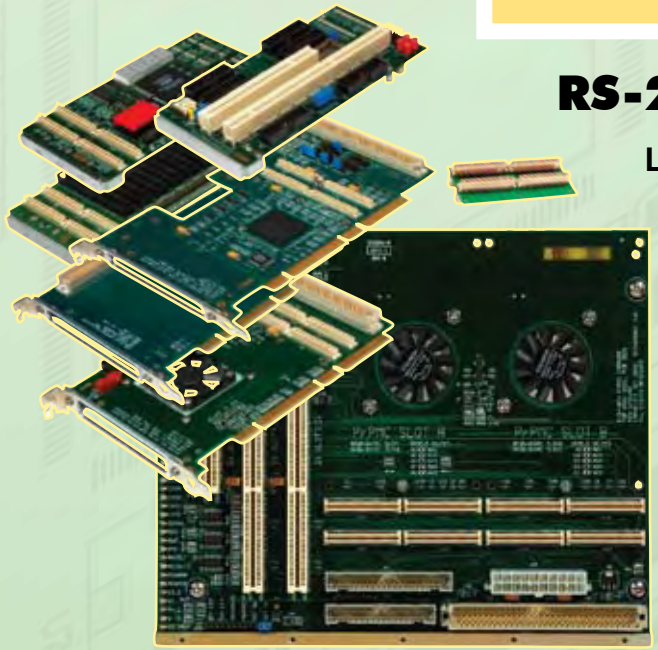

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Expansion Bus	PC/104 ISA Bus	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PCI-104 PCI Bus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
	PCI Bus Masters	4	4	4	4	4	4	4	4	4	4	4		4
	APIC (add'l PCI interrupts)	9	9	9	9	9	9	9	9	9	9	9		
CPU and BIOS	CPU Max Clock Rate (MHz)	1400	1400	1400	1400	1400	400	650	400	650	400	650	500	500
	L2 Cache (KB)	2048	2048	2048	2048	2048	256	256	256	256	256	256	128	128
	Intel SpeedStep Technology	✓	✓	✓	✓	✓								
	ACPI Power Mgmt	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0		
	Max Onboard DRAM (MB)	512	1024	1024	1024	1024	512	512	512	512	512	512	512	512
	RTD Enhanced Flash BIOS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Nonvolatile Configuration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	RTD Quick Boot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	USB Boot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Peripherals	Watchdog Timer & RTC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	ATA/IDE Disk Chip (MB)	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096	4096
	Audio		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	Analog Video	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA
	Digital Video	LVDS	LVDS	LVDS	LVDS	LVDS			TTL	TTL	LVDS	LVDS	LVDS	
	AT Keyboard/Utility Port	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PS/2 Mouse	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	USB Mouse/Keyboard	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
I/O	**RS-232/422/485 Ports**	4	4	2	4	2	2	2	2	2	2	2	2	2
	USB Ports	4	2	4	2	4	2	2	2	2	2	2	2	2
	10/100Base-T Ethernet	1	1	1	1	1	1	1	1	1	1	1	2	1
	ECP Parallel Port		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	aDIO (Advanced Digital I/O)	14	18	18	36	36	18	18	18	18	18	18	18	18
	multiPort (aDIO, ECP, FDC)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SW	ROM-DOS Installed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	DOS, Windows, Linux	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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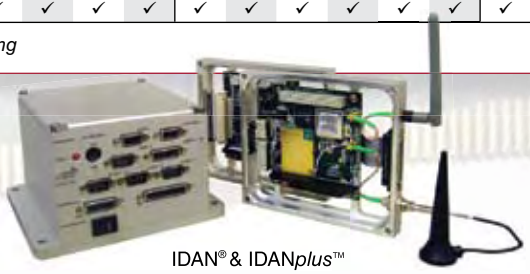

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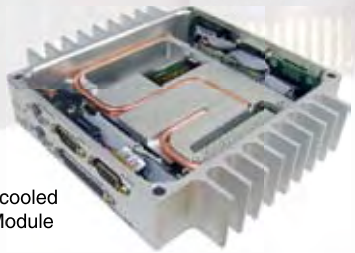

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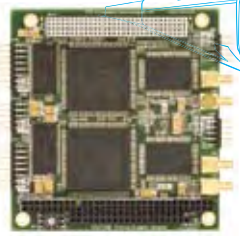

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Bus	Active Bus	PCI	PCI	ISA	ISA	PCI	PCI	PCI	PCIe	ISA	ISA	ISA	PCI	PCI	PCIe	PCI
	Passthrough Bus	ISA				ISA	ISA		PCI				ISA		PCI	ISA
	DMA or PCI Bus Master	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓
	McBSP Serial Ports	✓	✓			✓	✓	✓	✓							
Analog Input	Single-Ended Inputs	16	16	16	16	16	16	16	16							
	Differential Inputs	8	8	8	8	8	8	8	8							
	Max Throughput (KHz)	1250	1250	500	100	1250	500	500	500							
	Resolution (bits)	12	12	12	16	12	16	16	16							
	Input Ranges/Gains	3/7	3/7	3/4	1/4	3/6	3/3	3/3	3/3							
	Autonomous Calibration	✓	✓													
	Data Marker Inputs	3	3	3		3										
Conversions	**Channel-Gain Table**	1K	1K	1K	1K	1K	1K	1K	1K							
	Scan/Burst/Multi-Burst	✓	✓	✓	✓	✓	✓	✓	✓							
	A/D FIFO Buffer	8K	8K	8K	8K	8K	8K	8K	8K							
	Sample Counter	✓	✓	✓	✓	✓	✓	✓	✓							
	SyncBus	✓	✓			✓	✓	✓	✓							
Digital I/O	Total Digital I/O	16	16	16	16	16	16	16	16	48	18/9	64	48	48	48	48
	Bit Programmable I/O	8	8	8	8	8	8	8	8	24	6/0		48	48	48	✓‡
	Advanced Interrupts	2	2	2	2	2	2	2	2	2			2	2	2	✓‡
	Input FIFO Buffer	8K	8K	8K	8K	8K	8K	8K	8K							
	Versatile Memory Buffer												4M	4M	4M	8MB
	Opto-Isolated Inputs											48				
	Opto-Isolated Outputs											16				
	User Timer/Counters	3	3	2	2	3	3	3	3	3	3		10	10	10	6
	External Trigger	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓‡
	Incr. Encoders/PWMs										3/9		4/8	4/8	4/8	✓‡
Analog Out	Analog Outputs	2	2	2	2	2	2	2	2							
	Max Throughput (KHz)	200	200	200	100	200	100	100	100							
	Resolution (bits)	12	12	12	16	12	16	16	16							
	Output Ranges	4	4	3	1	4	5	5	5							
	D/A FIFO Buffer	8K	8K			8K	8K	8K	8K							

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Old Way: Piece by Piece

Solving the challenges noted above can typically be achieved effectively on a per-component basis. That is, a device to perform a task can be engineered to meet certain requirements. That's been the traditional role of the embedded computer vendor, who would typically be unaware of what the final system topography was going to be. To build a UAV payload system, a system integrator would typically contact one or more embedded computer suppliers and obtain specification data sheets.

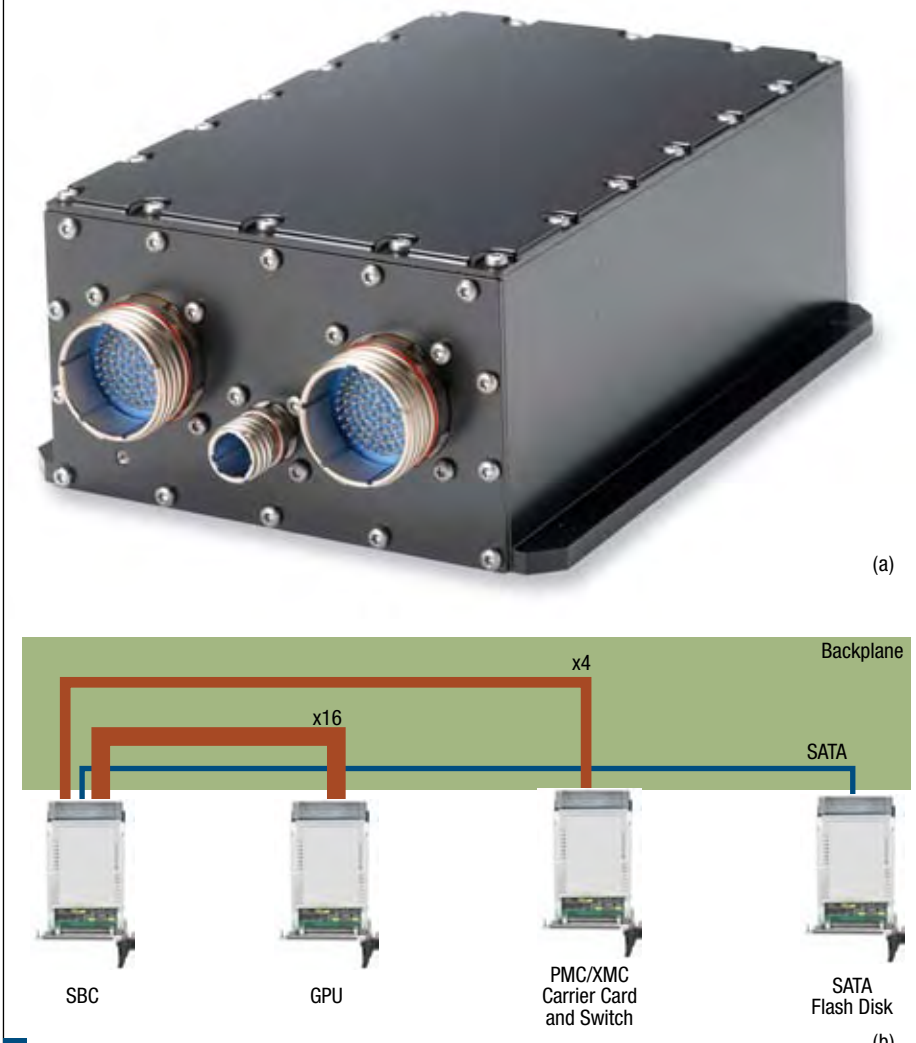


Figure 2

Selected for a UAV program in Europe, the MAGIC1 Rugged Display Computer provides a rugged enclosure (a) with a VPX backplane that can be customized for specific applications. It comes equipped (b) with a 2.16 GHz Intel Core2 Duo-based CPU connected via 16-lane PCI Express to a graphics processor designed around the NVIDIA G73 dual channel GPU.

Elements of a system would include items such as enclosures, power supplies, single board computers, I/O modules, coprocessor modules and so on. The system integrator would then select

components to meet the various system requirements, often from multiple embedded computer vendors. The system would be assembled with the embedded computer components, integrated, troubleshot and tested.

In the past, this approach typically worked well for many systems. But as the capabilities and complexity of each element in the system increased, it was not uncommon for certain nuances of a given product to make it not work correctly with other embedded computer products with which it had never been tested. For example, a graphics coprocessor from one vendor might not work with another vendor's single board computer—due to the lack of a compatible driver for the graphics device on the selected single board computer, for example.

Rugged System Design

Compatibility and interoperability are just part of the issue. Another challenge, when assembling a system of this type, is to ensure that environmental and ruggedness requirements are achieved. If products are selected from multiple sources—or even from a single vendor but on a "piece-meal" basis—there can be interactions that occur when these items are integrated together that affect the ruggedness of the overall system. For example, if a PMC with a device that runs relatively hot is connected to an SBC in such a way that a "hot" device on the SBC aligns with it, then the result may be a "hot spot" in the chassis. It is possible that the heat dissipation of the system may not be sufficient to handle this "hot spot"—even though all the elements individually have no difficulty meeting the requirements.

If anything, requirements have become even more demanding and more inherently self-contradictory—increasing compute power, for example, while minimizing size and weight—and as component interactions have become more complex, embedded computer vendors who previously only supplied components are now providing complete functional subsystems. This is especially true for UAVs, which are perhaps today's most demanding application of military computing. That's because of the stringent constraints placed on characteristics such as heat, weight and size. The design and construction of the subsystem not only leverages those vendors' intimate understanding of the constituent piece parts and the way in which they interact, it also reduces program risk while freeing the prime contractor to focus

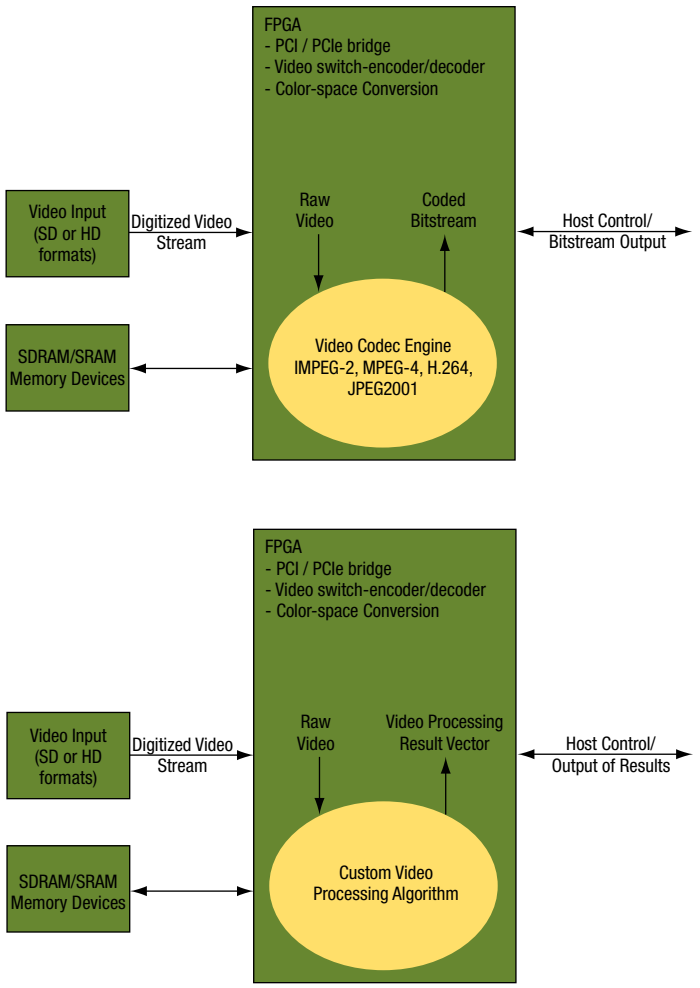


Figure 3

Many UAV programs require both a video capture and video transmission capability. In this example, the MAGIC1 was used as the basic building block, and augmented with a flexible processing module, a PMC card with an integrated FPGA and video I/O capabilities. At the top is a reconfigurable video processor with video codec load, and on the bottom is a reconfigurable video processor with custom video processing load. The fact that the identical hardware could be used made for a very desirable solution in a small UAV payload.

on higher level strategic issues and leave the connectivity, integration and testing issues to the embedded computer vendor.

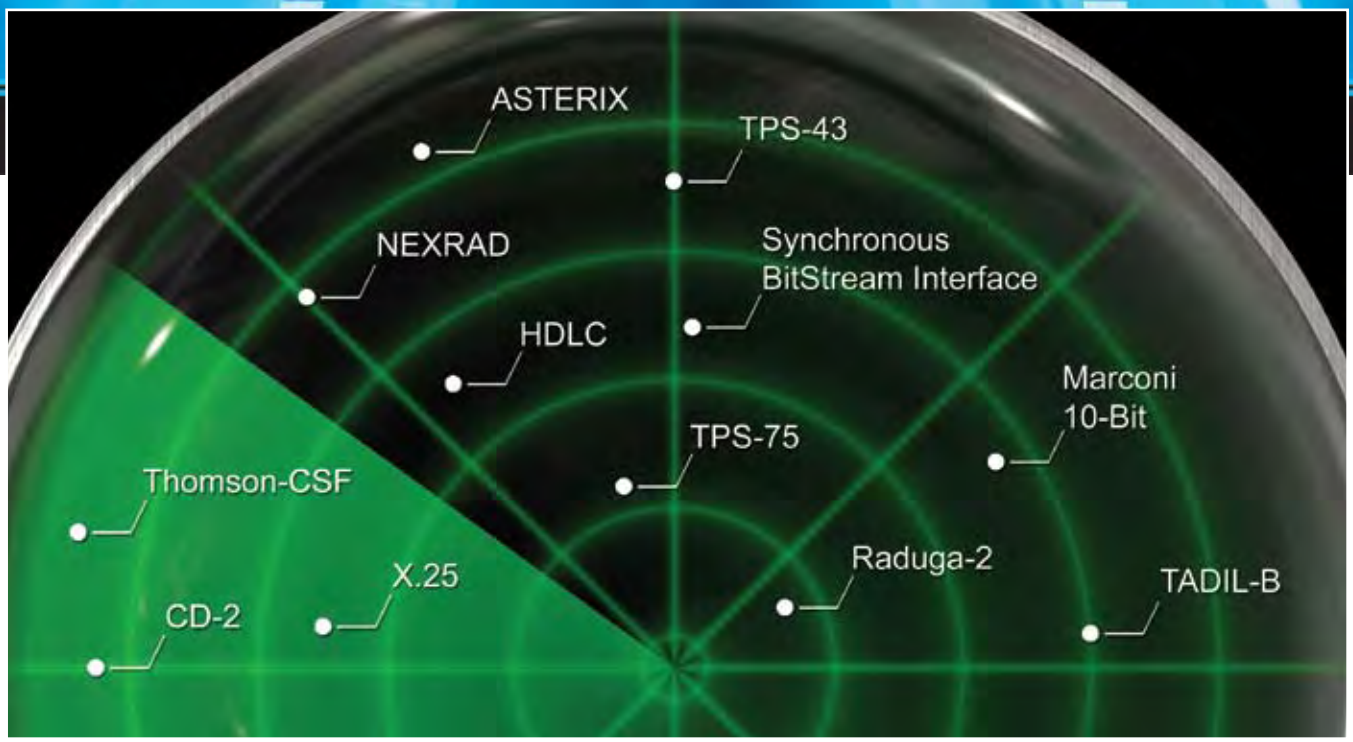
An example of how a subsystem can be specifically engineered for unmanned applications is the GE Fanuc MAGIC1 Rugged Display Computer (Figure 2a), which has been selected for a high-profile UAV program in Europe. The system provides a rugged enclosure with a VPX backplane that can be customized for specific applications. As standard, it comes equipped with a 2.16 GHz Intel Core2 Duo-based processor, connected via 16-lane PCI Express to a graphics processor designed around the NVIDIA G73 dual channel GPU—a GPU that has successfully featured in high-end PC gaming graphics cards (Figure 2b).

3U VPX for Small UAVs

The 3U VPX architecture is particularly well suited to the Small UAV market. The 3U form factor delivers the required compact footprint and low weight, while VPX is capable of delivering substantial computing horsepower. The VPX backplane connector was specifically designed to handle high-frequency serial fabric interconnect technologies such as PCI Express and Serial RapidIO. Pin density relative to VME, for example, is significantly increased while at the same time providing improved signal integrity relative to the CompactPCI architecture in its 3U form.

There's also an increase in maximum power dissipation available to a single chassis arrangement, which allows for more processing to occur in a single enclosure. While this may seem to be counterintuitive in an unmanned vehicle environment, due to the desire for minimal power dissipation, the reality is that more functionality can be achieved without needing to add a second system enclosure, power supply, heat dissipation system and so on. The overall result is very practical savings in critical elements of small unmanned vehicle payloads.

After system architecture has been selected, the choice of system components is the next critical element of the overall design. VPX may well be a desirable architecture to use, but if the selection of available processing components is severely limited, then the solution may not be viable. However, since it came to market in 2006, VPX has attracted interest and commitment from the majority of players in the military embedded computing marketplace, such that an excellent infrastructure of VPX embedded computer products now exists. This includes not



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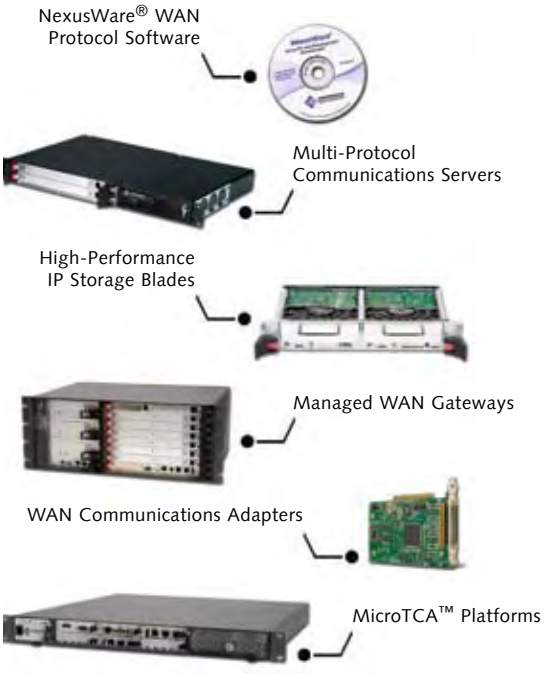

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Video Capture and Transmission

In the case of the UAV program described previously, as with many UAV programs, the requirement existed for a solution that included a video capture and transmission capability. Today, many UAV systems require some form of video data recording, and many require video transmission to a remote ground station. Some UAVs even demand onboard video and image processing technology for real-time, automated, decision-making and analysis. To achieve the required functionality, the MAGIC1 was used as the basic building block, and augmented with a flexible processing module, a PMC card with an integrated FPGA and video I/O capabilities. Each system uses two of these cards to provide the necessary processing capabilities. One card is performing a video capture, MPEG-4 compression and transmission over IP task, so that a remote viewing station can monitor the real-time video from the UAV. A second card is performing onboard custom image processing of another set of video streams for analysis and automated decision-making.

The fact that the identical hardware could be used, with only a firmware/software modification based on the application, was a very desirable solution in a small UAV payload. This provided for fewer hardware components to be managed, maintained and stocked for repairs. It also increased efficiency during system integration as there were fewer variables to consider and expertise with one piece of hardware could be applied to multiple processing elements in the system. In numerous ways, this approach helped to achieve the solution criteria of the UAV market in a way that is only possible with reconfigurable computing elements. Figure 3 shows the same reconfigurable product in two different applications for the UAV program.

The program described provides an excellent example of trends in payloads for UAVs. First, it leverages the growing capability of embedded computer vendors to create complete, functional subsystems, thus providing a valued service to the system integrator. Second, it takes advantage of leading-edge technologies—VPX, the Intel Core2 Duo processor and the NVIDIA N73 GPU—to deliver the significant computing capability demanded by current generations of unmanned vehicle. In particular, VPX in its 3U form factor allows the delivery of a high-performance solution in a small, lightweight package—something that has not previously been possible. Third, this high-performance infrastructure permits the inclusion of sophisticated applications such as video capture and analysis—supporting the growing requirement for aerial vehicles to be not only unmanned, but to be autonomous. The future for unmanned aerial vehicles looks very bright. ▮▮

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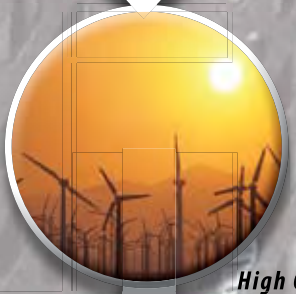

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Payloads for Small UAVs

Minimizing UAV Payloads with Ultra-Compact Computing

The increasing use of smaller unmanned aerial vehicles (UAVs) is driving developers to shrink sophisticated sensor systems.

Tom Roberts, Product Manager
Mercury Computer Systems

New generations of defense imaging systems, using sophisticated sensor technologies, generate invaluable information for modern warfare. Hyperspectral imaging (HSI) and laser radar (LADAR) will augment, but not replace, the electro-optic infrared (EO/IR) and synthetic aperture radar (SAR) sensors currently used today. The information generated by combining input from these sensors is powerful. For example, an infrared image overlaid on a radar image of a parking lot can determine which vehicles were recently used (still hot).

However, the timely use of that valuable information is impacted by bandwidth limitations in the data links that provide the transmission backbone from a sensor platform to a ground station. Current data links cannot transmit the full data streams generated by advanced sensors. Improvements in data communications will increase available bandwidth, but systems will still be overwhelmed by ever-larger information data streams from new generations of sensors. Combining multiple sensors on one platform presents even greater challenges to available bandwidth.

(a) (b)

Figure 1

Large UAVs such as the Predator (a) are capable of supporting onboard sophisticated imaging systems, however, the trend is to use increasingly smaller UAVs with reduced payload capacity like the Shadow (b). Designed for surveillance, the Shadow UAV is a tactical system designed for field operations. The system has mobile communications enabling the aircraft to be quickly launched by soldiers when needed.

Applying Computing Power

Imaging systems can address the bandwidth challenge by using computing technology to make better use of existing data-link bandwidth. Processing power co-located on a sensor platform can be used first to turn raw data into images, then for image compression, and, at the most sophisticated level, to execute image exploitation algorithms such as change detection in comparing two images. Each level requires more computing power but enables the data link to be used more efficiently to transmit useful information.

On large platforms—ships, wide-body aircraft, or ground vehicles—sophisticated imaging systems currently use onboard integrated computing engines that process the sensor data. In most cases the users, or at least the first echelon of users, are the crews

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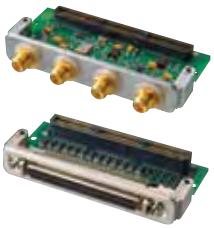

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staffing these large platforms. The users apply human intelligence to the timely analysis of the sensor-based images, supporting the effectiveness of large platforms.

In contrast, unmanned aerial vehicles (UAVs) offer a different set of significant advantages as platforms for imaging systems. UAVs can sustain very long surveillance missions without crew exhaustion. They can be constructed without any systems to support a crew and do not have to be built to fit human dimensions. And, most importantly, no lives are sacrificed if they are lost to accident or enemy action.

Early UAV implementations, such as the Global Hawk and Predator UAVs (Figure 1a), are fairly large platforms. Their size makes them capable of supporting the same types of sophisticated imaging systems as manned platforms, supported by the same types of integrated computers, transforming raw data to images. The images must, of course, be transmitted to ground stations for human analysis.

Small UAV Platforms

A parallel trend is to use increasingly smaller UAVs (Figure 1b). Defense forces always need more intelligence-gathering assets, and smaller UAVs can be deployed in great numbers, often attached directly to tactical units serving in the field. The operational trade-off is that the sensors supported by these smaller UAVs are currently limited to video cameras, which are compact, lightweight, and do not require computer processing to generate images that can be carried on available communications bandwidth.

Deploying large numbers of small UAVs generating video images is a positive step for military operations. The next step is to merge the two trends by shrinking the sophisticated sensor systems so they can be deployed on smaller UAV platforms.

One option is to just shrink the sensors and dispense with onboard computers, simply relaying the raw sensor data to ground stations for processing. However, this approach raises the communications-bandwidth challenge; data links are not able to handle the raw data stream from sophisticated sensors such as a SAR. To be truly effective, small sensor-based systems must be supported by a new generation of signal processing computers—powerful, rugged and ultra-compact.

Typical System Requirements

While needs vary across a range of Small UAV implementations, requirements for this next generation of ultra-compact computing can be summarized as follows:

Greater than 100 GFLOPS: Systems can be implemented with less than 100 GFLOPS of processing power, but image-exploitation algorithms, such as change

detection, geo-registration, or automatic target recognition demand that level of processing or more.

Less than 10 pounds: There is a widely deployed tactical category of smaller UAVs with a total payload capacity ranging from 60 to 200 lbs. In a general sense, it is reasonable to allocate up to 10 lbs. of that payload capacity to computing, but not much more.

Significantly smaller than half-ATR form factor: The ATR system for standardized electronics packaging evolved to meet the needs of deployment in manned aircraft. New generations of UAVs are not built to fit human dimensions, so it is not surprising that the ATR form factor, even in its half-ATR short form, is simply too big.

A range of I/O protocols: An embedded computing system that is processing sensor input must be flexible enough to support multiple types of sensors. Sensor payloads can change from one type to another, or use multiple types within one payload.

Flexible, networked configurations of sensor systems: To gain maximum effectiveness from multiple UAV deployments, computing solutions must be network-centric, capable of moving imagery information in a dynamic fashion using minimal bandwidth from one intelligent node to another. For example, overlaying images from different sensors can happen a lot more quickly, and easily, when all the sensors and the image processing computers are connected on a network.

Rugged enough to withstand difficult environmental conditions: Defense electronics systems must perform in harsh environmental conditions, including excessive heat, humidity, poor air quality, high altitude, shock and vibration. These embedded computers must not overheat, even when temperatures range up to 55°C and the air is too thin to be used for cooling. At the same time, they must possess the mechanical integrity to withstand high shock and vibration forces.

A general trend that's aided the drive for reducing the size and weight of UAV-based embedded computing systems is a move toward stand-alone rugged boxes. Embedded board vendors are adding stand-alone rugged box-level systems to their military market offerings. These complete system boxes—which often support standard form factor boards inside them—provide a complete, tested and enclosed computing solution that eliminates complex integration chores for customers. Currently there's about a dozen or more vendors that have some sort of stand-alone rugged box-level system in their offerings—many even have whole product lines in that category.

Figure 2

Suited for Small UAV payload implementations, the PowerBlock 50 is an ultra-compact embedded computer enclosed into a package measuring only 4.1 x 5.3 x 5.8 inches and weighing less than 7 pounds. It has 6 slots for processing or SATA storage modules and delivers up to 172 GFLOPS of processing power.

An example along those lines is the PowerBlock 50 from Mercury Computer Systems. This fully integrated ultra-compact embedded computer has 6 slots for processing or SATA storage modules, interconnected by a high-bandwidth PCI Express switch fabric. Processing cards include P.A. Semi PA6T-1682M, PowerQUICC III and Intel processors, and Xilinx Virtex-4 FPGAs, with a maximum processing performance of up to 172 GFLOPS per system.

This unit is enclosed into a package measuring only 4.1 x 5.3 x 5.8 inches (105 x 134 x 148 mm) and weighing less than 7 pounds (Figure 2). The chassis is designed throughout to isolate its internal electronics from all external environmental and physical conditions, enabling deployments in harsh environments. Rugged features include o-ring sealing for pressure, humidity and EMI isolation, high-reliability connectors, extended temperature ranges, and locking modules for shock and vibration immunity Each processing card can be mated with a dedicated I/O daughtercard into a single module, enabling, for example, a direct interface to an FPGA for real-time I/O processing. ■■

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System Development

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FPGA Computing Solutions Help Radar Systems Keep Pace

Today's military radar systems continue to demand more frequency range and bandwidth. To keep pace, FPGA-based solutions provide a blend of flexibility and performance not possible using general-purpose processors.

Martin Hassack, Senior Engineer
TEK Microsystems

Modern radar systems are operating over an ever increasing frequency range. Advances in analog conversion technology—both A/D and D/A converters—have lead to systems becoming highly frequency-agile. That in turn is boosting demand for radar receiver systems with a high instantaneous bandwidth. An increase in the instantaneous bandwidth of a system is coupled with a corresponding increase in compute power required to process the received data streams.

A processing architecture based on general-purpose processors would struggle to meet the processing requirements of modern embedded military radar systems, given the associated size, weight and power constraints. Conversely, an ASIC-based approach could achieve the performance, but is inhibited by lack of flexibility and prohibitive engineering investment. An approach based on FPGA technology provides the necessary high-density processing capabilities, with significant advantages in size, weight and power over general-purpose processors along with the benefits of unrivaled flexibility. This flexibility is delivered through their re-configurability, the diverse range of communications interfaces they offer

Figure 1

Navy's MH-60R multi-mission helicopter is fitted with a Lockheed Martin AN/ALQ-210 Electronic Support Measures (ESM) system. Electronic warfare systems include the ATK AN/AAR-47 missile warner, laser warning system, BAE Systems AN/ALQ-144 infrared jammer and BAE Systems AN/ALE-39 chaff and flare decoy dispenser.

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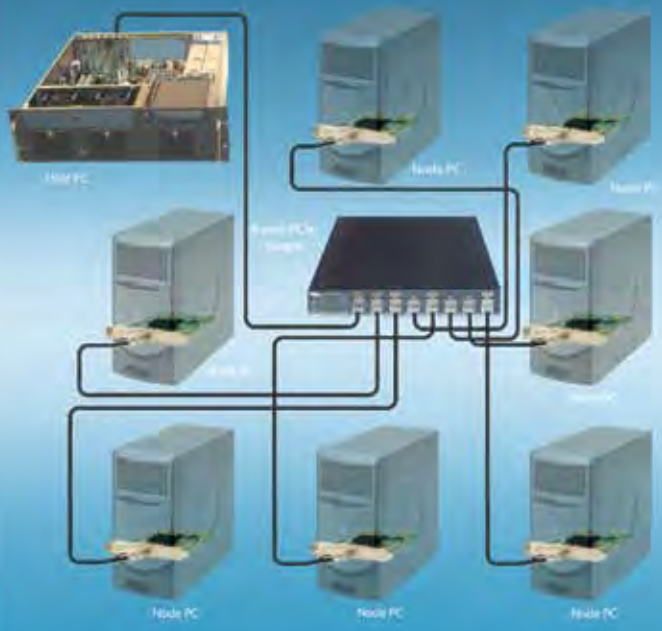

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and the range of IP cores available for modern devices.

Described here is an FPGA-based, two-channel radar receiver front end. The system has an instantaneous bandwidth of 2.2 GHz and implements two independent signal detection channels, as would typically be implemented in an Electronic Support Measures (ESM) system. The digitized data streams along with the output from the signal detection blocks are available for further processing—such as down conversion, direction finding, and so on—or streaming via a wide range of communication protocols. An example ESM system is the Radar Warning Receiver (RWR)/Electronic Support Measures (ESM) systems derived from the Lockheed Martin AN/ALQ-210 system, which is to be deployed on the U.S. Navy's MH-60R multi-mission naval helicopters (Figure 1).

Two-Channel Radar Receiver

Figure 2 shows an example architecture of a radar receiver front-end system. It highlights the key functional blocks within the system, partitioning of the design for an efficient FPGA-based implementation, and interfaces to input/output (I/O) and memory peripherals. The system is designed to be placed directly following an analog down conversion stage. Therefore, the system has an input bandwidth of 2.2 GHz, centered on DC.

The two A/D channels, both operating at 2.2 GHz, are used to carry out In-phase and Quad-phase (IQ) sampling in order to generate a complex data stream. A/D data is fed via an onboard demultiplexor chip to the A/D interface within the receiver channel FPGAs. The A/D interface highlighted in Figure 1 carries out further demultiplexing and synchronization of the A/D data streams. Each of the data streams is then replicated and passed across to the neighboring receiver channel FPGA such that each receiver channel can operate entirely independently.

A buffering stage is implemented for each of the channels to allow a user-

Network-Enabled FPGAs

While FPGA technology offers dramatic improvements in processing density compared to general-purpose processors, there are still challenges in integrating FPGA devices into a larger system with traditional processors acting as controllers. One approach is to use the FPGA's inherent flexibility to implement a Gbit Ethernet network endpoint, allowing the system to be viewed as a network-centric architecture of loosely coupled processing elements.

A set of firmware and software building blocks can be used to integrate Gbit Ethernet connectivity into an FPGA device. The combination of an IP core in the FPGA and a software library in the control processor creates a network-based connection between the application software in the host and the application firmware in the FPGA. The application can take advantage of both memory-mapped Remote DMA (RDMA) semantics for control and status functions as well as FIFO streaming semantics for data transfers through a host-resident set of API calls.

In a typical system, each FPGA has a network endpoint with a physical Gbit Ethernet connection through either a front panel copper or fiber interface or using the VITA 41.6 Gigabit Ethernet control plane. Network connectivity can also be managed through the VXS fabric or as a bridge from another FPGA device depending on the system topology.

To the host computer, the network-enabled FPGA resources are simply accessed as IP devices, isolating the application from the details of the system interconnections and creating an inherently scalable control plane for a heterogeneous embedded processing system that combines FPGAs and general-purpose processors.

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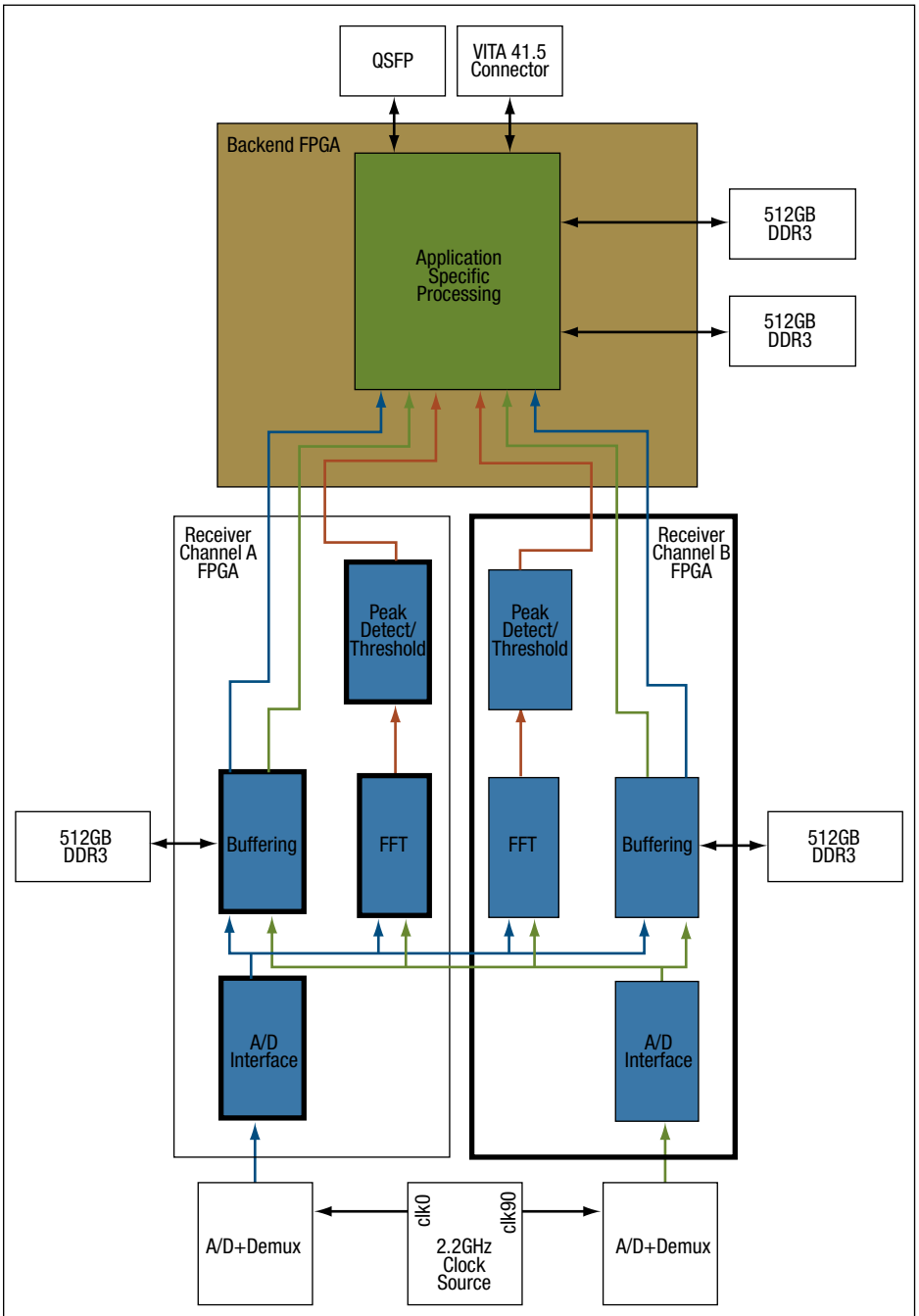

Figure 2

This example architecture of an FPGA-based radar receiver front-end system highlights the key functional blocks within the system. The system is designed to be placed directly following an analog down conversion stage. Consequently, the system has an input bandwidth of 2.2 GHz, centered on DC.

configurable amount of pre-triggering and to provide compensation for the Fast Fourier Transform (FFT) and peak detection/threshold latencies. A bank of DDR3 memory is configured as a circular buffer and data is continually streamed to memory and read back subject to a delay corresponding to the detection latency and user-defined amount of pre-triggering.

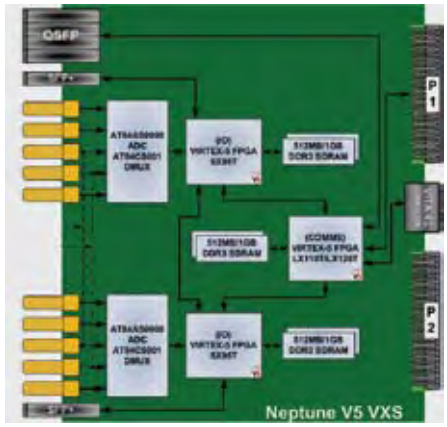

Figure 3

The QuiXilica Neptune-V5 VXS FPGA digitizer board provides two 10-bit 2.2 Gsample/s ADC channels, three Xilinx Virtex-5 FPGAs, DDR3 memory and high-speed serial I/O via front panel and backplane connections within an ANSI/VITA 41-compliant VME/VXS form factor.

FFT for Signal Detection

The signal detection mechanism is implemented using a high-performance FFT and a peak detection/threshold operation. The FFT core accepts the complex data stream at the A/D sample rate and generates a frequency domain representation of the data stream. The FFT can be configured at run time to operate in 1K, 2K or 4K point modes, allowing frequency resolution to be traded for a faster detection response. The FFT also allows a user-definable set of FFT window coefficients to be used, allowing its operation to be tailored to specific requirements.

The output from the FFT is fed directly into a peak detection and threshold block. This block will determine the FFT bin with maximum energy present and determine whether it exceeds the user-configurable detection threshold. Receive channels can independently have FFT bins excluded from the detection processing, thus enabling each channel to independently handle different regions of the overall bandwidth. Once a detection has been made, the FFT bin is flagged as being active; this active FFT bin is maintained until the energy returns below the detection threshold.

All configuration and control data is transferred to the processing hardware via a Gigabit Ethernet interface. This includes data such as FFT window coefficients, peak detection settings, detection threshold level and pre-trigger level. See sidebar "Network-Enabled FPGAs."

Back-End Processing

The data stream along with the output from the detection logic is collectively passed over to the back-end FPGA where application-specific back-end processing can be carried out on the two independent receive data streams. Examples of possible operations include high-bandwidth streaming over backplane, digital down conversion, direction finding or radar target recognition.

TEK Microsystems' QuiXilica Neptune-V5 VXS FPGA digitizer (Figure 3a and 3b) is one example of a high-performance data acquisition and signal processing hardware platform, which is well suited to the radar receiver system described earlier. This hardware platform provides two 10-bit 2.2 Gsample/s ADC channels, three Xilinx Virtex-5 FPGAs, DDR3 memory and high-speed serial I/O via front panel and backplane connections within an ANSI/VITA 41-compliant VME/VXS form factor.

The ANSI/VITA 41 VXS form factor builds on the traditional VME specification, increasing power supply and cooling capabilities along with providing backplane support for high-speed serial protocols such as Aurora, Gbit Ethernet and PCI Express. The Neptune-V5 digitizer is optionally available in ruggedized convection and conduction-cooled versions, making it deployable in a wide range of operating environments, ranging from benign laboratory to harsh UAV conditions. VXS systems are also highly scalable, allowing numerous cards to co-exist within a single chassis with high-bandwidth serial I/O available to/from the cards.

How the FPGAs are Used

The baseline specification of the digitizer hardware uses Xilinx Virtex-5 SX95T devices for the two front-end FPGA sites and a Xilinx Virtex-5 LX110T for the third "back-end" FPGA site. Build options are available that can further enhance the capabilities of the hardware, for example, an SX240T device can populate the back-end FPGA site to offer more extensive DSP capabilities.

A comprehensive developer's kit consisting of a range of IP cores accompanies the digitizer hardware in order to simplify the use of the onboard I/O and memory peripherals. This kit includes cores such as DDR3, ADC and QuiXtream Gigabit Ethernet interface cores.

The architecture of the radar receiver example described earlier directly maps onto the architecture of the digitizer considered above. The two FPGA receiver channel designs naturally align themselves with the two SX95T devices. Each of these devices has two banks of DDR3 memory to perform the buffering and high-bandwidth interconnections to neighboring FPGA devices to allow data transfer. The signal detection FFT is performed using a 4K Fast FFT core. When configured in 4K point mode, this core performs over 500,000 4096 point FFTs per second with a frequency bin spacing of approximately 500 kHz. The third FPGA is devoted to performing the back-end application-specific processing, which can take advantage of further banks of DDR3 along with QSFP and VITA41 high-speed serial I/O for data streaming.

The FPGA implementation of a two-channel radar receiver front end described here could be easily scaled to multiple sets of channels. It uses state-of-the-art A/D, FPGA and memory technology in order to implement a processing engine that exceeds the performance of a system many times its size, weight and power consumption. And this performance is achieved with all the benefits of a flexible and reconfigurable underlying architecture based on open standard off-the-shelf products. ▮▮

TEK Microsystems
Chelmsford, MA.
(978) 244-9200.
[www.tekmicro.com].

Technology Focus

Data Acquisition Boards

Data Acq Boards Ride the USB and FPGA Waves

Data acquisition has undergone a transformative revamping in both deployed military subsystems and system test labs. FPGAs, USB and PCI Express are fueling this revolution.

Jeff Child,
Editor-in-Chief

The role of the data acquisition subsystems at the heart of military applications—like radar, sonar, SIGINT and broadband comms—remains the same. They still capture, digitize and then move data onward for storage or processing. What's changed is that today's data acquisition systems are tasked to do all that at ever-higher speeds and wider bandwidths. That's the case at both low-end test lab data acquisition and in high-end deployed data acquisition systems.

At the lower-end of data acquisition, military projects are benefiting from the invasion of Universal Serial Bus (USB) into the realm of data acquisition. USB brings a blend of high performance, ease-of-use and high integration to data acquisition. That means fairly sophisticated test systems measuring temperature, vibration and other factors can be implemented on a desktop controlled by a PC rather than requiring a rack of A/D and controller boards.

Also, by leveraging the bandwidth and performance of USB 2.0 technology, data acquisition applications can do bidirectional high-speed transfer of data between the USB device and a computer. This "signal streaming" approach makes it possible to acquire and generate multiple analog and digital I/O signals simultaneously. The products compiled in the next couple of pages reflect both those trends of FPGAs enhancing high-end deployed data acquisition and the mainstream data acquisition world being transformed by the migration to USB.

Meanwhile, data converters used in high-end military applications, such as defense communications and radar systems, must operate at ever-increasing speeds and higher resolutions. As a result, the digital domain is encroaching on the antenna or sensor array. As this happens, military system designers face serious challenges when trying to move signal data in ever-increasing volumes. Behind all that are the twin trends toward higher sensor performance and the inclination to tie more sensors together into wider arrays. An example along those lines is the next-generation E-2D Advanced Hawkeye aircraft, which features a new radar system and multisensor integration (Figure 1).

Figure 1

An example program that applies sophisticated FPGA processing for data acquisition and recording is the E-2D Advanced Hawkeye. The data recording and playback systems for the E-2D can scale up to dozens of modular, heterogeneous I/O channels and FPGA-based protocol engines to support the demands of the aircraft's next-generation radar system.

To accommodate those demands, makers of high-end data acquisition boards and subsystems are designing the latest analog-to-digital converter (ADC) technology into system architectures designed to avoid bottlenecks at the back-end data movement phase. If one trend stands out in that scenario, it's the increasing use of FPGAs. More and more of these board architectures are embracing FPGAs as a means to efficiently channel digitized data as it's propelled to where it needs to go. Moving the analog to digital conversion closer to the front end is priority number one for applications such as radar, beamforming, electronic warfare and electronics counter measures. The sooner they get into the digital domain, the better such systems can operate in noisier environments.

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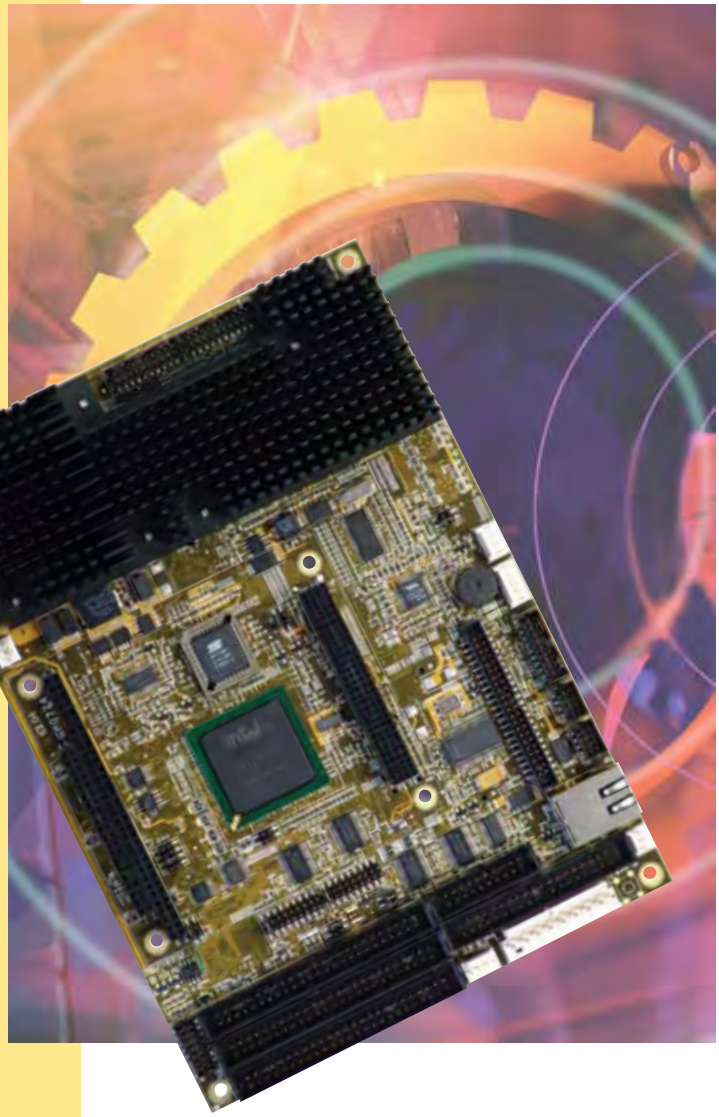

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Technology Focus:

Data Acquisition Boards Roundup

USB Analog Input Modules Are Software Selectable

USB has earned its way into the mindshare of military data acquisition system designers. ACCES I/O's latest offering in the USB analog input module space is its USB-AI Series. This line of 12 and 16-bit USB modules starts with its flagship model, the USB-AI16-16A. This high-speed USB 2.0, 16-bit multifunction analog input board is ideal for precision measurement, analysis, monitoring and control in a variety of military embedded applications. The USB-AI16-16A can sample inputs at speeds up to 500 kHz for the board's 16 single-ended or 8 differential analog input channels. Standard features in the USB-AI Series include 16 digital I/O lines and a 16-bit counter/timer. The USB-AI Series includes five models (USB-AI16-16A, USB-AI16-16E, USB-AI12-16A, USB-AI12-16 and USB-AI12-16E). A unique channel-by-channel programmable gain feature enables measurement of an assortment of large and small signals in one scan—all under software control at up to 500 kHz.

The USB-AI Series was designed to be used in rugged industrial environments, but is small enough to fit nicely onto any desk or testing station. The boards measure just 3.550 by 3.775 inches and ship inside a steel powder-coated enclosure with an anti-skid bottom. The USB-AI Series can be integrated into any PCI-104 or PC/104 stack by connecting it to a USB 2.0 port usually included on board with embedded CPU form factors such as EBX, EPIC and PC/104—especially important since many newer CPU chipsets do not support ISA and have plenty of USB ports. Prices range from $339 to $639.

ACCES I/O Products
San Diego, CA.
(858) 550-9559.
[www.accesio.com].

USB Digital Multimeter Is Paperback-Sized

The move toward small, compact USB-based data acquisition gear has had a revolutionary impact on military data acquisition. The ability to bring complex measurement gear in the field opens up a wide range of new options. Agilent Technologies offers a USB modular digital multimeter (DMM) roughly the size of a paperback book. The 5.5-digit U2741A DMM is the latest member of Agilent's USB modular instruments family. These compact instruments make it possible to carry two or three pieces of powerful test equipment in a briefcase alongside a laptop PC. The U2741A offers fast, 100 Samples/s measurements and maximum input levels of 300 VDC and 2A. It provides a broad range of essential features and 10 measurement functions: DC voltage and DC current; true-RMS AC voltage and AC current; two- and four-wire resistance; frequency; diode test; continuity; and temperature. The bundled Agilent Measurement Manager software provides a familiar user interface on a laptop or desktop PC.

The chassis also supports Agilent's line of USB data acquisition (DAQ) devices, which includes U2600A digital input/output modules, U2300A multi-function DAQ modules and U2500A simultaneous-sampling DAQ modules. These can be used alongside the USB modular instruments within the chassis. The Agilent U2741A USB modular DMM is priced at $1,040 and is available now.

Agilent Technologies
Palo Alto, CA.
(650) 752-5000.
[www.agilent.com].

cPCI/PXI Storage Unit Supports JBOD, RAID and SATA

Many aerospace and defense system developers need to capture and store vast amounts of data for high-speed data acquisition, digital signal processing, radar and sonar, telemetry and high-resolution video recording. Conduant offers the Big River DM-425-3U Storage Unit—a compact subsystem that plugs directly into a PXI or CompactPCI chassis and provides up to one terabyte of disk storage capacity, in a very small enclosure. Configurations are available for both legacy PXI and CompactPCI as well as the new PCI Express-based versions. With the DM-425-3U, a broad range of high-speed storage applications may be designed around a standard PXI/CPCI chassis.

When ordered with the onboard PCI Express SATA controller, the DM-425-3U integrates with major operating systems to provide additional storage capacity in JBOD or software RAID configurations. When ordered with the external multilane SATA connector, the DM-425-3U can be used with the Conduant StreamStor PXI-808 Disk Controller Card for high-speed recording without requiring an external chassis to hold the disk drives. The DM-425-3U is designed for use in a PXI / CPCI 3U chassis with variations available for both PCI Express and legacy PCI-based architectures. The storage unit is also available with solid-state disk drives in capacities up to 512 Gbytes. Base pricing for the Big River DM-425-3U starts at $1,380.

Conduant
Longmont, CO.
(303) 485-2721.
[www.conduant.com].

USB Data Acq Board Ready for System Duty

Today's military system designer is using USB not just for stand-alone plug-and-play data acquisition, but also in system configurations. Data Translation's latest offering is an OEM version of its popular DT9812-10V low-cost USB module. The DT9812-10V-OEM is the newest addition to the company's ECONseries of low-priced modules and provides two, 20-pin connectors to accommodate all I/O signals without an enclosure. This allows the user to embed this low-cost board into their own system.

Key features of the DT9812-10V-OEM include 8 analog inputs, 2 analog outputs, 16 digital I/O (8 in/8 out) and one 32-bit counter timer. The card supports independent subsystem operation at throughput rates up to 50 kHz. A signal range of +/- 10V is supported on both the analog input and analog output. The product can generate sine, rectangle, triangle, or DC waveforms with the analog outputs and offers 12-bit resolution for both the analog input and analog output subsystems.

The DT9812-10V-OEM ships with a full complement of software to get you up and running quickly. You can develop your software in .NET, Visual Basic, Visual C#, Visual C++, Visual J#, or you can use one of our ready-to-measure applications. Measure Foundry application builder can be used to create powerful test and measurement applications without writing any code. The DT9812-10V-OEM is priced at $349 and is shipping now.

Data Translation
Marlboro, MA.
(508) 481-3700.
[www.datx.com].

Digital I/O Board Duo Migrates to PCI Express

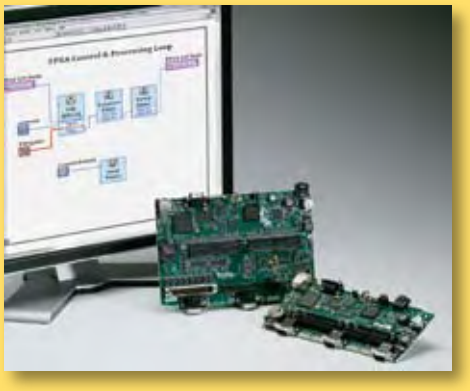
Desktop computing technologies such as PCI Express have enabled military test system developers to implement systems that once took racks of boards, in a compact desktop PCI Express-based system. In keeping with that trend, Measurement Computing has expanded their digital I/O offerings with the release of PCI Express versions of its two most popular PCI boards. The PCI Express-based products offer enhanced functionality while maintaining software and connector compatibility, allowing for seamless migration of existing applications to next-generation computer platforms. The PCIe-DIO24 features 24 channels of digital I/O with selectable 3.3V and 5V logic levels. The high-density PCIe-DIO96H offers 96 channels of 5V-compatible digital I/O with high drive capability (64 mA sink, 15 mA source). Both boards offer software-selectable pull-up and pull-down resistor configurations.

The PCIe-DIO24 and PCIe-DIO96H ship with an impressive array of software, including TracerDAQ, a full-featured, data logging, viewing and analysis application; Universal Library, programming libraries and drivers for most popular Windows-based programming languages; Universal Library for LabVIEW, VIs and program examples for LabVIEW; and InstaCal installation, calibration and test utility—powerful software solutions for programmers and nonprogrammers alike. The PCIe-DIO24 and PCIe-DIO96H operate under Microsoft Windows 2000/XP/Vista (32) operating systems. Pricing for the PCIe-DIO24 starts at $199. Pricing for the PCIe-DIO96H starts at $349.

Measurement Computing
Norton, MA.
(508) 946-5100.
[www.measurementcomputing.com].

FPGA Cards Enable Reconfigurable I/O

One way that today's military system designers are exploiting FPGAs is by using them to create reconfigurable I/O systems for data acquisition. Serving exactly such needs, National Instruments offers a family of single-board reconfigurable I/O devices that offers engineers and scientists a low-cost, integrated hardware option for deploying embedded control and data acquisition applications. The eight new sbRIO-96xx devices combine an embedded real-time processor, reconfigurable FPGA and analog and digital I/O on a single printed circuit board (PCB), making them ideal for applications that require flexibility, high performance and reliability in a small form factor. Engineers and scientists can use the NI LabVIEW graphical system design platform to customize NI Single-Board RIO hardware as well as develop all aspects of their embedded systems for increased productivity and shorter time-to-market.



NI Single-Board RIO devices feature an industrial 266 MHz or 400 MHz Freescale MPC5200 processor built on Power Architecture technology, the Wind River VxWorks real-time operating system (RTOS) and Xilinx Spartan-3 FPGA. The onboard analog and digital I/O connects directly to the FPGA to provide low-level customization of timing and I/O signal processing. The devices offer an operating temperature of -20° to 55°C for use in thermally rugged applications as well as an integrated 19 to 30 VDC power supply input and real-time clock with battery backup for increased reliability.

National Instruments
Austin, TX.
(888) 280-7645.
[www.ni.com].

Board Blends Quad 200 MHz, 16-bit ADCs, Dual FPGAs

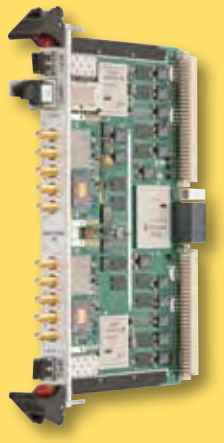
Gone are the days when mezzanine cards could only acquire analog data, passing the digital processing function onto the main VME processor board. Today, powerful FPGA-based processing can be performed right on the mezzanine. Along just such lines, Pentek's Model 7150 High Speed Data Converter features four 200 MHz, 16-bit A/Ds and a pair of high-performance Xilinx Virtex-5 FPGAs. The 7150 connects directly to the RF or IF inputs of a communications system, delivering the industry's highest resolution A/Ds and enhanced processing power in a single PMC/XMC module.

The Pentek 7150 stands apart from competing products on the market because its unique architecture combines the faster and higher precision DSP slices in the two Xilinx Virtex-5 FPGAs with four 200 MHz, 16-bit A/D converters offering increased resolution and wider signal bandwidths. This combination is ideal for anyone seeking to detect very small signals across a wide range of frequencies. Connected to the main processing FPGA are three banks of DDR2 Synchronous DRAM. Compared to previous designs, the 7150 doubles the amount of synchronous DRAM to a total of 1.5 Gbytes, supporting real-time capture of 2.56 seconds of data sampled at 200 MHz. The 7150 is designed to the PMC/XMC standard allowing it to mount on VME/VXS host boards. In addition, the board is available in other form factors including PCI and PCIe for use in desk top computers and blade servers, and 3U and 6U compact PCI. Initially, the 7150 will be delivered with a PCI-X interface, with a PCIe option available later this year.

Pentek
Upper Saddle River, NJ.
(201) 818-5900.
[www.pentek.com].

VXS Board Offers Six 160 MS/s ADC Channels

High-density processing is the watch word for military designers developing advanced signal generation solutions in applications such as radar, electronic warfare and mobile communications. For just such applications, TEK Microsystems has announced the new Tarvos VXS, the first VXS product to combine six channels of 16-bit, 160 Msample/s analog to digital conversion with FPGA-based DSP processing technology in a single slot along with a single digital to analog conversion output channel.



In a ANSI/VITA 41.0 VXS Payload card form factor, the board's analog to digital converters are linked into a Xilinx FPGA equipped with an advanced double data rate SDRAM memory architecture with a capacity of up to 5 Gbytes on a single card. FPGA also supports high-speed off-board communications through two front panel high-speed serial ports or eight high-speed serial links over the VXS standard P0 connector onto the backplane using protocols such as Gigabit Ethernet, VITA 55 / Aurora, Serial RapidIO, Serial FPDP, etc., programmable via firmware. The Tarvos VXS is available now and pricing starts at $19,900 for single unit quantities.

TEK Microsystems
Chelmsford, MA.
(978) 244-9200.
[www.tekmicro.com].

XMC Does 1.5 GSPS A/D Conversion

A blend of high-speed analog input and high-performance FPGA processing is ideal for demanding real-time applications such as Electronic Warfare (EW), Electronic Counter Measures (ECM), Radar and Telecommunications. Feeding those needs, VMETRO offers an improved analog performance high-speed analog input XMC module with the latest generation Xilinx Virtex-5 FPGA. The AD1520 is a dual channel 1.5 Gsample/s ADC XMC/PMC module. The analog input of the AD1520 utilizes a National Semiconductor ADC08D1520 8-bit converter that is directly connected to either a Virtex-5 SX95T, LX110T or LX155T FPGA back-end.

The AD1520 board shows typical performance characteristics of 7.4 ENOB, 61 dBc SFDR and 47 db SNR at 373 MHz. The full power input bandwidth extends to beyond 2 GHz. All of these metrics improve upon the AD1500 and across the input spectrum. The AD1520 has LVPECL trigger input and output connections along with sample clock input and general-purpose I/Os on the front panel. This connectivity allows the AD1520 to be operated in a range of modes, including multiboard synchronous sampling. Off-board data links are provided through either PCI-X/PCI via the PMC connectors or high-speed, multi-Gbit/s Virtex-5 RocketIO transceivers using the XMC connectors. The AD1520 is available in XMC and PMC form factors, for air- and conduction-cooled environments.

VMETRO
Houston, TX.
(281) 584-0728.
[www.vmetro.com].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Products

Editor's Note:
This product was mistakenly omitted from September's ***PXI, VXI and LXI Boards Roundup*** *section. We apologize for the oversight.*

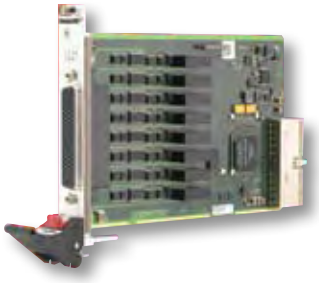
PXI Controller Boasts 2.53 GHz Core 2 Duo CPU

Long test cycles can be costly—and with pressure on the defense industry to reign in costs and development timelines, any test gear that speeds up test time is a welcome investment. With just that in mind, National Instruments rolled out their NI PXI-8108 last month. The PXI embedded controller board features an Intel Core 2 Duo T9400 processor and is designed for high-performance PXI and CompactPCI systems. With its 2.53 GHz dual-core processor and 800 MHz DDR2 memory, the PXI-8108 offers a 25 percent performance improvement over its dual-core predecessor, the NI PXI-8106, and a two times performance improvement over its single-core predecessor, the NI PXI-8196.

With NI LabVIEW 8.6 software, engineers and scientists can take full advantage of the latest multicore controllers, such as the PXI-8108, by simplifying multithreaded application development and achieving increased performance without requiring major changes to existing LabVIEW code. For engineers requiring maximum performance and reliability, the NI PXI-8108 controller can be upgraded to include a 32 Gbyte PXI solid-state hard drive instead of the standard rotating magnetic disk drive. The PXI-8108 paired with the solid-state hard drive offers an extended operating temperature range of 0° to 55°C, increased reliability and speed when reading and writing to files and streaming data and increased durability when exposed to shock and vibration due to no moving parts. Pricing for the NI PXI-8108 starts at $4,499.

National Instruments, Austin, TX. (512) 683-0100. [www.ni.com].

3U cPCI Board Provides Eight Channels of Serial I/O



CompactPCI—and particularly the 3U version of cPCI—is no longer an outsider looking in when it comes to the military market. It's proven itself and is here to stay. MEN Micro's latest 3U cPCI offering is a single-slot, 3U CompactPCI I/O board with eight 16550D-compatible UARTs. With the physical layers integrated on the board, each channel on the new F216 can be individually configured as single-end RS-232 or as differential RS-422 or RS-485 for added system flexibility. Each channel also has its own 500V isolation to decrease interference between channels.

The F216 provides exceptionally high data transfer rates of up to 921,600 bits/s as well as a 60-byte transmit and receive buffer, making the board useful in systems with large FIFO requirements. The operating temperature of -40° to +85°C enables the F216's use in rugged mobile applications. Although each port is available on a single front panel 78-pin D-Sub connector, an adapter cable can spread the connector to eight standard 9-pin D-Sub connectors, further increasing system flexibility. Pricing for the F216 is $733 per unit.

MEN Micro, Ambler, PA. (215) 542-9575. [www.menmicro.com].

1553 and ARINC 429 Climb Aboard AMC

Everyone's been on the lookout for signs that AMC and MicroTCA make sense for the military. Adding one more step in AMC's favor, vendors are beginning to roll out Mil/Aero-specific functions on the AMC form factor. Case in point is Data Device Corp.'s introduction of a new Multi-I/O 1553/429 AMC card that provides up to four dual redundant MIL-STD-1553 channels operating in BC, RT, MT, or RT/MT modes, eight ARINC 429 receive channels, four ARINC 429 transmit channels, six user programmable Digital Discrete I/Os, two RS-232 Serial I/O channels, two RS-422/485 Serial I/O channels and an IRIG-B time synchronization input.

The BU-65590A AMC card provides a unique solution by combining multiple protocols on one card, saving valuable space, power and weight in a MicroTCA or ATCA system. These features make it ideal for use in navy applications, flight data recorders, ground vehicles, and other embedded systems that require an AMC card. The card has a PCI-E back-end interface and provides front panel I/O using a rugged micro-miniature D connector. An intelligent hardware offload engine provides extremely low host CPU utilization while storing 1553 Monitor data in a convenient IRIG-106 Chapter 10 format.

Data Device Corp., Bohemia, NY.
(631) 567-5600. [www.ddc-web.com].

PC/104 Express 1 Gbit Ethernet Card with Four Ports

The military was slow to embrace switched fabrics, but to embrace advanced computing technology fabrics like PCI Express comes with the territory. PCI Express (PCIe) is used more and more in the military embedded systems market. The new Microspace MSM4E104EX PC/104-Express extension card from Digital-Logic now offers four ports on a 1G Ethernet card for applications in data servers and Ethernet video cameras. The compact card is based on the PEX8505, a PCIe switch IC, which has five ports/five lanes, cut-through architecture with low latency of 138ns and low power consumption of 0.8W. For fast network connectivity the MSM4E104EX contains four Intel 82573L PCIe 1 Gbyte LAN controllers, which are connected over the PCIe switch to the PCI/104-Express bus using one lane.

Network access takes place via four RJ-45 ports. Drivers are available for Windows and Linux. The card requires a 5V/3.3V power supply and operates within the standard temperature range of -25° to +70°C (1 Gbyte). On request, it is also available for an extended operating temperature range from -40° to +70°C. For shipments of 100 units or more, the MSM4E104EX is priced starting at $415.

Digital-Logic, Luterbach, Switzerland. +41 (0)32/ 681 58 40. [www.digitallogic.ch].

Software Radio PMC Duo Ramps Performance and Density

A core tenant of Software Radio is the ability to mix and match a variety of waveforms on one platform. Pentek takes that concept further by making its radio module PMCs capable of changing functionality by swapping in different IP core sets. A family of rugged software radio modules with two FPGA IP cores can be installed on Pentek's recently introduced Model 7141 Dual Channel 125 MHz 14-bit A/D and 500 MHz 16-bit D/A Transceiver. Because the IP cores are pre-installed, the end user is completely free from any FPGA development tasks. The 7141-420 and 7141-430 with GateFlow cores from Pentek are the first modules in a new family and transform the 7141 into two distinct and highly integrated products addressing a diverse range of applications.

The 7141-420 FPGA installed core with dual wideband DDC and interpolation extends the bandwidth range of both the digital up converters (DUCs) and digital down converters (DDCs) from very narrow to very wide. These modules are also available in a variety of form factors, including PCI, 3U and 6U cPCI, as well as a conduction-cooled PMC version. Linux and VxWorks drivers are available for the 7141-420. Pricing for the Model 7141-420 begins at $12,995, and for the Model 7141-430 at $11,995.

Pentek, Upper Saddle River, NJ. (201) 818-5904. [www.pentek.com].

Multi-Function 3U cPCI Card Adds ARINC 429/575 and More

The multi-function board trend has swept across the embedded system market, and military system designers are reaping the benefits. North Atlantic Industries (NAI) has announced an upgrade to the functionality of its single-slot, 2-module, multi-function, 3U cPCI card. This universal card eliminates the complexity and size constraints of using multiple, independent, single-function cards. The 75C2 is ideally suited for military and commercial programs, including airborne, shipboard, ground mobile and C3I applications. Its interchangeable modules increase functional density and reduce power consumption, size and cost of the overall system.

The 75C2 can accommodate up to two independent function modules. ARINC 429/575 (6-channels), RS-422/485/232 (4-channnels), D/S Converter (3-channels) and Reference Generator functions have recently been added to its library of available modules.

Other available function modules include Synchro/Resolver Measurement (4-channels), LVDT Measurement (4-channels), A/D (10-channels), D/A (10-channels), Discrete I/O (16-channels), TTL I/O (16-channels), Transceiver I/O (11-channels) and RTD (6-channels). The interchangeable multi-function design of the 75C2 provides extensive diagnostics and is available in both commercial temperature range and severe environment, industrial temperature range. The 75C2 is available with operating temperature ranges of -40° to +85°C and 0 to +70°C. Conduction-cooled versions with wedgelocks are also available. Pricing for 100 pieces starts at $1,995.

North Atlantic Industries, Bohemia, NY. (631) 567-1100. [www.naii.com].

FPGA-Based XMC Card Exceeds 300 GMACs/s

XMC has become the de facto upgrade path for the venerable and popular PMC mezzanine. The X5-GSPS from Innovative Integration is an XMC I/O module that serves up the National Semiconductor 1.5 GSPS ADC08D1500 dual-channel, 8-bit A/Ds connected to a Virtex5 FPGA computing core, DRAM and SRAM memory plus an eight lane PCI Express host interface. A Xilinx Virtex5 SX95T with 512 Mbyte DDR2 DRAM and 4 Mbyte QDR-II memory provides a very high-performance DSP core for demanding applications such as emerging wireless standards. The close integration of the analog I/O, memory and host interface with the FPGA enables real-time signal processing at extremely high rates exceeding 300 GMACs per second.

The X5-GSPS provides engineers a turnkey, modular solution suited to radio-frequency demodulation applications or other wideband analog signal capture applications. IP blocks available from Innovative can be embedded within the FPGA to perform digital down-conversion and decoding, unburdening the host of this computationally intensive processing function. The X5 XMC modules couple Innovative's Velocia architecture with a high-performance, 8-lane PCI Express interface that provides over 1 Gbyte/s sustained transfer rates to the host. Quantity one pricing for the X5-GSPS is $9,995.

Innovative Integrations, Simi Valley, CA. (805) 578-4261. [www.innovative-dsp.com].

MicroTCA Chassis Boasts Cooling, Full Redundancy

MicroTCA has a greater than even chance of gaining wide acceptance in the military market. Elma Electronic's newest offering is a MicroTCA enclosure that's fully redundant and features high-performance cooling. The Blu!Box is a 19-inch rackmount system in a 5U height. It is compliant to the MicroTCA.0 core specification. With redundancy throughout, the chassis features two MCH, two Power Modules and two high-performance EMMC cooling units. All of the modules/components are hot swappable and controlled via IPMI (Intelligent Platform Management Interface). The cooling units feature five each high-performance fans and have PWM (Pulse Width Modulation) control. The chassis holds up to 10 full size AMCs in the single module format.

The backplane for the Blu!Box offers a Dual Star topology in 22 layers. It has been optimized for high-speed routing via signal integrity studies. Other features include redundant FRU (Field Replaceable Unit) information devices and carrier locaters. Pricing for the MicroTCA Blu!Box is under $4,000 depending on volume and configuration options.

Elma Electronic, Fremont, CA. (510) 656-3400. [www.elma.com].

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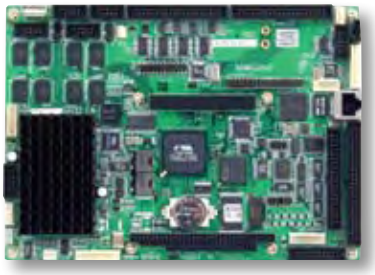


EBX SBC Family Gets Enhanced Temp Versions

The non-backplane segment of SBCs, EBX form factor for example, is rapidly gaining interest in the military market. That's because complete systems are now doable without the added volume and weight of a backplane. Four new members of the Hercules II EBX single board computer family from Diamond Systems offer enhanced temperature ranges, which are below the extended temperature ranges but lower in cost. The HRC800-5N512 model offers 512 Mbytes of RAM without data acquisition. Three more new Hercules II models are available with an enhanced temperature range of -20° to 70°C as compared to the extended operating temperature range of -40° to 85°C on the current Hercules II products.

Hercules II is an EBX form factor (5.75 x 8 inches or 146 x 203 mm) SBC integrating a Pentium III-level CPU with data acquisition and a DC/DC power supply on a single board. Hercules II uses a low-power 800 MHz VIA Mark CoreFusion processor with either 256 Mbyte or 512 Mbyte RAM and a broad set of system I/O. Hercules II data acquisition section includes 32 16-bit analog inputs with a 250 KHz sample rate and a 2 Ksample FIFO along with four 12-bit analog output channels. For models with data acquisition, prices start under $800. Without data acquisition, prices start at $500. Volume discounts are available.

Diamond Systems, Mountain View, CA. (650) 810-2500. [www.diamondsystems.com].

Instrument Family Does High-Accuracy Temp Measurement

Military test and measurement gear used to require large racks of backplane-based boards. Now the same functionality can be implemented on the desktop. Data Translations feeds that trend with a series of temperature measurement instruments that starts with an 8-channel entry-level version that can be easily extended to 16, 24, 32, 40, or 48 channels over time. This modularity allows customers to upgrade their system as needed while keeping their entry-level costs low. The TEMPpoint instruments are stand-alone boxes offering 8 to 48 separate 24-bit resolution inputs, each with its own A/D converter and CJC circuit, providing the ultimate in accurate temperature measurement. Thermocouple or RTD versions are available, as well as a USB or Ethernet (LXI) port for connecting to a PC.

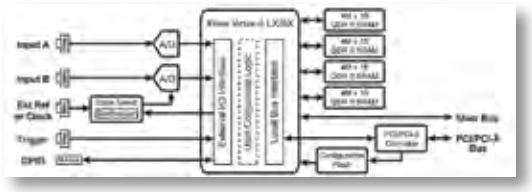
Key design features include up to 48 dedicated 24-bit A/D converters for ultimate resolution along with up to 48 dedicated CJC circuits that guarantee ultra-high (+/-0.01%) accuracy. The instruments also feature 1000V Channel-to-Channel galvanic isolation for superior signal protection with anytime auto-calibration. The units come in a compact, rugged 2U rack-mountable enclosure. Pricing for TEMPpoint ranges from $2,995 to $8,495 depending on number of channels (8-48), sensor input type (Thermocouple or RTD) and interface to PC (USB or Ethernet).

Data Translation, Marlboro, MA.
(508) 481-3700. [www.datatranslation.com].

PMC-X ADC Card Features AC- or DC- Coupled Links

Military signal processing applications inevitably require some degree of customization. Serving such needs is Red Rapid's Channel Accelerator Plus 14/400, a dual-channel receiver from Red Rapids based on the Texas Instruments ADS5474 A/D converter. The sample clock is supplied by an onboard frequency synthesizer or an external source. The frequency synthesizer can be phase locked to the local 10 MHz TCXO, or an external reference can be used to achieve system-wide phase coherence.

The analog inputs can be either AC or DC coupled to the A/D converters. The AC coupled configuration supports direct IF sampling (bandpass sampling) beyond the first Nyquist zone.



The FPGA can be selected from the Virtex-4 high-performance logic (LX) or signal processing (SX) platforms. A variety of size and speed grade options are offered to further optimize the price/performance ratio over a wide range of applications. The SX-55 device includes 512 DSP slices for math-intensive applications. A DMA FPGA core provided with the product manages data transfers between the Channel Accelerator and host memory. The DMA engine allows the transceiver to automatically initiate a PCI/PCI-X burst transaction when data is available. DMA chaining and scatter-gather techniques are supported by both the hardware and software to optimize data transfer efficiency.

Red Rapids, Richardson, TX. (972) 671-9570. [www.redrapids.com].

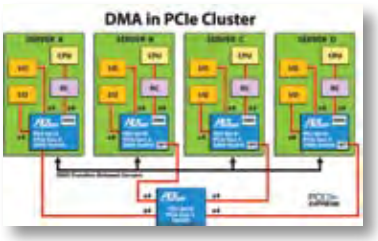
3U cPCI SBC Packs in Performance with PowerQUICC III

The military's focus on networking and Ethernet continues to ramp. Feeding such needs, the CSBX3545 from Actis Computer boasts Freescale's MPC8545E next-generation PowerQUICC III processor, which integrates the enhanced e500 PowerPC core and advanced features such as DDR2 memory controller with full ECC support, Dual Gigabit Ethernet, Dual PCI, single x4 PCI Express, double precision floating point APU and integrated Security Engine. This processor is rated at 2765 Mips at 1.2 GHz. An on-chip Security Engine (SEC) is designed to off-load computationally intensive security functions, such as key generation and exchange, authentication and bulk encryption from the processor core.

The CSBX-3545 offers a variety of onboard I/O including two Gigabit Ethernet ports, two asynchronous RS-232 ports, one I2C bus and five user general-purpose I/Os. All these ports are accessible on the rear J2 connector. A Cyclone II FPGA device is implemented to provide hardware computing resources for user-defined functionality. It is interfaced with the processor local bus and is connected to dedicated SDRAM memory. It is available in several densities and speed grades. Thirty-five I/Os are connected to the CompactPCI J2 connector. Memory features include up to 1 Gbyte DDR SRAM, 1 Gbyte NAND flash and 8 Mbyte boot flash.

Actis Computer, Tempe, AZ. (480) 838-1799. [www.actis-computer.com].

Gen2 PCI Express Switches Include Integrated DMA Controller



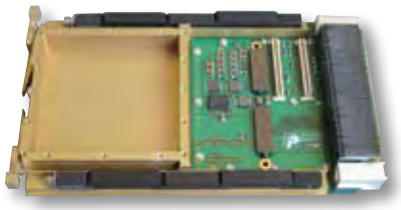
Three new PCIe switch devices feature an architecture that provides an integrated direct memory access (DMA) engine. Each switch provides four DMA channels to support the high data rates required in storage systems, servers, networking, control plane and embedded markets. By offloading the DMA function typically required of the processor, the DMA-capable switches from PLX Technology increase system performance and create a wide range of new options for next-generation PCIe designs.

The ExpressLane PEX 8619 (16 lanes, 16 ports), PEX 8615 (12 lanes, 12 ports) and PEX 8609 (8 lanes, 8 ports) PCIe Gen 2-compliant switches offer flexible and configurable ports ranging from x1 to x4 on all three devices, with up to x8 on the PEX 8619. The four DMA channels can support high-speed data transfers between I/O devices connected to any of the available ports, while maintaining independence from the unique transparent switch functionality with up to 3 Gbit/ss throughput per DMA channel. Additional features include a low latency maximum of 140ns and power requirements down to 1.2W typical (8609), with quality of service (QoS) by means of two virtual channels (VCs) per port, spread spectrum clock (SSC) isolation via dual clock domains, and end-to-end guaranteed data integrity.

The DMA engine in these devices implements a descriptor ring approach, while each of the four DMA channels can saturate a x8 link at Gen 2 speeds (up to 4 Gbytes/s) in one direction. Each descriptor provides support for large transfer sizes (up to 128 Mbytes) giving the user the ability to perform very large data transfers in any direction (memory to device, device to device, memory to memory). Descriptors can exist in host memory or, alternatively, inside the DMA switch. Up to 256 descriptors are supported internally in PLX DMA switches, which also support 32-bit and 64-bit transfers as well as programmable QoS. The PEX 8619, PEX 8615 and PEX 8609 volume prices are $28.55, $22.25 and $14.25, respectively.

PLX Technology, Sunnyvale, CA.
(415) 222-9996. [www.plxtech.com].

VPX XMC Carrier Board Is Conduction-Cooled



The ecosystem for VPX is fleshing out as more and more vendors roll out products based on this military-oriented form factor. For its part, PCI Systems has announced a new VPX Conduction-Cooled XMC carrier, enabling accelerated development of rugged conduction-cooled embedded systems. Several customized versions for VITA 46 and VITA 48 are available. The carrier has a separate +/- 12V, 150 mA DC to DC converter on board. VPX versions are available with a PCI Express bus implementation on the backplane, having 8 lanes per slot and a 64-lane switch, therefore allowing up to 7 add-on slots and a CPU slot for very high bandwidth computing applications.

The 3U VPX XMC Carrier is a rugged conduction-cooled single-slot 3U VPX XMC Carrier that can connect one XMC module to a standard VPX backplane using PCI Express 1x 8-lane or 2x 4-lane configurations. A XMC module can therefore have two PCI Express chips on board without using an additional switch on the XMC board.

PCI Systems, Laurel, MD. (301) 362-1233. [www.pcisystems.com].

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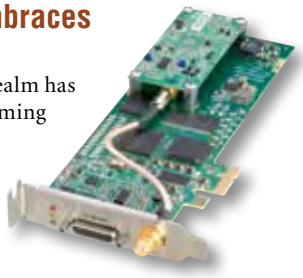
AMC Does High-Density Serial Comms at Extended Temps

Product offerings in the AMC form factor continue to expand, particularly in the area of aerospace/defense communications. TEWS Technologies announced the TAMC863, a new synchronous/asynchronous serial AMC module with four high-speed communication channels. The serial communication controller is implemented in FPGA logic, combined with the bus master capable PCI interface. It guarantees long-term availability with the option to implement additional application specific-functions for customers. The TAMC863 is designed for data communications, LAN/WAN networking, traffic control, simulation and telecommunications applications.

Several serial communication protocols are supported by each channel, such as asynchronous, isochronous, synchronous and HDLC mode. In addition, a maximum data rate of 10 Mbits/s is provided for synchronous protocols and 2 Mbits/s is supported for asynchronous protocols. Multiprotocol transceivers are used for the line interface. In order to reduce CPU overhead and increase data rates for critical applications, the TAMC863 features a receive and transmit FIFO of 512 long words (32 bit) per channel. Data transfer on the PCI bus is handled via TAMC863-initiated DMA cycles with minimum host/CPU intervention. In addition, several interrupt sources can generate interrupts on INTA for each channel, and interrupts may be enabled or disabled separately.

TEWS Technologies, Halstenbek, Germany. +49 (0)4101 4058-35. [www.tews.com].

Time Code Processor Card Embraces PCI Express



Everything in the military computing realm has made its trek over to switch fabrics. And timing processors are no exception. Spectracom announces the availability of a new feature-rich bus-level timing card for the PCI Express standard. The product, TSync-PCIe Time Code Processor, represents the state-of-the-art timing card for synchronizing critical operations in embedded computing systems for industries such as aerospace, defense and industrial automation. The new time code processor is based on Spectracom's new time synchronization platform that offers the most flexibility including the ability to add features in the field from future development and changes in user deployment.

The TSync-PCIe offers the most capability of any timing card for PCI express in the low-profile form factor. The card comes with a comprehensive set of standard features to allow users to read and generate time codes, program timing and frequency signals, and time-stamp events with greater flexibility than ever before. The card has the ability to read multiple prioritized time codes, generate multiple time codes and other synchronization outputs, and time tag multiple signals at a maximum rate over 50,000 events per second. Synchronization to GPS is available via an onboard or remote GPS receiver.

Spectracom, Rochester, NY.
(585) 321-5800. [www.spectracomcorp.com].

PCI-104 SSD Storage Adapter Offers RAID Features

Solid-State drives are rapidly usurping more and more military applications where once only rotating disk drives had sufficient capacity. The LT-PCI-104-CF from Lauron Technologies is a high-performance PCI-104 32-bit, 33 MHz, 4 channel SSD RAID adapter supporting data rates of up to 120 Mbytes/s. The module adopts the PC/104 stacking architecture offering embedded designs a compact Solid-State Storage device. This single-slot adapter is available in 2 to 64 Gbyte capacities and is populated with only the fastest, most reliable SLC Compact Flash modules available today. Since the adapter houses all SSD memory, the LT-PCI-104-CF provides the perfect single card solution for non-rotating media requirements.

The unit has an MTBF that is greater than 1,000,000 hours provided by built-in EDC/ECC and Wear Leveling algorithms. The endurance is phenomenal with Erase/Write Cycles greater than 1,000,000, with an extended version that offers 2,000,000 Erase/Write Cycles. The benefit of the Built-in flash SSD controller/bridge is that it supports Ultra DMA modes, which yield data transfers at speeds of up to 133 Mbytes/s per channel. The unit supports RAID 0, RAID 1, RAID 0+1, RAID 5 or JBOD. Stripping modes transfers data to all four channels simultaneously while mirror modes transfers data on both channels.

Lauron Technologies, Naples FL.
(239) 431-6237. [www.laurontech.com].

XMC Enables High-Speed Sensor I/O for Real-Time DSP

It's hard to express the magnitude by which today's FPGA technology has revolutionized the implementation of real-time DSP applications. VMETRO offers a new-generation user-programmable FPGA XMC/PMC module with fiber-optic transceivers. The XMC-FPGA05F incorporates the Xilinx Virtex-5 FPGA with four front panel, fiber-optic transceivers in air- or conduction-cooled versions. The popularity of high-speed serial interconnects in embedded real-time DSP systems and the effectiveness of FPGAs to interface to sensor I/O makes the XMC-FPGA05F ideal for demanding real-time applications such as remote sensor interfaces, data recorders and embedded real-time distributed computing.

The XMC-FPGA05F features a Xilinx Virtex-5 FPGA, high-speed fiber-optic transceivers, DDR2 SDRAM memory, DMA controllers and a choice of interfaces. The XMC-FPGA05F supports the Virtex-5 SX95T and LX155T FPGAs in the FF1136 package. Alternative FPGAs can be provided on request. Fiber-optic links are enabled by four single- or multi-mode, front panel, fiber-optic transceivers that support speeds including 2.015, 2.5 and 3.125 Gbits/s. An IP core for fiber-optic protocols such as Aurora, Serial FPDP, Serial RapidIO or Ethernet can be loaded into the FPGA to handle data flow through the transceivers. The XMC-FPGA05F has four 128 Mbytes banks of DDR2 SDRAM memory with bandwidth approaching 1 Gbyte/s.

VMETRO, Houston, TX. (281) 584-0728. [www.vmetro.com].

3U VPX Card Delivers Rugged FPGA Computing

High-end FPGA computing is a vital ingredient for system developers of deployable radar, signals intelligence, or software radio systems. Feeding exactly those needs, Curtiss-Wright Controls Embedded Computing has announced the availability of the VPX3-450, its first Xilinx Virtex-5 FPGA-based 3U VPX (VITA 46/48) compute engine. The VPX3-450 combines the flexibility of a Xilinx Virtex-5 FPGA (LX110T or SX95T) and the high-performance general processing of a Freescale 8640 Power Architecture processor with VPX's support for high-bandwidth serial switched fabrics such as PCI Express and Serial RapidIO (SRIO).

The computing power of the Virtex-5 FPGA is complemented by a balanced mix of memory and I/O. Attached directly to the FPGA is one bank of DDR2 SDRAM and two banks of QDR-II+ SRAM. Two 4-lane high-speed serial ports to the backplane and an additional port to the XMC site provide a total of 7.5 Gbyte/s bandwidth into and out of the FPGA in addition to the primary 4-lane PCI Express link to the onboard fabric. The VPX3-450 is designed to operate in rugged environments and is available in air- and conduction-cooled formats. Innovative cooling techniques are employed to handle high-performance FPGA implementations. Pricing for the VPX3-450 starts at $12,850. Availability is Q1 2009.

Curtiss-Wright Controls Embedded Computing, Leesburg, VA.
(703) 779-7800. [www.cwcembedded.com].

SpaceWire 4-Port Router Targets Aerospace Apps

Originally developed by the European Space Community, SpaceWire is a standard governing serial communication between nodes. The protocol is self-managing and provides a high-speed, low-power serial interface while offering a simple, low-overhead user interface. The standard supports data rates of 2 Mbits/s to 400 Mbits/s over 10 meters of cable. Aeroflex Colorado Springs has developed a SpaceWire 4-Port Router, the UT200SpW4RTR, to satisfy SpaceWire networking and fault-tolerant networking requirements for the aerospace community.

The UT200SpW4RTR 4-port router has a system interface port for 5 total ports, data rates up to 200 Mbits/s on all four SpaceWire ports and is compliant to Standard ECSS-E50-12A. Power supply core is 2.5V with 3.3V I/O with a host (FIFO) clock frequency of 50 MHz. Radiation performance is targeted at 100 krad(Si); packaging is a 255-lead CLGA. QML Q and V qualification is planned. The UT200SpWRTR is priced at $5,725 in QML Q lots of 100. Prototypes are available 1Q09 with production units 2Q09.

Aeroflex Colorado Springs, Colorado Springs, CO.
(719) 594-8035. [www.aeroflex.com/SpaceWire].

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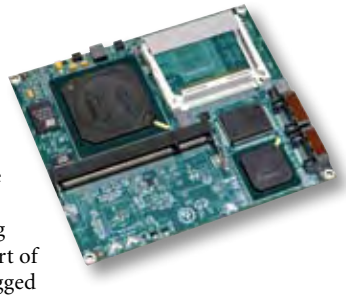
Rugged Fiber-to-USB Converter Does Optical Isolation

USB has opened up a whole new world of performance for military embedded PC applications. Blending that with a fiber link sweetens the deal. Electro Standards Laboratories has announced the Model 4165, a ruggedized Fiber-to-USB interface converter. With its integrated rate buffering, the Model 4165 converts USB 2.0-compliant data from a standard PC to a serial asynchronous data interface over fiber with a user-selectable baud rate of up to 3 Mbits/s.

Model 4165 is ideal for PC communications requiring high speed, secure communications and optical isolation. Applications include constructing an optically isolated point-to-point communication link between the USB ports of two PCs, or an optically isolated high-speed communication link between a PC and a serial data network subjected to a high EMI environment that might corrupt the communication over a copper interface. The Model 4165 features ESD protection circuitry on the USB I/O connector. The converter is available as the Model 4166 board only with front-mounting threaded brackets for rack mounting in embedded applications. It is also available in a desktop package with DIN rail mounting hardware for applications that require an enclosure.

Electro Standards Laboratories, Cranston, RI. (401) 943-1164. [www.electrostandards.com].

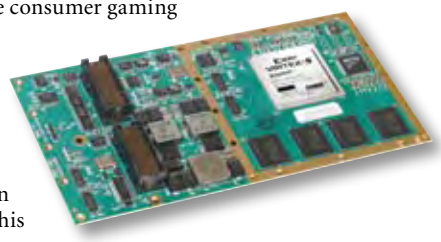
Geode LX 800-based ETX Card Meets Rugged Needs



COM Express—in its many variations—is proliferating to become the new face of modular computing. ADLINK Technology's newest offering along those lines is the ETX 620, as part of an initiative to extend its Extreme Rugged product lines. ETX 620 brings the proven design methodology of the high-end ETX 802 to harsh environments where lower processing performance is required. ETX 802 has exceeded expectations under battlefield conditions in Iraq. ETX 620 features the low-power AMD Geode LX 800 processor and CS5536 companion chip. ETX 620 is designed for extreme rugged environments, able to operate over temperature extremes of -40° to +85°C, vibrations up to 15 Grms and shock up to 50 Grms. With processor speed of 500 MHz and memory support for up to 1 Gbyte of DDR RAM, the ETX 620 fills the price/performance void beneath the ETX 802 module. ETX 620 contains all of the PC-compatible subsystems without the I/O connectors themselves. ETX 620 I/O includes (2) Serial ATA (SATA) ports, (4) USB 2.0 ports, Intel 10/100 Ethernet, (1) UDMA IDE interface, (2) Serial RS-232 ports, Floppy, Keyboard/Mouse and AC '97 Audio. Prices start in the $200s for the ETX 620 in production quantities.

ADLINK, Irvine, CA. (949) 423-2354. [www.adlinktech.com].

XMC Serves Up Obsolescence-Proof GPU

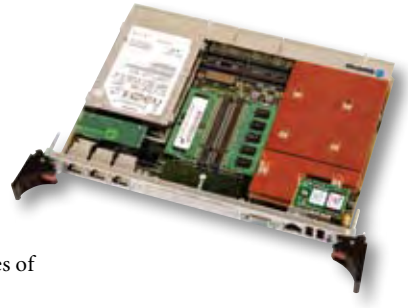


Subject to the whims of the consumer gaming market, graphics processing technology suffers some the worst obsolescence problems. Quantum3D announced the availability of its Sentiris AV1, an XMC it claims as the first to offer an obsolescence-proof design. This is accomplished by leveraging a FPGA-based video- and graphics-processing core instead of the traditional approach of using dedicated graphics processing units (GPUs), which are rapidly made obsolete by end-of-life (EOL) announcements.

The Sentiris AV1 XMC was conceived to address the ongoing needs of high safety- and security-critical applications such as primary flight instrumentation and multi-level security (MLS) systems. Certifiable to DO-178B for software and DO-254 for hardware, Sentiris AV1 is the first Sentiris AV1 built using a groundbreaking design approach. The company's approach is different from traditional GPUs, however, in that it has fully DO-254-certifiable firmware rather than the traditional approach of obtaining a hardware waiver based on a statistical time test. Sentiris AV1 offers 512 Mbytes of ECC-protected DDR2 memory, dual RGB and dual HD-SDI outputs and eight lanes of PCI Express. The product comes standard as a conduction-cooled XMC. The company is currently accepting orders for Sentiris AV1, starting at $9,980.

Quantum3D, San Jose, CA. (408) 361-9999. [www.quantum3d.com].

45nm Dual Core Intel CPU Climbs Aboard cPCI



Gone are the days when only pure performance mattered in a military embedded computer. Today performance-per-watt is the watchword. With just that in mind, Kontron's CP6016 is a 6U CompactPCI SBC based on the high-performance and low-power 45nm Intel Core2 Duo processor T9400. Designed for densely packed, thermally constrained CompactPCI systems that require outstanding performance in a typical 50W or less power envelope, the board enables out-of-band communication with all hardware components through IPMI (Intelligent Platform Management Interface). Bandwidth-intensive image processing, multimedia and test and measurement applications will also benefit from the impressive 6 Mbytes of L2 cache and up to 16 Gbytes of registered DDR2 ECC SO-RDIMM memory.

The board's I/O features include 6x SATA ports with RAID 0/1/5 functionality for enhanced data security, 7 x USB 2.0 ports, 2 RS-232 ports, VGA and High Definition Audio (HDA) interfaces as well as 5 x Gbit Ethernet interfaces connected via PCI Express to meet the high-performance requirements of communications applications. An XMC socket (via PCI Express x8) and PMC socket for mezzanine cards ensure plenty of room for customized expansions.

Kontron America, Poway, CA. (858) 677-0877. [www.kontron.com].

Quad-to-10Gig Intelligent NICs Bring 10 Gigabit Ethernet into the Mainstream

An upgradeable quad-to-10 Gigabit LAN on motherboard (LOM) architecture for government/military blade and server platforms, equips the NX3031 Intelligent NIC silicon from NetXen to be the catalyst for the government/military server industry's migration to 10 Gigabit Ethernet (10GbE). Running Windows and operating in stateless NIC mode, NetXen's NX3031-based Intelligent NICs deliver an improvement in network I/O performance. According to a new Tolly Group Up to Spec Certified test, NetXen achieves 22 Gbit/s of bi-directional throughput and greater than 14 Gbit/s receive throughput for 1500-byte packets. These test results represent a near doubling of previous industry benchmarks. This best-in-class performance milestone is achieved through a new form of stateless offload enabled by the programmability of the Intelligent NIC.

The NX3031 Intelligent NIC family of chips and boards has been designed to address both current and future go-to-market needs of volume server OEMs. For the cost of a 25-cent connector and a small riser card that incorporates the customer's choice of physical layer interface, servers are instantly readied for the transition from Gigabit to 10 Gigabit Ethernet. The solution enables server OEMs to commit 10 Gigabit Ethernet to the motherboard without worrying about a specific connectivity variant, such as SPF+, CX4 or the emerging 10GBASE-T. This "above-board" connectivity option future-proofs their servers while removing risk for both the OEM and the end user.

NetXen is now shipping its third-generation NX3031 Intelligent NIC solution, which is the foundation for its new series of intelligent network adapters. These include:

- NX3-20GxR: Dual-port 10GbE low-profile PCI Express 2.0 cards with pluggable SFP+ optical interconnect modules
- NX3-20GCU: Dual-port 10GbE low-profile PCI Express 2.0 card with direct attach twinax copper wiring for cost-effective in-rack connectivity
- NX3-4GBT: Low-profile PCI Express 2.0 card with four Gigabit Ethernet ports for maximum flexibility in mixed 1G/10G environments

NetXen, Santa Clara, CA.
(408) 327-1347. [www.netxen.com].

5x7 SMD True Sinewave SAW-Based VCO

Military applications such as frequency translation, test and measurement, avionics, point-to-point radios and multi-point radios all rely on SAW-based oscillator technology. Along just such lines, the CVS575S-500 from Crystek is a 500 MHz Voltage Controlled surface acoustic wave (SAW) Oscillator, or VCSO, which provides low-noise and low-jitter performance with true sine wave output. The lead-free, RoHS-compliant device is offered in a 5 x 7.5 x 2.5 mm SMD package.

Phase noise is excellent at -135 dBc/Hz at 10KHz offset. The oscillator has no sub-harmonic, and the second harmonic is typically -14 dBc. The CVS575S-500 operates from -20° to +70°C from a +3.3V power supply. Pricing for the CVS575S-500 will start at $45 each in volume. For additional pricing details, contact Crystek Corporation.

Crystek, Ft. Myers, FL. (800) 237-3061. [www.crystek.com].

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VPX Conduction-Cooled Rugged Enclosures

New VPX conduction-cooled rugged enclosures encompassing a variety of COTS modular designed conduction-cooled chassis for VPX, VME, CPCI and CPCI Express applications enable accelerated development of rugged conduction-cooled embedded systems. Two-level maintenance models from PCI-Systems include 3U, 6U, ATR, ARINC600 and custom chassis and all are available with interchangeable backplane-bus versions.

The design allows the user to select different top and bottom parts for the enclosure to get an air-cooled, conduction-cooled (cold plate) or liquid-cooled chassis. During development an easy exchange of chassis parts generates a different type of cooling of the chassis. Also, during development, each slot has its own rear I/O PCB to ease definition and testing of the final custom wiring. This setup can be easily exchanged with a custom rear I/O PCB set. Thus cost of ownership is minimized, since development and production versions of the chassis have the same basic design components.

VPX versions are available with a PCI Express bus implementation on the backplane, having 8 lanes per slot and a 64 lane switch, therefore allowing up to 7 add-on slots and a CPU slot for very high bandwidth computing applications. Current CPU boards are available with x4 or x8 lane PCI Express configuration and include a Intel core duo board based on the Intel 3100 chipset with ECC and a Freescale MPC8572E CPU dual core PowerPC processor board.

The 3U Conduction-Cooled Chassis shown here comes with a 5-slot backplane plus CPU slot, 220 watt Modular PS with 12-36 VDC input and an external AC input adapter for lab testing. The 5-slot backplane will accommodate the Modular PS, a one-slot width CPU, and five add-on card slots. CompactPCI Express Type 3, CompactPCI and VPX backplanes with Rear I/O are available.

PCI-Systems, Laurel, MD.
(301) 362-1233. [www.pcisystems.com].

Ethernet Device Server Talks to RS-232/422/485 Ports

The military has warmed to Ethernet in a big way. It's a useful means to talk to a wide array of serial I/O. The Industrial Automation Group of Advantech introduces the EKI-1524 Serial Device Server, which is the latest addition to the EKI-1500 family, allowing up to four RS-232/422/485 serial devices to be remotely monitored, managed and controlled over Ethernet and Internet Protocol (IP) networks. Equipped with dual 10/100Base-TX Ethernet ports and dual Media Access Controllers (MACs), this innovative device ensures data transmission even in the event of a network link failure.

The EKI-1524 offers a number of conventional operating modes that allow connections to be initiated by either attached serial devices or remote Ethernet hosts using both UDP/IP and TCP/IP protocols. The EKI-1524 Serial Device Server is packaged in a compact and thin DIN-rail mount chassis. They are ruggedized for demanding industrial applications with 4,000 VDC Ethernet ESD protection, dual 12 to 48 VDC power inputs with power line surge (EFT) protection of 3,000 VDC, and feature an operating temperature range of 0° to 60°C to ensure system uptime.

Advantech, Irvine, CA. (949) 789-7178. [www.advantech.com].

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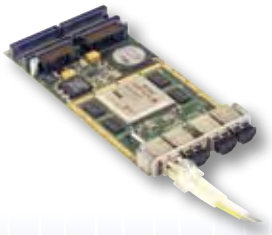
XMC-FPGA05F



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Coming Next Month

COTS JOURNAL

- *Military Power Supplies and Converters.* At one time they were an afterthought in the system design process. But today power supplies and power conversion electronics rank as a make or break technical choice in embedded military computer systems. With more and more computing stuffed into smaller spaces, power has direct implications on the size, cooling and mobility of a system. Articles in this section examine technology trends affecting DC/DC converters, power supply module bricks and slot-card power supplies (VME, cPCI and others).
- *Implementing MILS and Information Assurance.* You'll find the term Information Assurance (IA) part of any discussion about today's network-centric programs like FCS, WIN-T and JTRS. The information and databases on the military's networks are national assets, and enemy access to them threatens our warfighters. To ensure security in these systems, developers are leveraging architectures like MILS (Multiple Independent Levels of Security). This section examines the embedded OS and hardware building blocks central to MILS and IA.
- *Simulation & Test Subsytems and I/ITSEC Products Preview.* Military simulation and test systems have taken on a whole different character as PC-based platforms take center stage. Articles in this section analyze the technologies behind that trend. Also featured is a preview of the products and papers to be showcased at the Interservice/Industry Training, Simulation and Education Conference (I/ITSEC).
- *Rugged Stand-Alone Box Products.* Traditional embedded board vendors are adding stand-alone rugged box-level systems to their military market offerings. These complete system boxes often support standard form-factor boards such as PMCs or PC/104 cards inside them. The result is a complete, tested and enclosed computing solution that eliminates complex integration chores for customers. This section looks at this emerging product class and outlines the problems they solve. A product album rounds up the latest representative products in this area.

COTS

Editorial

Jeff Child, Editor-in-Chief

Ten Years of Change

When I took over as Chief Editor on COTS Journal, my colleague Pete Yeatman gave me a copy of the inaugural issue of this magazine from 1998—ten years ago. "The Editor-in-Chief should have this," he said. I took that to heart and keep it always prominently displayed in my office—its presence serves as a good reminder about where it all began and the legacy this publication has built. It's interesting to look back and see how much has changed since then—changes in the embedded computing industry, changes in military market, changes in technology, and perhaps most importantly: the way all those changes related to one another.

One immediate fact that struck me is that nearly half of the companies advertising in COTS Journal's 1st issue ten years ago have since been acquired or merged with other companies. That trend of consolidation in the embedded computer industry still continues today. What's interesting is that—although mergers and acquisitions can be a sign of a shrinking market—that's not the case in this industry. The M&A activity has been a sign that the industry is maturing and that larger corporations—like GE, for example—have recognized that there's money to be made in this area of technology. Acquisitions have also proved a way for vendors to bring together a broader set of product areas in order to provide a more complete, integrated solution for their customer.

All that said, there's been a side effect to this that's proven beneficial to the smallest of companies—those in around the sub-$10 million range. Oftentimes larger firms can't justify some of the smaller program contracts they inherit with their acquisitions. As a result, I know of several cases where a smaller independent supplier has come in to happily take that business.

In many ways, not much has changed in the way companies in our industry position themselves to do business with the military market. But there are some key differences compared to ten years ago. If anything, established relations with prime contractors and the DoD have become even more important. Another key change is that customers in the military market—at the primes or the DoD—depend magnitudes more on the knowledge and expertise of their electronic component and embedded computer suppliers than they did 10 years ago. Computer technology changes so fast that it now only makes sense for military system designers to let the embedded computer vendors be the experts on all the facets that make up embedded computing. That means looking to the embedded computing industry for advice on performance roadmaps, cooling solutions, I/O and fabric interface standards, and so on. This shift hasn't been consistent across the board, but I think it will accelerate as primes are forced to control costs better by outsourcing more.

Finally, looking back at 1998 and COTS Journal's first issue, the technology advances that have occurred over the past ten years are staggering. My thoughts on that could fill many pages, but here are a few items that would have been alien to the technology of those years: mulitcore processors as a mainstream technology, FPGAs as the preferred choice of DSP processing, and so on. I will expand a little on one area of technology that, I think, exemplifies the success of the COTS movement and the contribution of the embedded computing industry: switched fabrics.

Even when switched fabrics started to migrate into the mainstream embedded computing realm around ten years ago, the military market expressed absolutely ZERO interest in them, and rightfully so. Because of the decades-long design cycles in the defense arena, it was too risky to take any long-term development project on an interconnect scheme that wouldn't be around in a few years. On the other hand, the inherent performance limitations of parallel buses like ordinary VME64 and PCI, telegraphed an eventual shift toward serial switched fabrics.

Fortunately the VME community, to its credit, started the ball rolling years ago on the underlying spec development to bring serial switched fabrics into the VME space. Among those are VXS and VPX. The VME realm isn't the only arena where switched fabrics are making a presence. It's been a busy year for switched fabrics—PCI Express, in particular—across all areas of standards-based mid- and high-embedded architectures including MicroTCA.

Like the embedded board-level community itself, the editors of COTS Journal were covering switch fabrics long before they were fashionable. Over the years we've published more articles on all the various switched fabrics—and all of their ins and outs—than any publication in the industry. So we've been on top of the evolution of fabrics all the way through. Now that the ever-cautious military market has warmed to them, it's clear that switched fabrics have broken free from their status as exotic, risky solutions. I find it rewarding to see these technologies move into center stage and become a real factor in military system designs.

Clearly the changes in our industry, the military market and technology over the past 10 years are all intertwined. I wish you all an equally interesting next 10 years, along with my promise that COTS Journal will continue our leadership as your primary tool for understanding the technologies that enable and drive military systems. ▮▮

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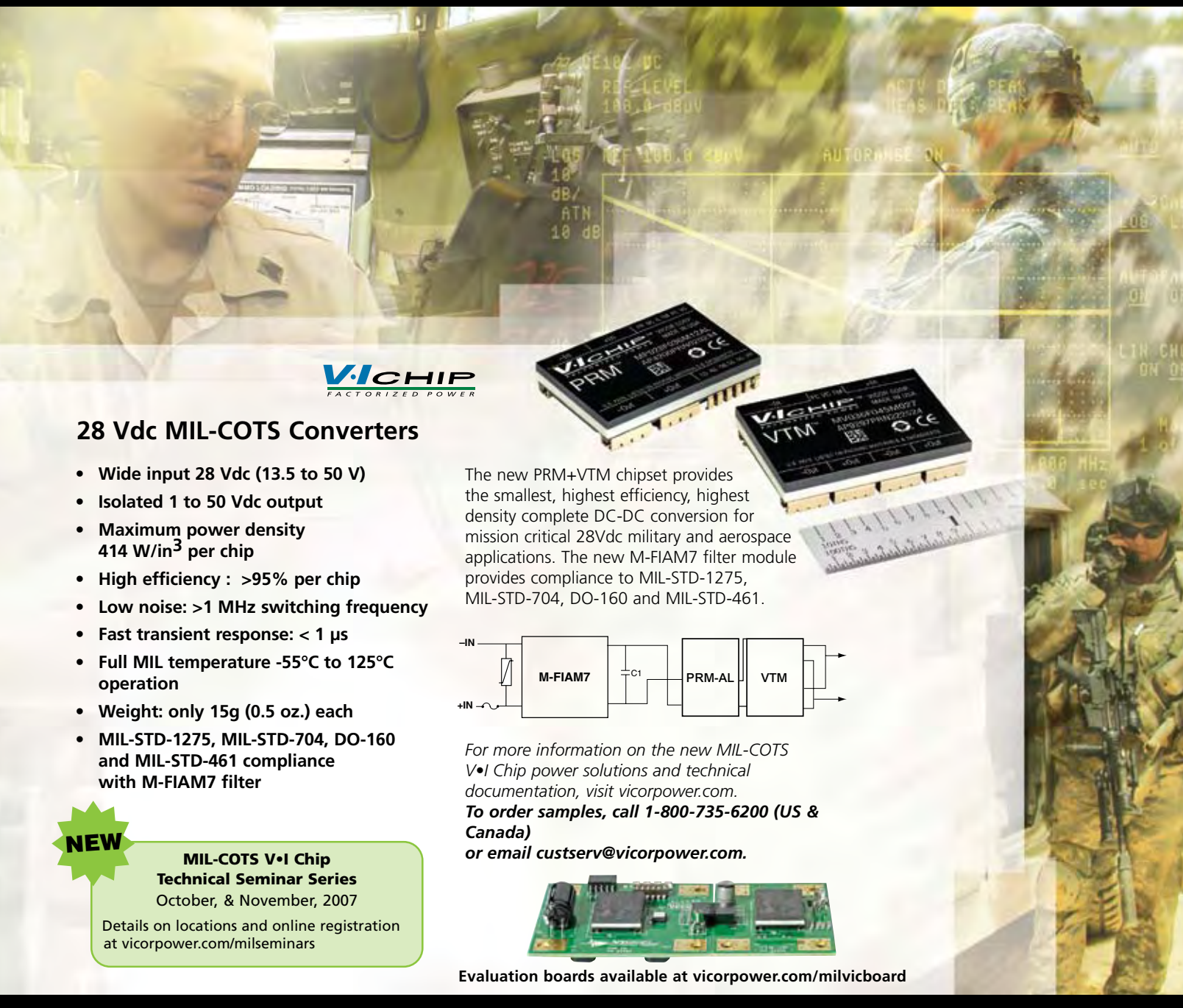

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