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The Journal of Military Electronics & Computing

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NET-CENTRIC PROCESSING CHAIN

LEANS ON FPGAS AND ETHERNET

PLUS:

Low-Power Strategies for Video and Data Movement

Airborne Systems Present Unique Cooling Issues

An RTC Group Publication

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Volume 11 Number 9 September 2009

MILCOM 2009 ISSUE

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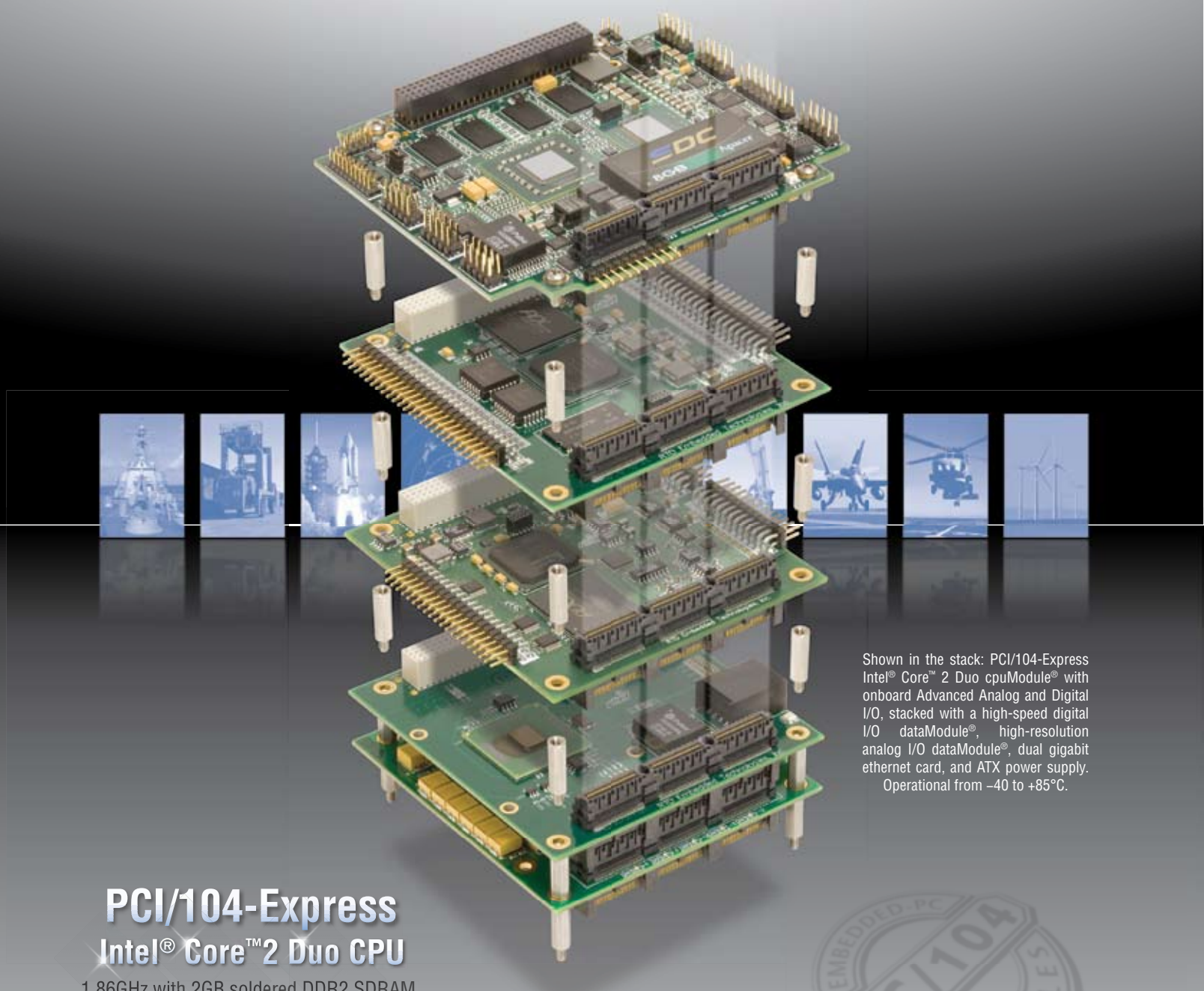

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Features

September 2009 Volume 11 Number 9

Special Feature

Net-Centric Processing and RF Challenges

Tech Recon

Low-Power Video and Data Movement

System Development

Cooling Challenges in Airborne Systems

Technology Focus

Solid-State Disk Drives

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Departments

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An information transfer system that controls mission-critical capabilities on DDG 51-class guided missile destroyers is based on switched Gbit Ethernet. Among those vessels to be fitted with the Boeing Gigabit Ethernet Data Multiplex System (GEDMS) AN/USQ-82(V) is the USS Benfold. The Benfold (DDG 65) maneuvers as she prepares to moor pier-side at Naval Station Pearl Harbor.

U.S. Navy photo by MCS 1st Class James E. Foehl

COTS JOURNAL
The Journal of Military Electronics & Computing

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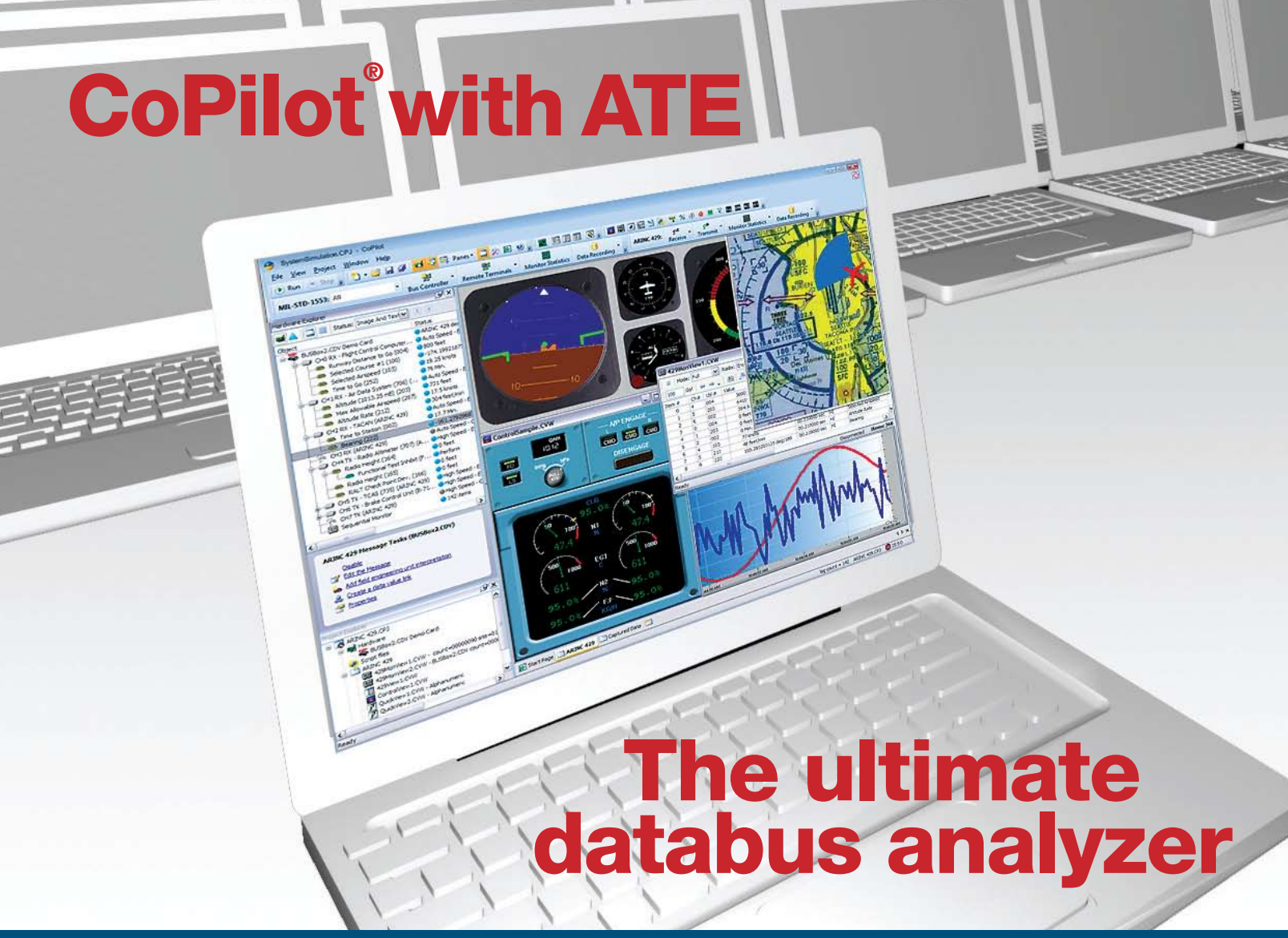

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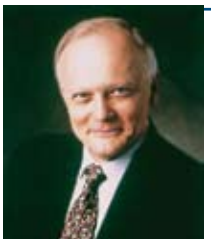

Publisher's Notebook

Reading the Tea Leaves

Another Labor Day. Time to start putting thoughts of vacation and barbeques behind us and get back to trying to figure out exactly what the DoD and Congress will agree on with respect to future military programs. The development time cycles of 18 to 24 months that the embedded marketplace has to contend with dictates that we need to start working on the 2011 concepts and design-ins now.

Suppliers of subsystems, preconfigured systems and boards will probably have an easier time of it than companies targeting building a from-the-ground-up deliverable system. Most embedded suppliers don't design one product for one specific deliverable—they tend to develop products that may be used across many platforms and that are based on accepted or up and coming technologies. When the DoD shifts its interest from one platform to another, these suppliers are able to quickly shift their focus and make minor product changes to accommodate the shifts.

Even market analysts are scurrying to figure out exactly where things are going. For the most part, many are treading water until they can get better feedback from their connections within the Beltway. Now that some real data is becoming available, reports and analyses that were written last year with the usual caveats and speculation about the new administration are all going to have to be updated.

Since early spring *COTS Journal* has been extremely fortunate to have four renowned analyst organizations—Forward Concepts, Frost and Sullivan, Jane's DS Forecasts and Venture Development Corp.—working with us to provide you with key industry trend data. Each organization focuses on a slightly different segment of the military market and that segment's use of embedded electronics. In aggregate they cover the whole spectrum of our market. In each issue one analyst provides us with one pertinent key piece of information that concerns our marketplace. *COTS Journal*'s focus remains on technology, but from its inception we've always included critical industry information so our readers are able to put that technology in context of the big picture. The analyst segment opens a window that readers may wish to further explore with the writer.

Our decision to add an analysts segment within *COTS Journal* was the outcome of our highly successful breakfast meeting we had at last year's MILCOM. That meeting brought together key analysts and a select group of suppliers to candidly discuss the military market and its future needs and direction. *COTS Journal* will once again have its analyst breakfast at this year's MILCOM. Last year's participants, including *COTS Journal*, found the discussions extremely enlightening and a valuable foundation for our future decisions.

As of this writing, the organizers of MILCOM have not yet issued a final agenda; however, it is clearly evident that embedded military electronics is becoming a bigger element in MILCOM's program. Computer Hardware, Computer Software, Communications Systems, Rugged Computers and Systems Engineering are in the top fifteen technologies and solutions list that the organizers are promoting. Any conference venue selection has to take place years before the event, and this year's MILCOM venue in Boston doesn't allow the organizers to cope with the show's unforecasted growth. As a result, fewer organizations are able to participate than at the last event held in San Diego. MILCOM is currently sold out and many companies are wait-listed hoping to get in. Even with the reduced number of total participants, there will be about a thirty percent increase over last year in the number of companies that have at least one foot in the embedded military electronics market.

With all the uncertainty regarding what programs the DoD and Congress will settle on, MILCOM should be a beehive of activity with everyone trying to read the tea leaves. That thirst for information should also drive up attendance. AFCEA's magazine that focuses on military programs, *SIGNAL*, should be there in full force, so will *COTS Journal* to cover the technology side of the military embedded electronics changes. Unless the MILCOM organizers intentionally do something to restrict it, MILCOM will more than likely become the conference home for the embedded military electronics market. This is the one conference that has the most synergy with our marketplace. Demand for systems focused on the transmission and processing of data has experienced exponential growth and is expected to continue for the foreseeable future in spite of talks of budget cuts. Couple that with the fact that most voice is now also digital by default, and it's clear that embedded electronics will be an ever-increasing element of military communications.

Year before last, *COTS Journal* read the tea leaves and started to strongly support MILCOM and will continue to be part of its growth and increasing significance in the embedded military electronics industry. As the organizers come to see the light regarding our industry's role in the market they are serving, we will be there to assist with the technology issues. ■■

Pete Yeatman, Publisher
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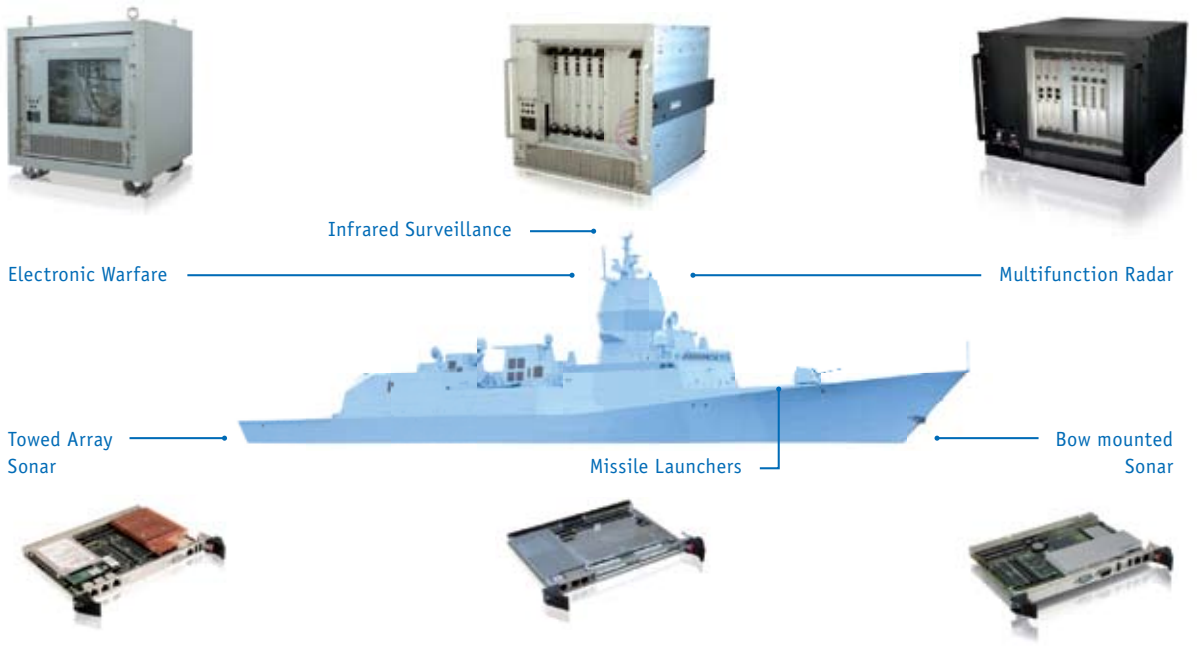

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The Inside Track

Aitech SBCs Selected as Processing Engines for Ares I Avionics

Aitech Defense Systems has been selected to provide two key embedded processing components for the Ares I Launch Vehicle's Instrument Unit Avionics (IUA) Flight Computer (FC) and Command Telemetry Computer (CTC) systems under a contract to Ball Aerospace & Technologies Corp. Aitech's next-generation S950 SBC and new S750 PCI PMC will be used in a triple-redundant configuration to provide flight control redundancy in the IUA FC function. The new S950 SBC offers a faster 1 GHz processing engine and an increase of more than 20 percent in performance than the previous version. The soon-to-be-released Aitech S750 four-port Gigabit Ethernet PMC, hosted on the S950 SBC as a single-slot CompactPCI card set, will relay high-speed imaging data to the crew exploration vehicle's (CEV) solid-state recorder and ground support system.

Both radiation-tolerant cards are optimized for a wide variety of applications in low and high earth orbit space vehicles such as flight computer and control, engine control and rocket staging, robotic manipulator control and instrument interface units. The cards are also used in command and telemetry control, attitude and combustion control, payload control, solar array and directional control as well as solar array drive electronics (SADE). The Ares I (Figure 1) first stage vehicle booster launches the Orion CEV, which will join other elements of NASA's Constellation program to propel astronauts to the moon—and beyond—by 2020. The IUA FC and CTC provide the guidance, navigation and control hardware for the new Ares I crew launch vehicle, serving as the vehicle's control subsystem during the rocket's ascent to orbit.

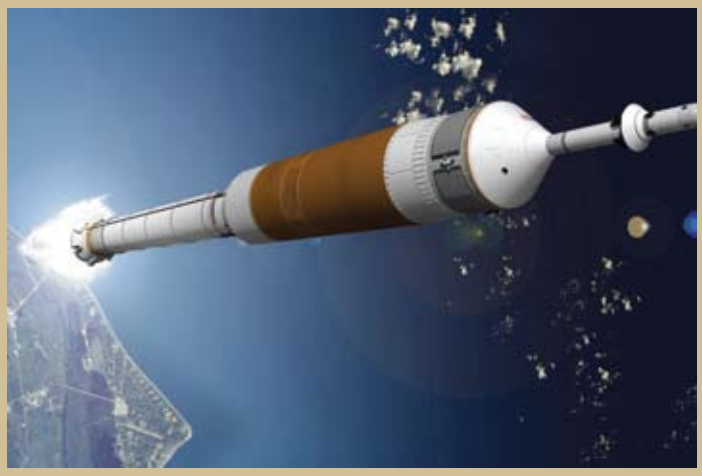

Figure 1

The Ares I first stage vehicle booster launches the Orion CEV, which will join other elements of NASA's Constellation program to propel astronauts into space.

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Industry Innovator John J. Peters Passes Away

John J. Peters of Performance Technologies passed away unexpectedly earlier this month. Peters served as Senior Vice President, Platform Engineering and Chief Technology Officer Performance Technologies since March 2009. He was greatly respected in the industry as the "father" of the VME-64 specification. In a message regarding Peters to VITA members, VITA's Executive Director, Ray Alderman cited Peters' contributions to the industry. "I knew John and he was a world-class thinker and engineer,". said Alderman, "He brought the multiplexed VME data/address technique to VITA and the VSO, and initiated the activities to incorporate those enhancements into the VME-64 standard."

Previously, Mr. Peters served as Senior Vice President of Embedded Engineering and Chief Technology Officer since November 2005. From 2000 to 2005, he served as Vice President of Engineering. From 1997 to 2000, he held the position of Vice President of Development, Network Switching Products. From 1994 to 1997, he held the position of Vice President of Hardware Engineering. From 1990 to 1994, he served as Technical Director of the Hardware Products business unit, and from 1986 to 1990, he served in various engineering positions. Prior to joining the Company, he held various engineering positions with Computer Consoles, Inc. (now a division of Nortel Networks). Mr. Peters holds a BS degree in engineering from the Rochester Institute of Technology.

General Dynamics Adds Soldier Radio Waveform to JTRS Radios

The Handheld, Manpack, Small Form Fit (HMS) team, led by General Dynamics C4 Systems, has successfully added the highly capable Soldier Radio Waveform (SRW 1.0c) to the Rifleman Radio (AN/PRC-154) and the HMS Manpack Radio (Figure 2) intended for use in vehicles. This places HMS first in line to bring the JTRS SRW 1.0c to dismounted soldiers for an unprecedented level of network connectivity.

Figure 2

Networking HMS Manpack Radio, now with the JTRS SRW 1.0c waveform, is intended for use in vehicles.

Next steps for the Rifleman Radio include Security Verification Testing and final certification, followed by a Department of Defense Milestone C decision, which is the last step before low-rate initial production (LRIP). The government expects to make its LRIP award for HMS in November 2009. In preparation for initial production, the General Dynamics-led team has qualified four manufacturers as suppliers of HMS radios to the

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government. Each of the manufacturers—BAE Systems, General Dynamics, Rockwell Collins and Thales Communications—have successfully built and delivered HMS radios to the government for testing and use during military exercises. General Dynamics is prime contractor for the JTRS HMS program. The JTRS HMS team includes BAE SYSTEMS, Rockwell Collins and Thales Communications.

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

Cavium Networks and GE Fanuc Team for Low-Power Multicore Solutions

GE Fanuc Intelligent Platforms has initiated a collaborative effort with Cavium Networks in which the two companies will facilitate high-performance compute technology using low-power multicore processor architectures in military/aerospace applications. The collaboration is expected to lead to the development of new solutions designed for military/aerospace applications that are based on multicore technology.

GE Fanuc delivered a range of Cavium OCTEON processor-based solutions to its telecommunications and enterprise customers. This collaboration will enable their military/aerospace customers to take advantage of the same high-performance, low-power and secure technology. Applications for the OCTEON-based technology that will likely be of interest to military customers relate to the requirement for the absolute security of information transmitted via a network, together with the need to manage network resources in the most efficient manner so as to maximize throughput. These will include deep packet inspection, network monitoring, intrusion detection, firewalling and other intelligent networking applications.

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Military Market Watch

U.S. Government Ramps up Cybersecurity Investment

Cybersecurity is information security as applied to computers and computer networks. Department of Defense (DoD) organizations such as the Defense Information Systems Agency (DISA) and National Security Agency (NSA) are the chief influencers for cybersecurity policy and procurement in the federal government. The Department of Homeland Security (DHS) is the key non-DoD stakeholder; its National Cyber Security Center (NCSC) has been tasked with protecting critical infrastructure throughout the U.S. from cyber attacks. No effective central authority for standards, budgets, or planning exists. Government cybersecurity budgets are about $2,154.6 million in 2009. Figure 3 graphs the U.S. Government Cybersecurity spending forecast to 2013. Most funding is contained in the information assurance elements of computer and enterprise networking programs of record. DoD is the primary government consumer of cybersecurity products and services with about 68.3 percent of spending.

The government has recognized the importance of adopting commercial standards as the cybersecurity problem crosses both the public and private sectors. Once IPv6 becomes more widespread among government users, small form factor embedded information assurance products that utilize NSA Type 1 Future Narrow Band Digital Terminal (FNBDT), Secure Communications Interoperability Protocol (SCIP) and High Assurance Internet Protocol Encryptor (HAIPE) formats will be a focus of the market. In addition, continued expansion of commercial products such as firewalls, intrusion detection, Suite B encryption, compliance and training services is growing rapidly.

The government will continue to depend on commercial partners for technology updates and maintenance of industry standards. Component security down the manufacturing supply chain is expected to receive increased scrutiny. Currently, network integrators and bulk encryption providers dominate the U.S. government cybersecurity market, but end users are increasingly relying on innovative COTS products to meet expanding demand and gain quick technology updates. As network access via small form factor, multi-use, mobile devices evolves, the demand for embedded computing and encryption products will continue to broaden, especially for applications that are power efficient, lightweight and ruggedized for shock, dust and heat. For more information please contact Brad Curran of Frost & Sullivan at: Brad.Curran@frost.com

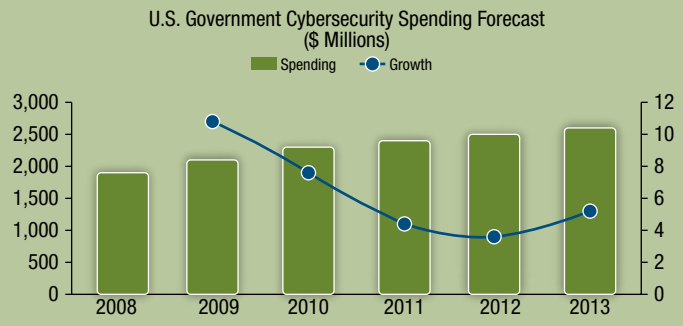

Figure 3

U.S. Government Cybersecurity spending forecast to 2013. 2009 government cybersecurity budgets are about $2,154.6 million. Source: Frost & Sullivan.

Frost & Sullivan
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[www.frost.com].

Hunter UAV Completes GPS-Guided Viper Strike Testing

Northrop Grumman Corporation's Hunter Unmanned Aircraft System (UAS) has successfully completed testing of the new GPS-guided Viper Strike (VS) weapons system at White Sands Missile Range, N.M. GPS VS will soon deploy to theater on board Hunter in support of contingency operations. GPS VS aides the weapons guidance by providing proximity based on coordinates while maintaining pinpoint accuracy with laser guidance. While previous VS systems required the Hunter to be directly overhead, GPS VS offers the advantage of nearly six miles of stand-off range. GPS VS can also hone in on both moving and stationary targets.

The MQ-5B Hunter (Figure 4), which is currently deployed in contingency operations, provides warfighters with state-of-the-art reconnaissance, surveillance and target acquisition (RSTA), communications relay, signal intelligence and weapons delivery. Hunter recently surpassed 80,000 flight hours, 53,000 of which are combat-related. The MQ-5B is the next-generation Hunter, continuing a legacy of service to Army corps, division and brigade warfighters. Flying over the battlefield with its multi-mission optronic payload, the MQ-5B gathers RSTA information in real time and relays it via video link to commanders and soldiers on the ground.

Figure 4

Northrop Grumman's Hunter UAV has successfully completed testing of the new GPS-guided Viper Strike weapons system at White Sands Missile Range, NM.

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www.rtecc.com/longbeach2009

October 1
Real-Time & Embedded Computing Conference
San Diego, CA
www.rtecc.com/sandiego2009

October 5-7
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October 19-21
MILCOM 2009
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October 27
Real-Time & Embedded Computing Conference
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Special Feature

Net-Centric Processing and RF Challenges

Network-Centric Technologies Flow into Land, Sea & Air Systems

The military's drive to network all areas of its forces is stirring up interest in technologies that connect that chain of communications. FPGA processing, switched Ethernet and advanced graphics chips form the critical building blocks.

Jeff Child
Editor-in-Chief

The Defense Department's broad Network-Centric vision calls for real-time sharing of voice, video and data between soldiers, aircraft, satellites, ships, robots and UAVs, all over a global network. The technology areas fueling those goals include software and programmable radios, RF beamforming, ultra-wideband optical communications and IP networking on land, sea, air and space platforms. Suppliers specializing in those areas will be represented at next month's MILCOM show in Boston.

Making every vehicle, aircraft, ship, ground installation and soldier part of a network will fuel demands for sophisticated compute-intensive radio and network nodes—each suited for a different environment, platform or user. Moreover, processing and displaying the information on all those network nodes—be they on aircraft, ships, vehicles or in soldiers' backpacks—calls for upgrading the embedded computers and displays in all those platforms.

There are many areas of technology that go into making this Net-Centric vision work, but three top the list in importance. First, FPGA-based processing is the key enabler for systems that take in and process data, including radar and SIGINT systems. And software-based tactical radios also fall under that umbrella—although, of course, radios are both receiving and transmitting points in the networked military. Next is switched Ethernet, which is being used as an interconnect fabric in compute-intensive applications like sonar, radar or any application that networks sensor arrays together.

And finally, a blend of graphics and video performance is vital for advanced sensor fusion, image/frame capture and recording in applications like tactical, Red Force/Blue Force tracking and for avionics and tactical area moving map applications. Here, cutting-edge graphics chips developed for the demanding gaming market, military graphics subsystems, are now able to offer complex video and graphics functionality in highly integrated board-level solutions.

FPGAs Take on Processing Duties

Applications like sonar, radar and SIGINT that center around waveform processing rank among the applications that have been most transformed by FPGA advances. Faster FPGA-based DSP capabilities coupled with a broader range of IP cores and development tools for FPGAs are joining forces to form new system architectures. System developers can now build radar receiver systems with a higher instantaneous bandwidth thanks to the converters, and can handle the corresponding increase in compute power required to process the received data streams using FPGAs. The ASIC-based radar design approaches of the past can achieve the performance needed, but that path lacks the flexibility inherent in designs based on FPGA technology.

An example system requiring this level of FPGA processing is the data recording and playback systems developed for the E-2D Advanced Hawkeye (Figure 1). The data recording and playback systems for the E-2D can scale up to dozens of modular, heterogeneous input/output channels and FPGA-based protocol engines to support application-specific processing in real time during record and playback. As storage and FPGA technology advances, that approach allows the system architecture to boost throughput and storage capacity through reuse of the modular building blocks within an open standard framework.

Figure 1

The data recording and playback systems for the 2D Advanced Hawkeye 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.

Figure 2

3U VPX Gigabit Ethernet switch technology is being deployed on M1A2 Abrams tanks as part of the U.S. Army Heavy Brigade Combat Team (HBCT) M1A2 Abrams Ethernet Switch Module (ESM).

Switch Ethernet as an Embedded Interconnect

Ethernet switch boards are emerging as a critical building block for a variety of programs. Once used only as a pure networking solution for command and control systems in the military, Ethernet is now gaining traction in numerous other military applications as an interconnect fabric in compute-intensive applications. It's also deployed as multilayer switches with dual IPv4 and IPv6 forwarding to support the DoD's sweeping plans to leverage the benefits of IPv6 (Internet Protocol version 6). The number of programs embracing Ethernet—including both upgrades and new advanced systems—continues to ramp upward.

Last month GE Fanuc Intelligent Platforms secured an order from General Dynamics Land Systems (GDLS) of Sterling Heights, MI. GE Fanuc is to supply a custom version of its 3U VPX NETernity GBX410 Gigabit Ethernet switch and XMCXGO XMC card on the M1A2 Abrams Tank (Figure 2). The boards will

Figure 3

Guided missile destroyer USS Barry (DDG-52) is among the vessels to be retrofitted with Boeing's Gigabit Ethernet Data Multiplex System (GEDMS) AN/USQ-82(V). Shown here, the ship steams through the Atlantic Ocean while participating in a multinational exercise conducted off the coast of Morocco.

be deployed as part of the US Army Heavy Brigade Combat Team (HBCT) M1A2 Abrams Ethernet Switch Module (ESM). The NETernity GBX410 is an IPv6-capable fully managed Layer 2/3 Gigabit Ethernet switch in the 3U VPX form factor, designed to meet the most demanding requirements for network switching in tactical applications.

Boeing meanwhile recently was awarded a U.S. Navy contract to produce the information transfer system that controls mission-critical capabilities on guided missile destroyers. The production of six shipsets of the Gigabit Ethernet Data Multiplex System (GEDMS) AN/USQ-82(V) further strengthens Boeing's support for the Navy's modernization efforts on DDG 51-class warships. The equipment will be retrofitted on the USS Barry (DDG 52), USS Stout (DDG 55), USS Benfold (DDG 65) and three foreign navy vessels. The U.S. Naval Surface Warfare Center, Dahlgren Division, Dahlgren, Va., awarded the contract, which also includes spares. According to Boeing, the new system enhances reliability, maintainability and survivability by managing data from the ship's most basic systems, including navigation, steering control, damage control, machinery control, combat and internal communications. ▮▮

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Special Feature

Net-Centric Processing and RF Challenges

Software-Defined RF Measurement Aids Radar Beamforming

Modern military radar systems depend on electromagnetic beam steering as a replacement for the traditional mechanically steered transmit signal. Software-defined multichannel RF instruments let you customize that functionality.

David A. Hall, Marketing Engineer
National Instruments

Since the transmission of the first radio waves, engineers have continually sought new ways to use electromagnetic microwave signals. RF signals have been used for a variety of applications, and two specific applications that use phase-coherent radio waves are MIMO wireless communications and military radar. In essence, both applications are unique in that they use the spatial dimension of electromagnetic waves. Today, many wireless communications systems incorporate multiple-input, multiple-output (MIMO) antenna schemes to take advantage of the multipath signal propagation. In addition, many of today's modern military radar systems use electromagnetic beam steering as a replacement for the traditional mechanically steered transmit signal. These applications and others are some of the primary drivers for multichannel phase-coherent RF measurement systems.

The modular architectures of software-defined PXI RF instruments such as the NI PXIe-5663 6.6 GHz RF vector signal analyzer (VSA) and NI PXIe-5673 6.6 GHz RF vector signal generator (VSG), lend themselves to the phase-coherent RF measurements required for MIMO and beamforming applications. With software-defined multichannel RF instruments, engineers can customize a measurement system for their specific application. In fact, the LabVIEW example programs mentioned here are completely open source—and can be modified to fit unique requirements. Examining the process of RF synchronization provides a better understanding of the technical requirements to configure a phase-coherent RF generation or acquisition system. The example system that is described here is a software-defined PXI instrumentation system shown in Figure 1 and is based on the modules mentioned above.

The configuration of any phase-coherent RF system requires synchronization of every clock signal on the devices.

Figure 1

This typical PXI Phase-Coherent RF Measurement System uses a PXIe-5663 6.6 GHz RF vector signal analyzer (VSA) and a PXIe-5673 6.6 GHz RF vector signal generator (VSG). These lend themselves to the phase-coherent RF measurements required for MIMO and beamforming applications.

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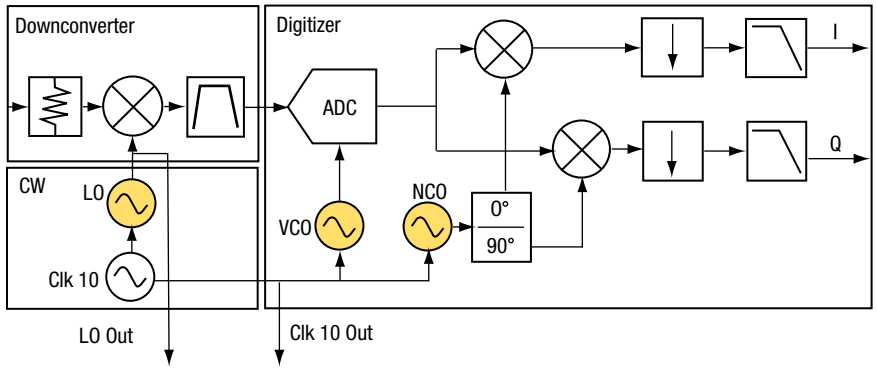

Figure 2

Shown here is a detailed diagram of an PXIe-5663 RF Vector Signal Analyzer. Even though a single local oscillator is used to downconvert from RF to IF, each analyzer must share three clocks.

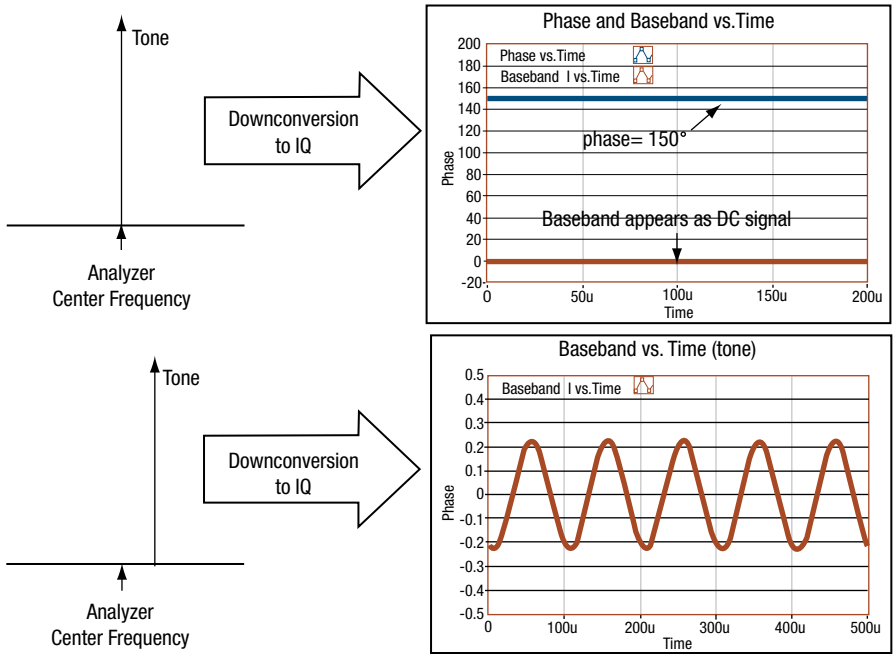

Figure 3

A downconverted RF signal that is precisely at the analyzer's center frequency appears as a DC signal at baseband. Note that the phase versus time waveform appears as a constant phase offset as long as the RF vector signal generator and analyzer are tuned to the same center frequency.

With the NI PXIe-5673 6.6 GHz RF vector signal generator, direct upconversion is used to translate baseband waveforms into RF signals. In the basic architecture of a two-channel RF vector signal generator, both baseband sample clocks and the local oscillators must be shared between both channels. Using three modules together—a continuous wave synthesizer, the arbitrary waveform generator and the RF modulator—forms a single-channel RF vector signal generator and combines with additional arbitrary waveform generators (AWGs) and RF modulators for multichannel signal generation applications. In our example system examined here, a standard NI PXIe-5673 (consisting of three modules) is combined with an NI PXIe-5673 MIMO extension kit. The extension kit includes an additional AWG and modulator for the second channel of signal generation.

Multichannel Applications

In addition to the vector signal generator, the vector signal analyzer can also be configured for multichannel applications. When configuring multiple signal analyzers for phase-coherent RF signal acquisition, you must ensure that both the local oscillator (LO) and baseband/intermediate frequency (IF) signals are synchronized. The RF signal analyzer uses signal stage downconversion to IF and digital downconversion to baseband. This architecture is one of the simplest to configure for phase-coherent applications because unlike a traditional three-stage superheterodyne vector signal analyzer, only a single LO must be synchronized between each channel. To synchronize multiple RF signal analyzers, a shared IF sample clock and LO must be distributed between each analyzer to ensure that each channel is configured in a phase-coherent manner.

The vector signal analyzer consists of the continuous wave synthesizer, the downconverter and the IF digitizer. When this vector signal analyzer is combined with an additional MIMO extension kit, an additional downconverter and digitizer are added to complete the two-channel RF acquisition system. To understand the synchronization method between multiple RF vector signal analyzers, it's helpful to investigate a more detailed block diagram of the NI PXIe-5663 RF signal analyzer. Observe in Figure 2 that even though a single LO is used to downconvert from RF to IF, each analyzer must share three clocks.

In addition to a local oscillator, each RF signal analyzer must share an ADC sample clock and digital downconverter (DDC) numerically controlled oscillator (NCO). In some instances, it is sufficient to share a common 10 MHz clock between each digitizer with each ADC sample clock derived independently from the 10 MHz reference. However, one can also share the ADC sample clock directly as well.

Before investigating the precise methods used to calibrate phase-coherent

RF acquisition systems, it's important to understand how RF signal characteristics can be observed at the baseband level. For example, consider the scenario where a VSG and VSA are configured in a loopback mode at the exact same center frequency. As shown in Figure 3, a downconverted RF signal that is precisely at the analyzer's center frequency appears as a DC signal at baseband. In addition, because the baseband signal is a complex waveform, one can also analyze the phase of the signal as a function of time. In Figure 3, note that the phase versus time waveform appears as a constant phase offset as long as the RF vector signal generator and analyzer are tuned to the same center frequency.

By contrast, an RF tone that is slightly offset from the center frequency of the analyzer yields a different result. When downconverted to baseband, an offset tone produces sinusoidal baseband I (and also Q) signals. In addition, the frequency of the baseband sinusoid is equal to the frequency difference between the input tone and the center frequency of the analyzer. As a result, a phase versus time graph appears as linear relationship, shown in Figure 4a.

Observe that the phase increases by approximately 360 degrees every microsecond in Figure 4a, indicating that the generated tone is exactly 1 MHz offset from the center frequency of the analyzer. Also notice that a small, but constant, phase difference is maintained between two simultaneously sampling digitizers. This discrete phase difference is caused by differences in cable length between the LO sourcing each downconverter. It can be easily calibrated by adjusting the start phase of the DDC for one of the RF channels.

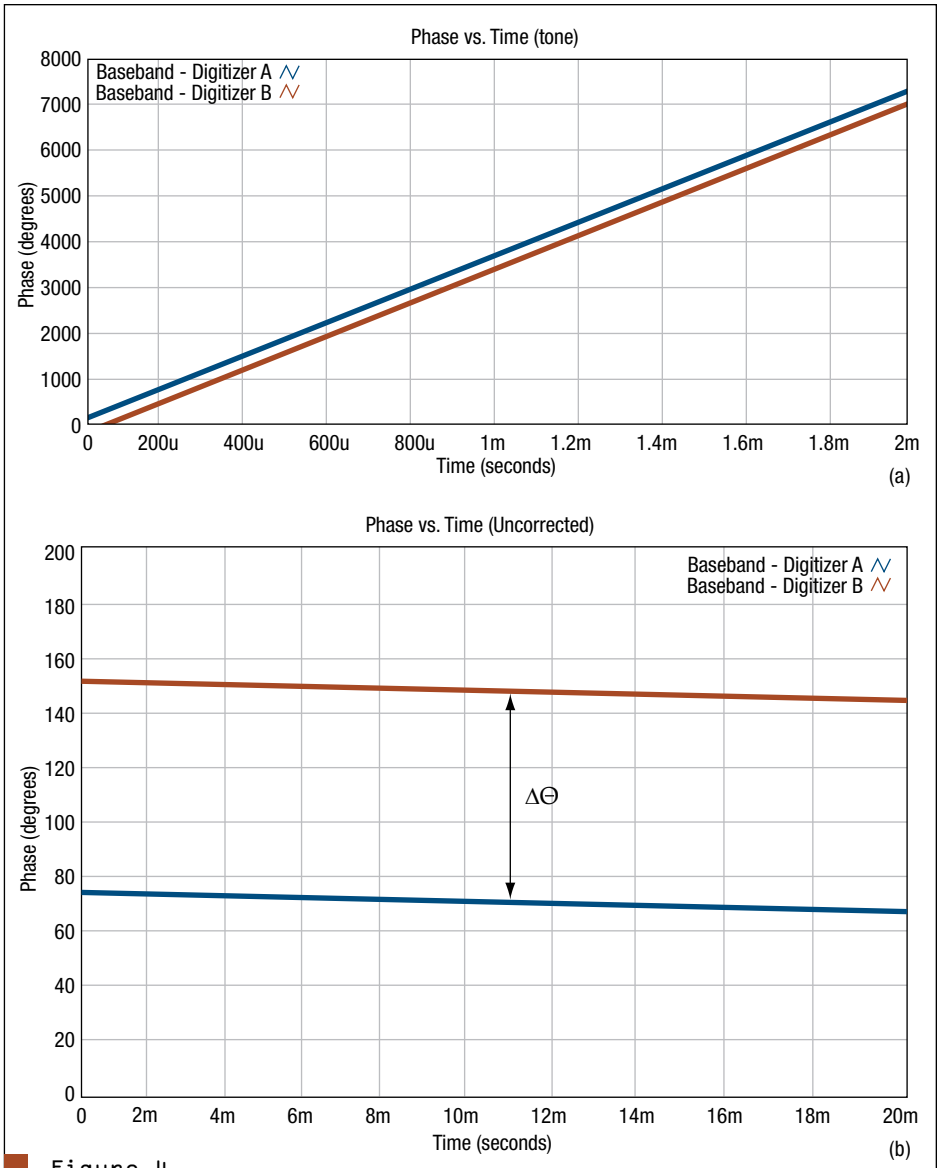

Figure 4

A phase versus time graph (a) appears as a linear relationship. This shows phase versus time for 10 MHz tones in an uncalibrated system. Assuming that the signal generators and analyzers are centered at the same RF frequency, note that a constant phase versus time plot for each analyzer is constant (b).

Measuring Phase Offset

One of the most accurate ways to measure the phase offset between two analyzers is to generate a single tone at the center frequency of both analyzers. Using a splitter and matched cable lengths to each analyzer, you can measure the phase versus time for each analyzer. Assuming that the signal generators and analyzers are centered at the same RF frequency, observe that a constant phase versus time plot for each analyzer is constant, as illustrated in Figure 4b.

The two analyzers sharing the same LO and IF sample clock will maintain a constant phase offset over time. In fact, one can measure and compensate for the phase difference between each analyzer by adjusting the start phase of the NCO in the DDC. An NCO is a digital sinusoid at the IF center frequency, which is used to produce the resulting baseband I and Q signals. In Figure 4b, observe that the daisy-chained RF analyzers produce a carrier phase difference of 71.2 degrees at a particular center frequency.

The exact phase offset is determined by a combination of cable length to the second LO and by the center frequency used. By applying a phase delay of 71.2 degrees to the NCO of the master DDC, one can successfully align the phase of the baseband signals of both channels. Because the LO is shared directly, the phase relationship between each channel should be stable over time. Figure 5 illustrates phase versus time for a four-channel acquisition system over 3 hours. After calibrating the NCO of each ana-

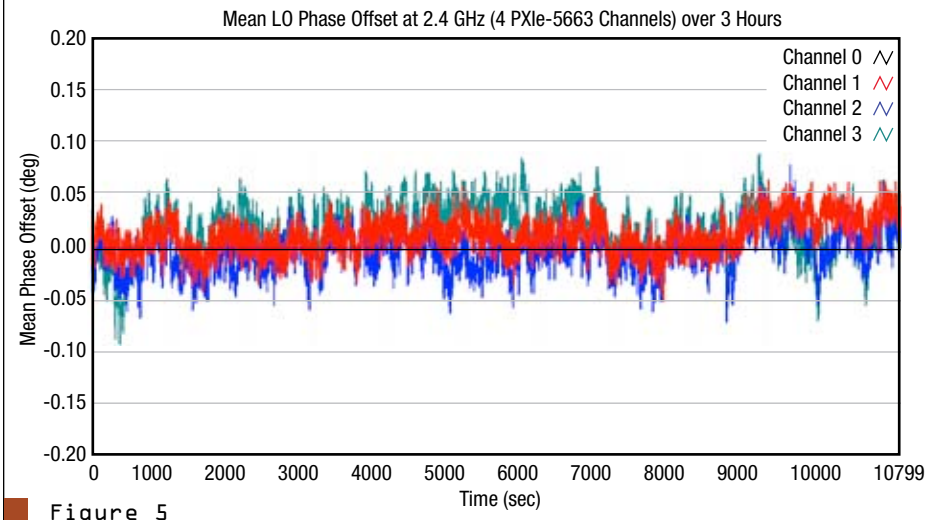

Figure 5

This graph illustrates phase versus time for a calibrated four-channel RF acquisition system over 3 hours.

lyzer, the RF analyzer system is capable of acquiring phase coherent RF signals for extended periods of time.

While emerging technologies such as MIMO and beamforming produce new challenges for test engineers, modular RF instrumentation provides a cost-effective and accurate measurement solution to this challenge. In fact, PXI instruments such as the NI PXIe-5663 VSA and NI PXIe-5673 can be configured for up to 4x4 MIMO and phase-coherent RF measurement applications. ▮▮

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Tools Enable Smart Radios to Do Complex Spectrum Navigation

Developing "smart" radios with Dynamic Spectrum Access capability is a complex task. The DoD has craft tools and program initiatives to help smooth the way.

Sharon Rushen, PAO Program Coordinator
CERDEC

A "smart" radio knows which radio frequencies are vacant, temporarily unoccupied, or occupied, and acutely bounces from one to the other providing seamless, efficient communication for soldiers in the battlefield. These radios are defined by software—also known as a cognitive radio. Engineers with the Communications-Electronics Research, Development and Engineering Center (CERDEC) have been developing key technologies that help such radios know what frequencies are open and what policy constraints exist in any given operational environment. Specifically, they have focused on solving the problems that arise when managing spectrum, which is the range of frequencies used in radio communications.

The challenge of managing spectrum to ease communications in operational environments has recently come to the forefront of Army communications. With the inundation of commercial wireless products and the variety of communication devices used by deployed military personnel, spectrum is in high demand, with finite supply.

According to Alan Scrime, branch chief of CERDEC's Spectrum Analysis and Management Branch, Improvised Explosive Devices and Unmanned Aerial Vehicles also crowd the spectrum. "We've got more jammers than we've ever had before to help stem the IED threat. We're using more unmanned vehicles, particularly UAVs, and they're very costly and very valuable to us. But if we don't have enough spectrum to operate, we can't fly them. That coupled with all the modern communications gear, that's more and more wireless gear," Scrime said.

Getting a handle on the number of systems that use spectrum and the

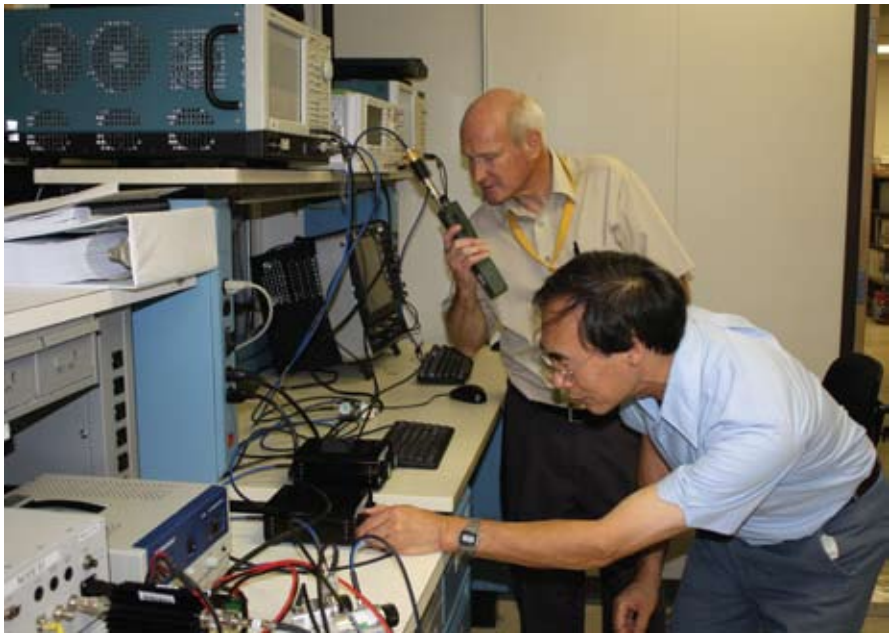

Figure 1

CERDEC electrical engineers, Bill Wong and Charley Konig, test a PRC-152 radio to ensure it is communicating with the cognitive radio software.

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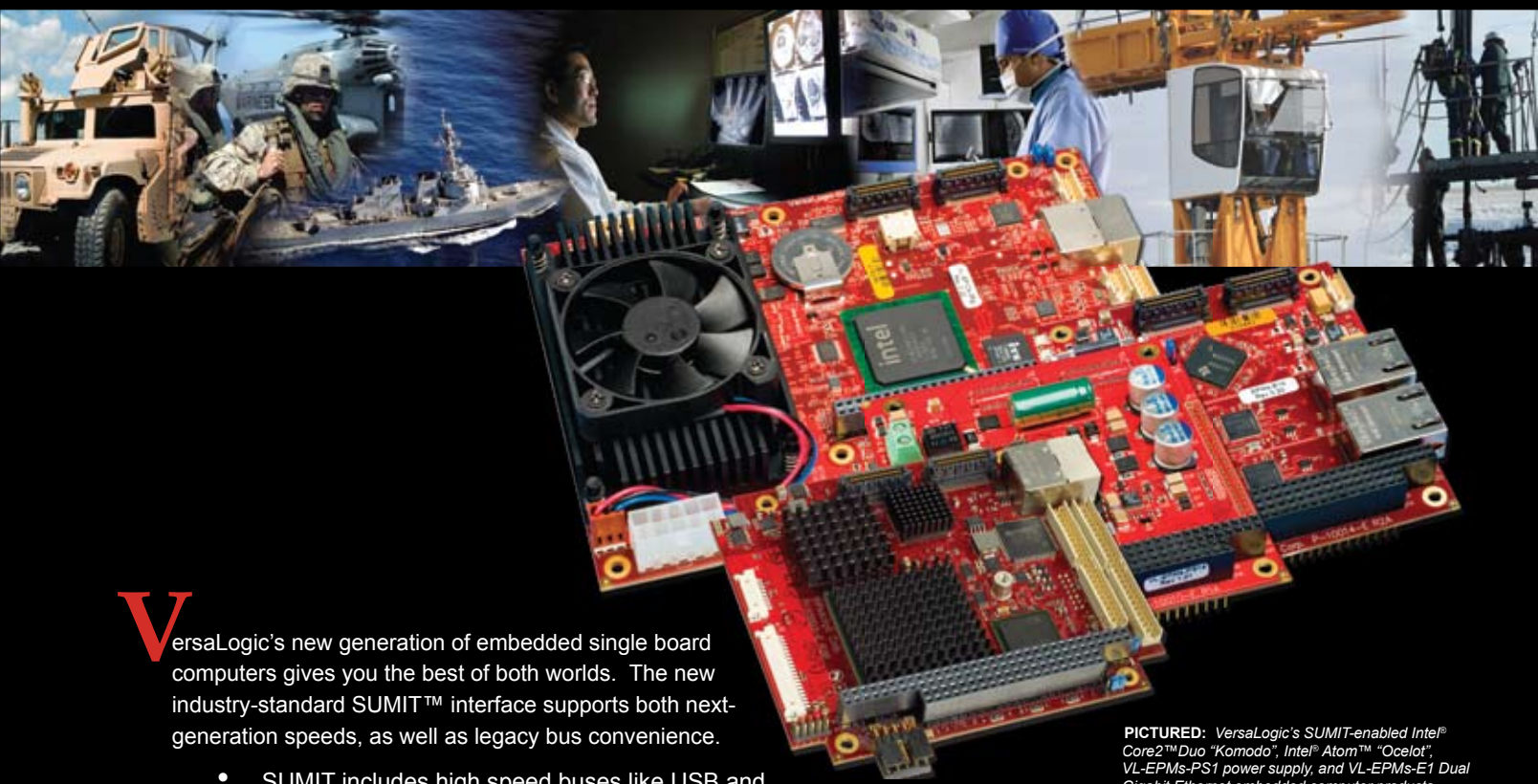

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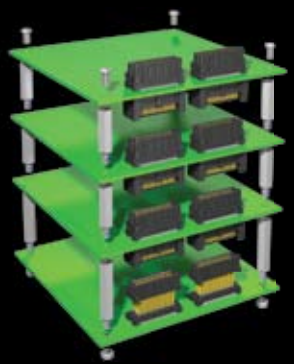

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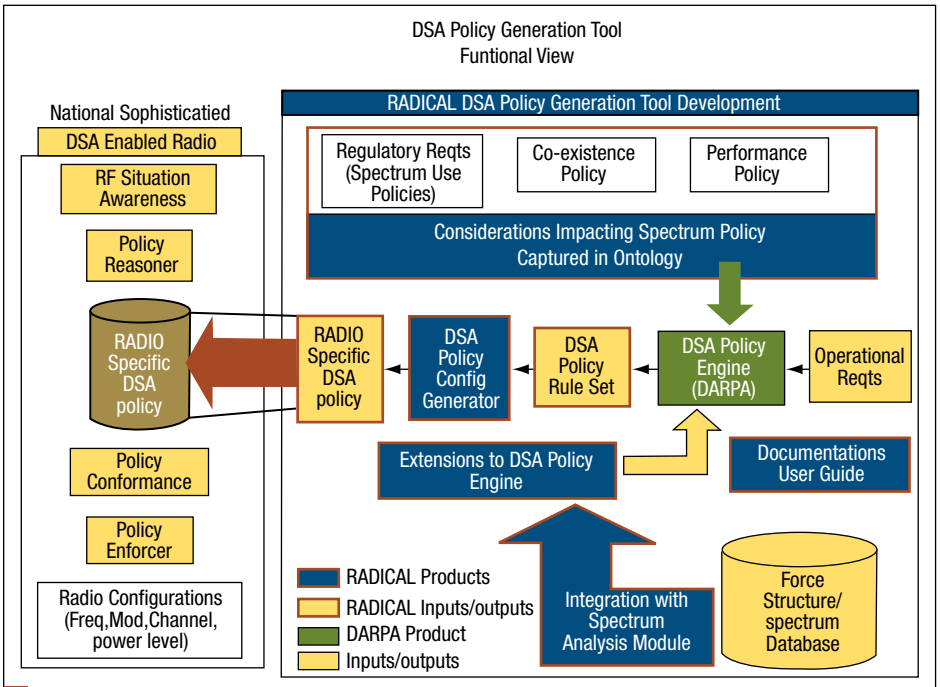

Figure 2

DSA (Dynamic Spectrum Access) policy generation tool provides the "do's and don'ts" of operating these radios when applying the DSA capabilities in the battlefield. DSA technology allows users of most modern radio devices to take advantage of underutilized spectrum by dynamically sensing and adapting to the radio frequency environment.

amount of spectrum available to them, calls for an understanding of the operational environment and that environment's policy requirements to use spectrum. Addressing that need, the Coalition Joint Spectrum Management Planning Tool (CJSMPT) is software that maps out a mission plan, taking into account the spectrum resources of the force structure, background emitters in the area of interest, and the terrain and propagation of the operational environment. The other, RF Adaptive Technologies Integrated with Communications and Location (RADICAL), is a technology program that aims to create software to automate policy regulations for using spectrum in any given environment. Figure 1 shows two engineers using these tools in a lab environment.

By looking at the physical aspects of an operational environment, taking into account topography and mission requirements, CJSMPT helps to take the guess work out of determining available radio frequencies. Depending on the unit in a given environment, the kinds of radios

and spectrum requirements, the software user maps out the unit locations and movement, and the software creates a frequency proposal that satisfies the mission requirements.

Easing Spectrum Assignment

The implementation of CJSMPT aims to help ease the management and assignment of spectrum by leveraging existing modeling and simulation capabilities in an automated planning tool. The tool supports all phases of spectrum operations from the highest level, which is determining what your spectrum requirements are when you deploy to a new area of operations, all the way down to the lowest level of the process, which is identifying and troubleshooting interference problems. It ties together all of the steps in that process and provides automated capabilities to assist the spectrum manager in doing his job.

In 2010, CJSMPT will become a program of record under a bigger program managed by the Defense Information Systems Agency called the Global Electromagnetic Spectrum Information System, a project that seeks to bring interoperability among the various spectrum management tools and capabilities being used in a given environment. In the fall, CERDEC's partner PD NetOps (Product

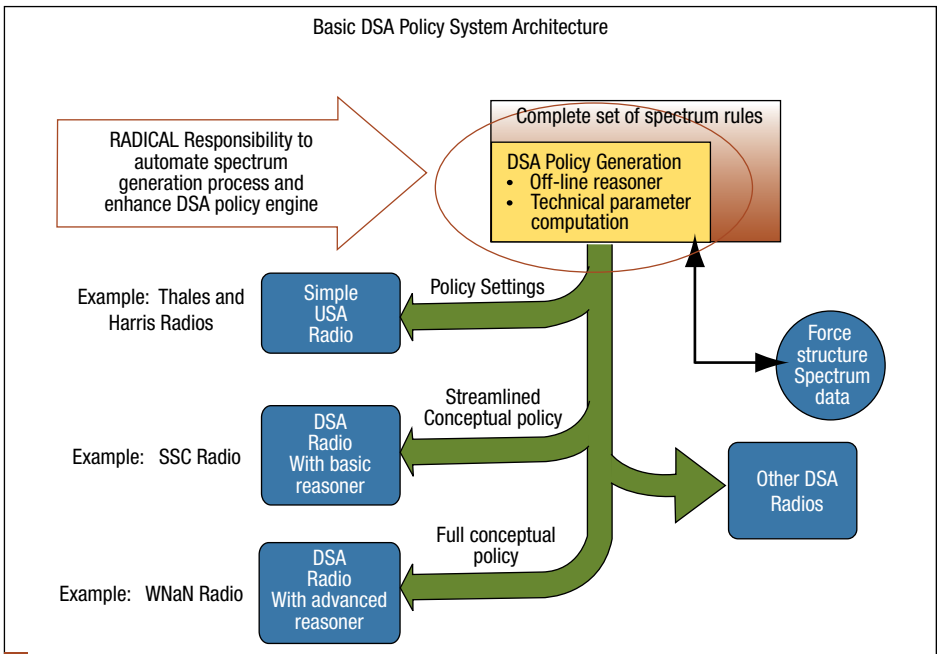

Figure 3

Shown here is the basic DSA policy system architecture using some example radios.

Director, Network Operations Current Force) will begin deploying CJSMPT to the United States European Command and the United States Central Command. CERDEC is currently in the final stages of development and testing of the CJSMPT software.

So far, the CERDEC team has seen good success in their most recent testing, particularly at their Joint Military Utility Assessment, which was done by the Joint Interoperability Test Command in Fort Huachuca. The event had participating subject matter experts from all four military services. In that evaluation the software was shown to have military utility, but there were some bugs and some functional enhancements that were deemed to be beneficial to get fixed or addressed before deployment.

After incorporating the high-priority software changes, the team will complete one more test to verify that the changes they have made have been implemented according to plan before passing the technology to PD NetOps, who will then deploy the technology before the end of the year. The plan now is to start the initial deployment of CJSMPT in theater some time in October. The obvious benefit of CJSMPT is in its fielding, but there are additional ways the project will aid warfighters, particularly for CERDEC engineers, who can leverage some of the technology's core capabilities for RADICAL.

Policy Generation Tool

One of the technologies developed under RADICAL is the policy generation tool—which aims to support the deployment and operations of Dynamic Spectrum Access (DSA)-enabled radios by automating spectrum policy generation using ontology and intelligent reasoning capabilities. DSA technology allows users of most modern radio devices to take advantage of underutilized spectrum by dynamically sensing and adapting to the radio frequency environment. The tenant of DSA is to ensure the operation of DSA-enabled devices without causing interference with the primary users. Figure 2 shows a functional view of the DSA Policy Generation Tool.

The current way to determine available frequencies for use in an environment is a manual process, using regulatory policies and requirements set by the FCC or National Telecommunications and Information Administration. This spectrum management process does not support deployment of DSA-enabled radios and limits the availability of frequencies soldiers can access in the battlefield.

According to Kwai Chan, RADICAL Army technology objective manager, RADICAL's DSA policy generation tool will provide the "do's and don'ts" of operating these radios when applying the DSA capabilities in the battlefield. "Let's say you are going to a deployment with a lot of coalition partners and operating at the same time. This is a very densely populated area and you run into interference very easily, and what's available to you would be limited because there are so many people in that area," Chan said.

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"DSA would allow you to listen to what frequency is available, use it, and vacate that frequency when the primary user comes back."

Harvesting Underused Frequency

The act of "borrowing" or "harvesting" an underutilized frequency is one of the key components of RADICAL that Chan and his team aim to address with their current work on a policy generation tool. The first step to accomplish such a task, Chan says, is to create an ontology of all of these requirements and additional information such as performance and coexistence requirements. "An ontology is the framework to establish relationships between the different requirements. So, once the requirements are captured in an ontology they can be fed the information along with other considerations such as mission needs, through the policy generation engine.

Chan is also leveraging existing work done by the Defense Advanced Research Projects Agency (DARPA) on a policy generation engine. DARPA has an initial engine that they put together, but Chan's group is expanding the ontology. So, under RADICAL, they're building an extension to the policy engine. According to Chan, the ontology and policy engine extension are two key components in the development of the DSA policy generation tool. The next step is to translate these spectrum operating policy statements into a set of parameters that can be interpreted by DSA-enabled radios. Figure 3 shows the basic DSA policy system architecture using some example radios.

Into the Hands of the Warfighter

Once Chan and his team have established their ontology and the engine's needed capability, they will have a sample policy that they will test and evaluate to ensure the engine is properly developed and doesn't contradict the policy statement. RADICAL is scheduled to be completed in 2012 and will give soldiers in operational environments the capability to use underutilized available spectrum in a specific area within the outlined policy constraints. "It's important in the sense that it allows them to communicate when the resources that are allocated to them are not available, and in this case the resource is spectrum," Chan said.

Both CJSMPT and RADICAL help create a radio that can better manage spectrum. RADICAL gives the radio parameters to work within to help prevent interference and jamming while CJSMPT will aid the GEMSIS program in picking specific frequencies to operate in. Both technologies are innovative approaches to aid in managing spectrum to help "smarten" radios and ease communications for deployed warfighters. ■■

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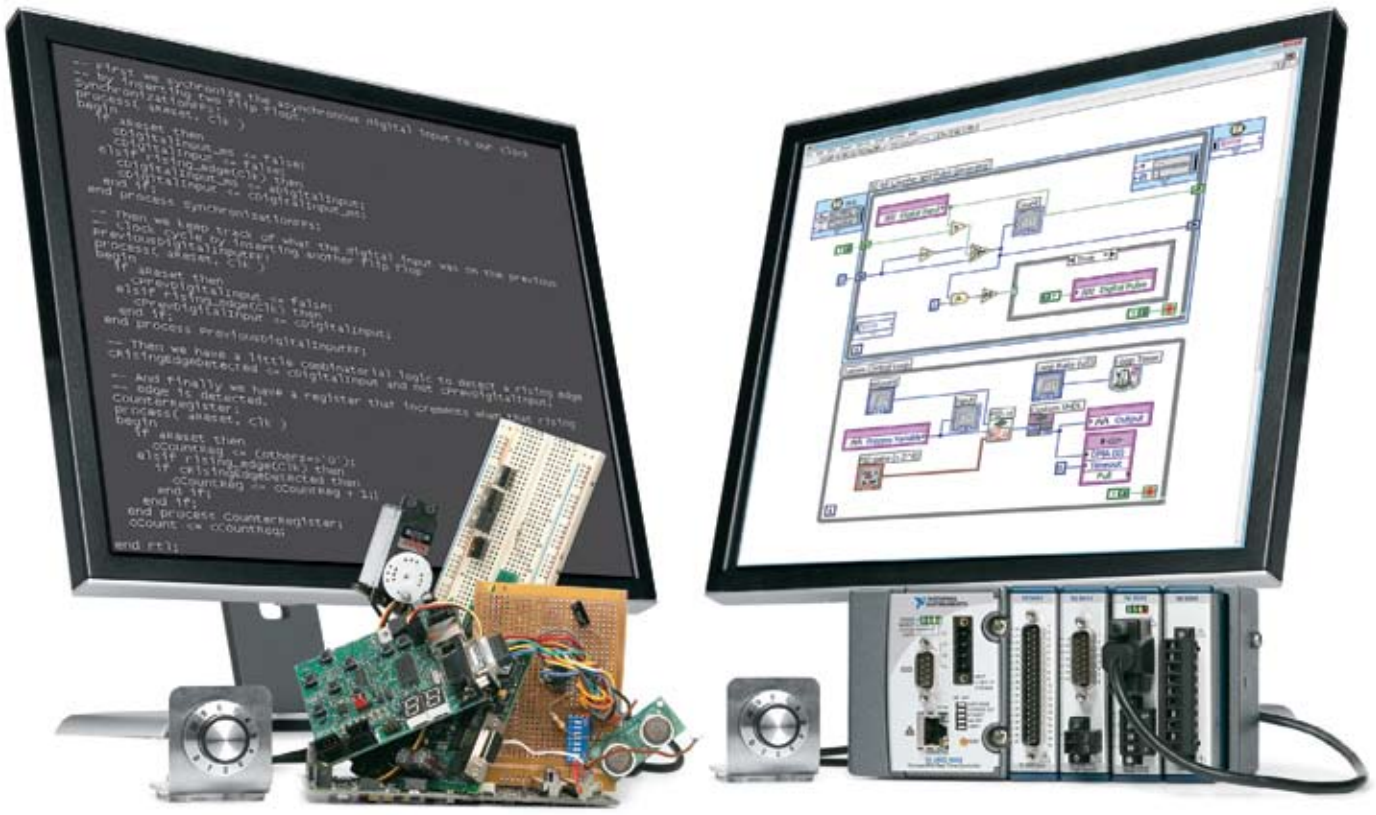

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Suhel Dhanani, Senior Manager, DSP
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Many of today's military electro-optical/infrared (EO/IR) systems require high-complexity, real-time video processing within a constrained power budget. The latest low-power, low-cost FPGA families—with their inherently parallel digital signal processing (DSP) blocks, an abundance of embedded memory blocks, large number of registers and high-speed memory interfaces—are ideal for developing the next generation of night vision, thermal imaging, head-mounted displays, avionics displays and other such EO/IR systems. The Predator UAV (Figure 1) is equipped with an electro-optical/infrared (EO/IR)-stabilized gimbal containing color and infrared video cameras, plus laser designation, laser spotting and laser range-finding capabilities.

However, the video processing required for these systems when done on FPGAs presents some unique challenges, such as implementing efficient external-frame buffer interfaces, interfacing different video function blocks, integrating signal processing to the on-chip processor, as well as performing the lengthy debug and prototyping cycles.

While building imaging video pipelines for such systems, engineers must not only keep in mind the low-cost and low-power characteristics of FPGAs, but also the video solutions provided by the FPGA

Figure 1

Predator is equipped with a satellite data link system; an Electro-Optical/Infrared (EO/IR)-stabilized gimbal containing color and infrared video cameras, plus laser designation, laser spotting and laser range-finding capabilities.

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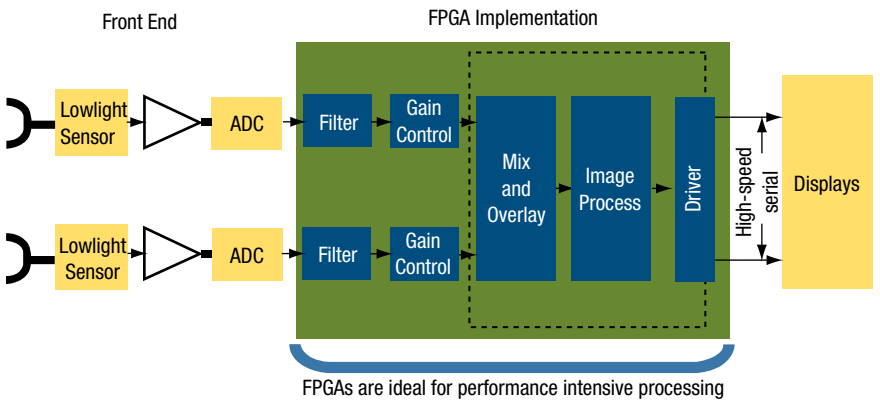

Figure 2

Shown here is a block diagram of a generic EO/IR sensor-processing signal chain.

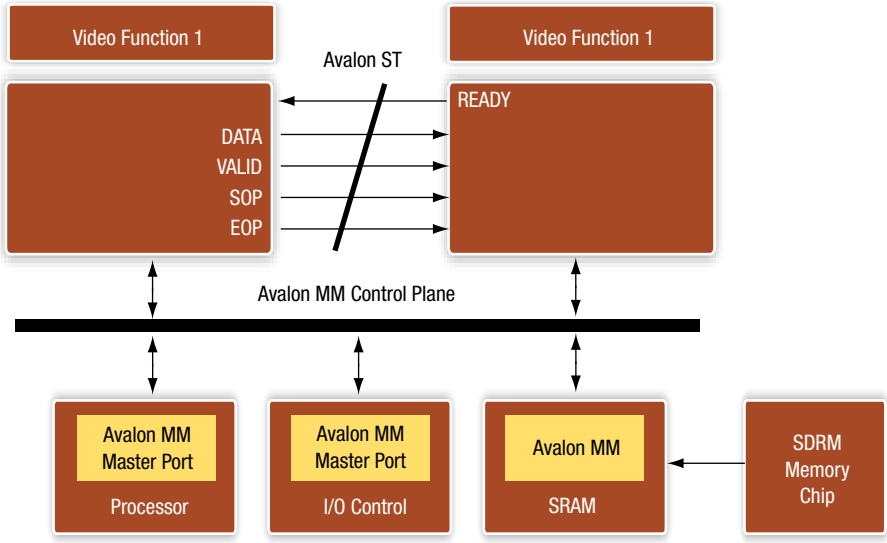

Figure 3

A video system using both Avalon-ST and Avalon-MM interfaces.

vendors that can significantly impact designer productivity. This article focuses on both the advantages of using the latest generation of low-cost, low-power FPGAs for video/imaging, and also the video solutions provided by FPGA vendors that enable rapid design and development.

Accelerating FPGA Video Designs for EO/IR Systems

A typical EO/IR system has sensor processing at the front end and complex image processing at the back end, as shown in Figure 2. FPGAs are ideal for implementing the back-end video processing, which is where high-performance video algorithms are implemented. If a custom sensor processing pipeline needs to be developed, that also can be integrated within the FPGA.

To rapidly design and develop these video signal chains, engineers need a design framework. That framework starts with video function blocks to implement specific image processing functions, such as image composition, multi-tap video scaling, deinterlacing and so on. Basic video processing building block functions are also required, such as frame buffers, color space conversion, gamma correction and so on. Also required are open video streaming and memory mapped interface standards so video blocks with differing latencies can be connected to each other as well as embedded processors and external memory. And finally, system-level design tools help integrate embedded processors and memory controllers. A design framework with all these components is useful to jumpstart video design development, thereby significantly improving productivity when developing video and image processing applications.

Video Function Blocks

EO/IR systems implement different types of image format conversion. Each design is a collection of different video functions—ranging from color space converter to a polyphase scaler and motion-adaptive deinterlacer. A collection of such video function blocks is required to build various image format conversion designs. A large productivity advantage for designers is having access to a library of hardware verified common video functions. This frees up developers to focus on proprietary functions such as custom image sensor processing or proprietary noise reduction algorithms. It's helpful for these blocks to have standard video interfaces that allow easy plug-and-play capability, work with the standard BT-656 video format, and enable rapid prototyping of the system.

A collection of reference designs using these video function blocks in conjunction with some custom code has been created. These designs not only showcase the different types of video designs that can be implemented using such a suite of IP, but also serve as a starting point for the design of even more complex or custom signal chains.

Open Interface Standard

A video signal chain is created by connecting multiple blocks with differing interface characteristics, different latencies, and sometimes each built by a different design team. Connecting different blocks to each other so that inter-block communication and error handling is coherent is in many ways as complex as creating the video function itself. In addition, some functions may need to be controlled by an on-chip processor. The in-

Figure 4

The Video Development Kit that works with a range of inputs/outputs—Composite, DVI, S-Video and VGA.

terface between the processor and a given function is often custom designed and may be different for each function block. The design and debug of such an interface is different from the key value-add algorithmic designs developed by video system designers.

What is needed is a standard interface protocol that can be used to connect the different blocks and control the functional block operation using an on-chip processor. The key characteristics of such an interface are its "openness" (non-proprietary) and its (low) overhead (in terms of logic and performance).

One such protocol is the Avalon Streaming (Avalon-ST) video protocol. This is a packet-oriented method of sending video and control data from one video-processing block to another. The key feature of this protocol is that it does not require any form of license. Using this specification does not in any way lock the design into using FPGAs from specific vendors; however, all the video IP and video reference designs from Altera utilize this interface.

The Avalon-ST video protocol defines a video stream as packets of video data and packets of control data. A video data packet has two sets of parameters: static parameters that cannot vary at run time, such as bits per color plane and sequence of the color plane; and dynamic parameters that can be changed at run time, such as frame size, field size and interlace format.

Controlling Video Functions

Often it is necessary to control the behavior of a video function by using control logic such as an embedded processor. This has defined a standard slave interface—Avalon Memory Mapped (Avalon-MM)—that enables a video block and an on-chip processor to communicate. This interface allows two-way communication where the processor can program the video function, and the function can raise interrupts to notify the processor of exceptional events. Figure 3 shows how different video functions can be connected using this protocol.

Video systems generally include an embedded processor and a memory subsystem to manage the video frames in the external memory. Connecting these elements with the video signal chain requires processor instantiation, DDR memory interface and system-arbitration logic design. Tools such as SOPC Builder automate the task of integrating hardware components. Traditional design methods dictate that HDL modules must be manually written to wire together the pieces of the system. Using SOPC Builder, the system components in a GUI are specified and the interconnect logic is automatically generated. HDL files are generated that define all components of the system and a top-level HDL file that connects all the components. Either Verilog HDL or VHDL are generated equally.

Video is very time-consuming to simulate in software, thus debug and verification are typically performed in hardware with actual video signals and displays. Different video applications use different physical interfaces (such as composite, DVI, SDI, HDMI, etc.) to transport video in and out of the chip. A complete video development system with a range of inputs and outputs is required for rapid prototyping and debugging a video design.

Figure 5 shows a video development kit based on the Cyclone III EP3C120 FPGA. This video kit comes with two daughtercards allowing composite, S-video and DVI video sources/sinks to be connected to the development board. Also, the video development kit is bundled with designs that showcase 4-channel picture-in-picture, 1080p color space conversion and an HD encoding design using H.264. A design framework that includes the development kit, video I/O daughtercards, IP for video functional blocks as well reference designs that provide a starting point for a design—can significantly jumpstart the development process providing improved designer productivity.

The latest military EO/IR systems demand high-performance video processing combined with low power consumption. This trend is intersected by the increasing signal processing capability of low-cost FPGAs—making FPGAs an almost default platform for next-generation EO/IR systems. FPGA vendors are responding to this market need by developing a suite of IP, design tools and development kits that help rapid design, development and prototyping of such systems. The platform selection for an EO/IR system must also include a careful survey of the video processing solutions offered by the different vendors—since the right combination of IP, reference designs, development kits and system-level design tools can significantly increase design productivity and shorten time-to-market. ■■

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Expansion Bus	PC/104 ISA Bus			✓						✓	✓	✓	✓	✓	✓
	PCI-104 PCI Bus	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓
	PCIe/104 Express Bus	✓	✓												
CPU and BIOS	CPU Max Clock Rate (MHz)	1860	1200	1400	1400	1400	1400	1400	1400	650	650	650	650	500	500
	Intel SpeedStep Technology	✓	✓	✓	✓	✓	✓	✓	✓						
	ACPI Power Management	3.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	2.0	2.0
	Max Onboard DRAM (MB)	2GB	2GB	512	1GB	512	1GB	1GB	1GB	256	256	256	256	256	256
	RTD Enhanced Flash BIOS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Nonvolatile Configuration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	RTD Quick Boot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	USB Legacy (Keyboard & Boot)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Peripherals	Watchdog Timer	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Solid State Hard Drive Disk Chip	8GB	8GB	8GB	8GB	8GB	8GB	8GB	8GB	8GB	8GB	8GB	8GB	8GB	8GB
	Audio				✓	✓	✓	✓	✓		✓	✓	✓		
	Analog Video	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA	SVGA
	Digital Video	LVDS	LVDS	LVDS	LVDS	LVDS	LVDS	LVDS	LVDS			TTL	LVDS	LVDS	
	PS2 Mouse/Keyboard/Utility Port	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	USB Mouse/Keyboard	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
I/O	RS-232/422/485 Ports	4	4	4	4	4	2	4	2	2	2	2	2	2	2
	SATA	2	2												
	USB 2.0	6	6	4	2	2	4	2	4	2	2	2	2	2	2
	Gigabit Ethernet	1	1												
	10/100Base-T Ethernet			1	1	1	1	1	1	1	1	1	1	2	1
	Parallel Port				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	aDIO (Advanced Digital I/O)	14	14	14	18	18	18	36	36	18	18	18	18	18	18
	aAI (12-bit Advanced Analog Input)	8	8												
	multiPort (aDIO, ECP, FDC)				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SW	ROM-DOS Installed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	DOS, Windows, Linux	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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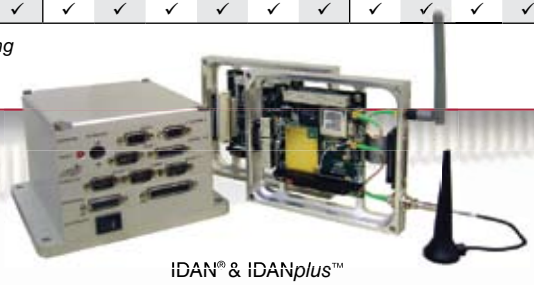

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Bus	Active Bus	PCI	PCI	ISA	ISA	PCI	PCI	PCI	PCIe	ISA	ISA	ISA	PCI	PCI	PCIe	PCI
	Passthrough Bus	ISA				ISA	ISA		PCI				ISA		PCI	ISA
	DMA or PCI Bus Master	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓
	McBSP Serial Ports	✓	✓			✓	✓	✓	✓							
Analog Input	Single-Ended Inputs	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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Power over Ethernet Blends Distributed Power and Data Management

As Ethernet gains in popularity and energy consumption and cost concerns rise, Power over Ethernet provides coherent data and energy administration options to military systems developers.

Steve Yates, CTO
ADI Engineering

When building sophisticated networked electronic systems, power and data distribution are two of the biggest challenges for military systems integrators. The labor, material and logistical costs of laying cable are growing as systems become more sophisticated. For next-generation high-performance military systems placing an increasing emphasis on data throughput and energy management and conservation, the struggle is significant. And, while wireless approaches limit cabling, they have significant restrictions in operational use, due to limitations in battery capacities and the ongoing need for clandestine operation.

Power over Ethernet (PoE) is a technology gaining significant momentum in commercial and industrial applications and which has significant potential for military systems in simplifying distributed system administration while increasing performance and managing costs. PoE utilizes standard Ethernet cables, such as Category 5/5e (Cat5), to transmit both power and data on the same lines to distributed devices. Because of the ubiquity and low-cost of Cat5 cabling, PoE installations could be used to provide both power and data in a variety of scenarios, while limiting cabling complexity and cost. Yet, while PoE has been utilized for several years in commercial/industrial circles, PoE is relatively new in military circles. While more COTS PoE solutions are becoming available, as with any technology, PoE's utility depends on the application. So, proper evaluation of PoE's advantages and disadvantages is necessary to determine whether it is appropriate for a given system.

Figure 1

The Parvus DuraMAR1000 Military-Grade Ethernet Switch provides three PoE-enabled Ethernet ports and is designed for wireless and mobile applications with MIL-STD-810F, MIL-STD-461E and MIL-STD-704E standards compliance.

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Figure 2

The Cinnamon Bay SBC with PoE+ Option Module—from ADI Engineering—provides a complete Intel Atom-based embedded computing solution with extended temperature operation, low-power consumption and an 802.3at-compliant PoE+ gigabit Ethernet interface for power and data.

Features of the Current 802.3af Standard for Power over Ethernet

Voltage range	The Power Sourcing Equipment (PSE) provides 44-57 VDC, nominally 48 VDC.
Power	Selectable current between 10 and 350mA, resulting in up to 15.4 W, though with cable losses, about 12.95W are typically available at the Powered Device (PD).
Ethernet versions	Support for 10BASE-T, 100BASE-T, 100BASE-TX, and 1000BASE-T (Gigabit Ethernet) data protocols and bandwidths.
Power modes	Two power modes determined by the PSE, with Mode A providing power on pin pairs 2 and 3 (pins 1 and 2 and pins 3 and 6, which also carry data) and Mode B providing power on pin pairs 1 and 4 (pins 4 and 5 and pins 7 and 8, which are the spare pairs in 10 Mbps and 100 Mbps Ethernet).
Non-intrusive signaling and detection	This allows interoperability of PoE-enabled and non-PoE devices on the same network, and to allow PDs to signal their power requirements to PSEs. A PD signals itself to a PSE by implementing a signature resistance of 25 kOhms between the powered pin pairs. An additional classification step allows the PD to optionally indicate the amount of power needed. If omitted, the PSE assumes full power is required by the PD.
Cabling	Compatible with Cat3, Cat5, Cat5e and Cat6 cabling.

Table 1

Summarized here are the features of the current 802.3af standard for Power over Ethernet.

PoE Is Standardized

In 2003, the venerable IEEE 802.3 Ethernet standard incorporated PoE as IEEE std. 802.3af. Today, IEEE std. 802.3at (known as PoE+) is close to ratification and incorporates new features that extend the original standard. The ideas behind these standards are not new, as there have been many attempts to standardize power and data distribution systems to reduce cabling costs.

A variety of power-line communications standards and approaches have been tried, but these approaches try to su-

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perimpose data on relatively low-quality power lines that are typically ill-conditioned for data. As a result, signal quality and signal distribution issues have limited the data bandwidth, distance and utility of power-line communications. More recently, USB has been a very successful approach for providing power and data to distributed devices along a single cable. The standardization and ubiquity of USB have led to a plethora of successful industrial and military implementations.

Advantages over Power Line and USB

PoE has significant advantages over both power-line and USB communications. Relative to power line, PoE is based on Ethernet so it starts with a high-fidelity data cable, injecting power on the cable. The result is that the limitations are on the power side, relative to the electrical current capacity of the cable, not on the data side. So PoE can be utilized in high-performance Gigabit networks. And, unlike USB, which has noteworthy current capacity limitations, PoE on standard cables can provide significantly more power. Furthermore, USB has major host/client topology limitations, while PoE benefits from the flexibility of the purely distributed nature of Ethernet. Table 1 summarizes the features of the current 802.3af standard for PoE.

While the power capabilities of the 802.3af standard are reasonable for typical PoE devices such as IP phones and wireless access points, many military applications that involve higher-powered peripherals such as IP cameras for security and sophisticated embedded computers with power-hungry displays utilize more power. The upcoming 802.3at standard extends the current standard by utilizing all wires for power and allows such PoE+ PSE devices to provide up to 24W of power (50W in certain implementations), while maintaining backward compatibility with the 802.3af standard. PoE+ implementations are not supported on Cat3 cables, which have greater limitations than Cat5e and Cat6 cables. It also must be noted that the higher power capabilities and other features of PoE+ are still under consideration and there are issues that remain to be sorted out with the pending standard update.

PSE devices that provide the power are typically of two types, endspans or midspans. Endspans (also known as endpoints), such as PoE-enabled Ethernet switches, provide power to their Ethernet interfaces, allowing any connected PD device to draw power. Midspans are essentially power supplies with two Ethernet connections and the conversion between PoE and non-PoE Ethernet. Midspans connect to standard non-PoE switches on one side and PoE-enabled Powered Devices (PDs) on the other side.

PoE Is Effective

For military systems integrators, PoE has many significant advantages over separately managed power and data distribution implementations. Primary among these is the concept of "no new wires,"

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since PoE utilizes standard cabling and works with common Ethernet connector interfaces. While standard Ethernet cabling and connectors may not be rugged enough for certain military applications, most Ethernet cabling in military installations actually will be over-specified from a current- and data-carrying capacity perspective, and thus still appropriate for PoE implementations.

The advantages of "no new wires" are major, since existing cabling infrastructures can be utilized, greatly simplifying installation and reducing installation cost. And, when new network/power cabling is installed, expensive conduits and electrician labor are avoided, since PoE cables are classified as low voltage and not subject to Underwriters Laboratories (UL) or other regulations.

Another advantage of PoE is that individual devices on the network can eliminate AC power supplies, wall-wart transformers and other high-voltage AC power conditioning circuits. This capability reduces the cost and size of devices, while also reducing the potential for failure of individual devices. And, with all the focus on energy conservation and management within the military and civilian communities, PoE provides a level of consolidation and flexibility of power distribution that allows more centralized management of energy consumption, with the ability to consolidate battery backup and surge protection. PoE also provides remote power diagnostics and status reporting that is not available from conventional separate power and data wiring techniques. Finally, since distances of over 300 feet can be realized with Ethernet cabling, it is possible in certain applications to isolate PSEs and their power sources in protective surroundings, separate from harsh PD environments.

In general, PoE will make the most sense when local power sources are scarce and separately distributing power is relatively costly and cumbersome. Conversely, because PSE and PD devices by their nature incorporate PoE circuitry, unless that circuitry is utilized by a reasonable percentage of the devices on the network, PoE may represent a cost burden. This may occur on existing networks that sparsely supplement traditional power sourcing with PoE, so a careful cost-benefit analysis should be undertaken. Additionally, while PoE can minimize single points of failure by simplifying the power circuitry on PDs, PoE can be vulnerable to attack on PSEs, since a single PSE may provide power to multiple PDs. So, as with any distributed power sourcing approach, systems integrators may wish to supplement PoE with local backup power sources, such as batteries on critically important PDs, as appropriate.

Available Technology

The good news for military systems designers is that PoE is increasing in popularity and more and more COTS PoE-compliant devices and technologies are coming to market. While many of these devices are still rooted in commercial and industrial implementations, as can be

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seen from the listing of products below, a migration to more rugged military-grade solutions has started.

For rugged endspan PSEs, companies such as MOXA, Sixnet and Ethernet Direct offer industrial-grade PoE-enabled Ethernet switches with DIN-rail mounting. Parvus' DuraMAR1000 (Figure 1) is a military-grade IP router with multiple PoE ports and supports MIL-STD-810F shock, vibration, humidity, crash safety and water immersion standards with MIL-STD-461E EMC compliance and a MIL-STD-704E power supply. The Parvus unit is designed for mobile applications such as in-vehicle installations. For midspan injection of power, Phihong and SL Power Electronics have several options, and Citel's C2MJ8-505-RJ is designed for outdoor applications with a rugged housing and extended temperature operation.

Cameras and More

On the PD side, a variety of COTS PoE-based IP cameras are available for security and surveillance applications. Included in these are the Arecont Vision AV3105 PoE camera (with 3 Megapixel resolution and H-264 compression) and ACTi's ACM-1431 PoE camera (with MPEG-4 and IP-66 weatherproofing for outdoor operation). For those looking to develop custom embedded computer systems, ADI Engineering's extended temperature Cinnamon Bay SBC with PoE+ Option Module supports the new 802.3at standard, and because it is based on the advanced low-power Intel Atom processor, 20+W of PoE power is available for peripherals (Figure 2).

At the silicon level, several vendors provide single-chip solutions for PSE and PD devices, which manage PoE signaling and convert inputs to a regulated DC voltage suitable for powering electronic circuits. With the addition of appropriate transformers and other passives, complete PoE PD board-level solutions can be created with extended temperature components such as the On Semiconductor NCP1081 PoE-PD Interface & DC/DC Converter Controller and the Texas Instruments TPS23754 High Power/High Efficiency PoE Interface and DC/DC Controller. Additionally, Texas Instruments' TPS23481 High-Power, Wide-Voltage Range, Quad-Port Ethernet Power Sourcing Equipment Manager component can be utilized in the creation of board- and system-level PSE solutions with extended temperature requirements. ▮▮

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System Development

Cooling Challenges in Airborne Systems

Airborne Electronic Systems Face Unique Cooling Hurdles

Designing airborne cooling systems means factoring in several environmental variables. Air density, temperature, humidity and pollutants must all be taken into account.

Bob Sullivan, Vice President of Technology
Hybricon

Modern digital and analog electronics products are finding applications in multiple airborne systems. These applications are as diverse as communications, platform system level control and signal processing, visual data transmission information processing and sensor data collection. As these systems pack in more computing power—many based on VPX—thermal management of these systems is becoming an ever increasing challenge.

A number of design considerations need to be taken into account to meet the operational challenges in airborne systems. Among these is the variation of air density and temperature that occurs with changes in altitude. Another is the vibration characteristics of the platform. Added to those are other environmental conditions that are unique to where the platform and system are designed to operate—such as humidity and pollutants in the air (including sand and dust). Also important is the ability to clean the system with aggressive cleaning compounds.

Figure 1

Most airborne systems are designed so that air is the cooling medium used for thermal management of the electronic components. This means using either recirculated air within the airborne platform or ram air, which is the directing of outside air into equipment cavities.

Air Properties

A central idea in the airborne cooling challenge is understanding the density of the "fluid" used for cooling, which will often be air. These air properties need to be understood in order to have a solution that meets the customer's operational requirements. Aside for the the air density, other properties are important to understand, such as pollutants and moisture. Those factors can impact design considerations such as material finishes and air mover selection.

With any electronic system application, the basics of power dissipation, system size, critical device maximum temperatures and overall packaging architecture are required to be understood, characterized and stabilized for Mean Sea Level (MSL) operation prior to extending the system application to airborne applications.

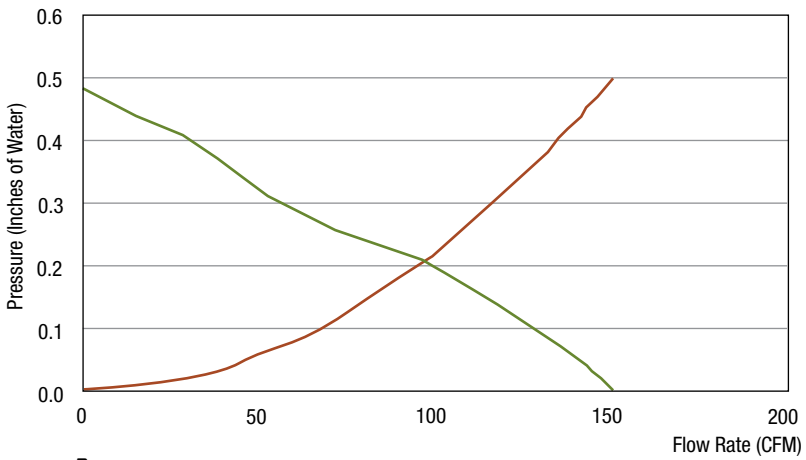

Figure 2

Here the system resistance of a specific geometry is plotted against the fan performance curve of pressure delivery versus flow rate.

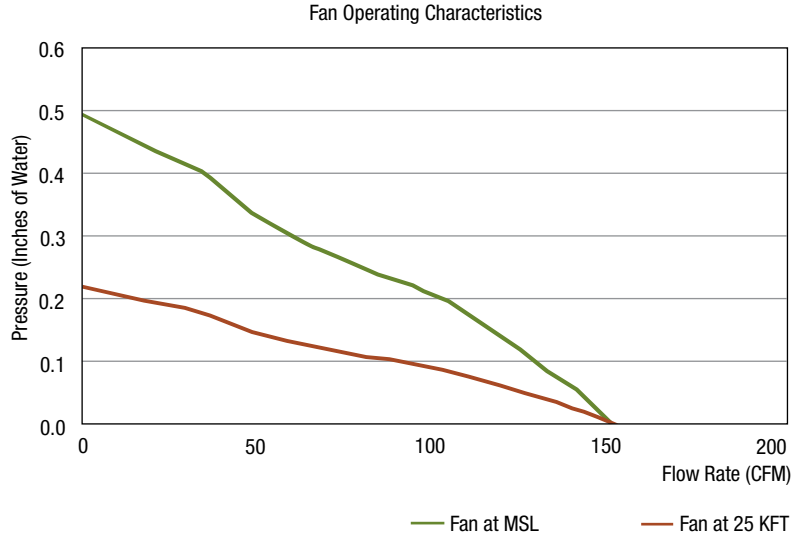

Figure 3

Plotted here is the relative impact of the density change of air as altitude is increased. The plot compares the 20°C Mean Sea Level fan performance to the same air mover operating at a higher altitude condition.

Altitude-Driven Changes in Environment

Flight and operational characteristics of aircraft are governed by the physics of fluid mechanics, which has grown into the field of aeronautics. This is also true of electronic systems operating in these same environments. Air temperature and air density variations directly affect the ability of a thermal management system to move the heat energy away from critical components so they can operate reliably. This is why characterization of the operating altitude for the airborne electronic systems is so important. Information is available that plots the variations in air temperature and air density as altitude is increased from Mean Sea Level Conditions. This information and data are available from governmental agencies, such as National Aeronautics and Space Administration (NASA) and National Oceanic and Atmospheric Administration (NOAA).

The vast majority of the airborne systems are designed so that air is the cooling medium (fluid) used for thermal management of the electronic components (Figure 1). This can be in the form of recirculated air within the airborne platform, or ram air. "Ram air" is the directing of outside air into equipment cavities in order to lessen the volumetric flow rates that fans need to drive through the chassis.

There are a number of reasons why air is a good choice for cooling airborne electronics, the first of which is simplicity—air is almost always there and available. Also, unless liquid cooling is built into the platform, liquid cooling will increase the size, weight and power. Simpler system designs are available for air-based cooling since fans move air, while liquids require pumps, valves, pipes and heat exchangers. Ram air may be available from the platform to provide cooling capacity when operating at the platform's prescribed operating altitude. It's important to remember that airborne platforms themselves are "fluid" devices since they are operating in the fluid we call air.

Understanding the Environment

For any convection heat transfer to be initiated—either natural or forced convection—characteristics of the operating "fluid"—in this case air—need to be identified. Air is the default choice for airborne systems. The density of the air needs to be known and understood and its expected changes need to be characterized. This characterization of the fluid is needed to design an acceptable thermal management solution.

Natural convection cooling is described as an increase in the temperature of the air particles adjacent to the warm surface of the system dissipating heat, thus changing its local density and causing the air particle to become more buoyant in comparison to the air particles away from the warm surface. This is what drives natural convection currents in closed off spaces in airborne platforms, where ram air may not be able to be implemented. This effect in traditional heat transfer terminology is characterized by the Grashof Number. Stated in a simpler manner, the Grashof Number is the ratio of buoyancy forces compared to the fluid viscous forces acting on the fluid particle.

To see where air density comes into play with natural convection cooling, it's helpful to review some heat transfer theory and correlations. The convective heat trans-

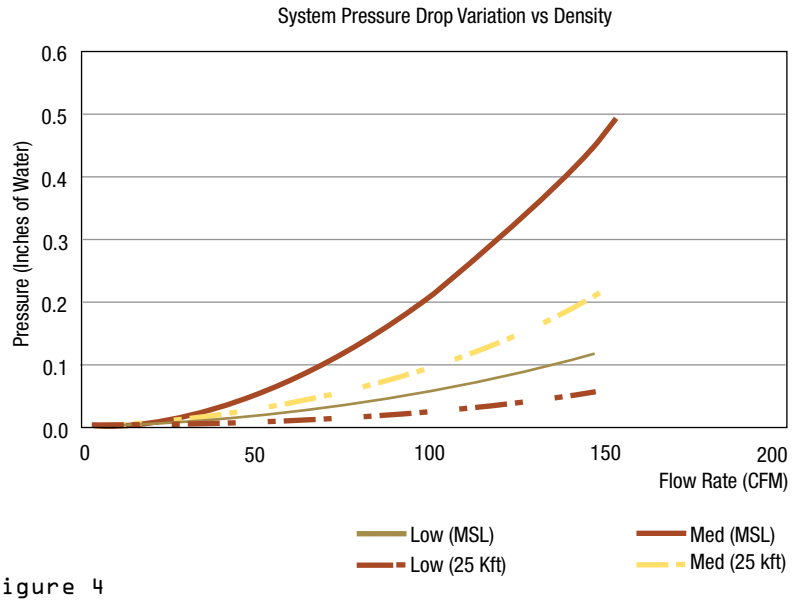

Figure 4

Illustrated here is the relationship to system pressure drop characteristics for the medium and low system resistance curves. Note the relative change in flow resistance as air density is reduced.

fer number is related to a quantity called the Nusselt Number, which is the ratio of convective to conduction heat transfer across (normal to) the boundary. As density decreases there is a lessening of convective heat capability for natural convection, since the buoyancy force effects acting on the air are being eliminated by the decrease in density of lighter air at altitude.

Impact on Cooling Capacity

To see how this impacts the cooling capacity of a system that is expecting to use natural convection cooling, consider a typical value for convective heat transfer coefficient for natural convection being 10 W/m^2-C. Cutting the air density by 50 percent—which is equivalent to going from sea level to 12,000 feet in elevation—reduces the convective heat transfer coefficient also by 50 percent, so one needs to take air density into account when dealing with airborne systems.

Forced convection systems are also impacted by changes in air density as we increase in altitude. The fundamental design point in all forced convections systems involves the fact that only a single operating point can be realized with a given chassis geometry when using a specific air-moving device. Figure 2 shows the system resistance of a specific geometry plotted against the fan performance curve of pressure delivery versus flow rate. The graph shows a single volumetric flow rate delivered from a set geometry of entrances, bends and contractions, finned surface, along with the air filter and EMI filter effects on flow rate. This is what maintains thermal management of critical electronic devices within the same system.

Air Density and Flow Rate

Air density plays a primary role in the determination of the minimum required flow rates. For example, if the air density is cut by 50 percent, the total volumetric flow rate would have to double to provide the same system cooling capacity as we go up in altitude. Fan performance and system pressure drops now need to be evaluated, to determine the final volumetric flow rate needed for cooling critical components. Fans are greatly influenced by air density, since they are mass moving devices, and as the mass density of the air changes, the performance of the fan must change. The relative impact of the density change of air as altitude is increased is clearly shown in the Figure 3. The plot compares the 20°C Mean Sea Level fan performance to the same air mover operating at a higher altitude condition.

System flow resistances are also impacted by reductions in fluid densities. Various studies and published papers over the years have calculated the relationship between system pressure drop and air density. Applying this relationship to system pressure drop characteristics for the medium and low system resistance curves is shown in Figure 4, which also shows the relative change in flow resistance as air density is reduced.

It's important to remember that the performance of the air mover—a fan in this case—is also reduced with air density changes. Recombining the changes in system resistance and air mover performance, Figure 5 shows the comparison of system operating points for systems when the fluid density is changed. All of the previous discussion leads to the following key idea: The chassis design must ensure that the operating points of the system provide the minimum required flow rates for cooling the payloads at all of the environmental conditions of temperature and altitude where the system is intended to operate. This is required to maintain critical component temperatures within their known temperatures ratings to provide reliable electronic system operation in airborne applications.

More Environment Challenges

There are other environmental challenges that arise in the application of electronics in airborne systems, including vibration characteristics of the airborne platform as well as humidity and pollutant. To deal with vibration, chassis and enclosure designs need to select air movers with ball bearings rather than bushing-style bearings. This is due to vibration causing high cycle fatigue failures and causing microscopic surface fractures in the high contact area of bushing style bearings. This accumulated fatigue damage results in premature failures of some fan bearings and thus shorten the life of the onboard electronics.

Humidity content in the air for airborne systems and platforms also varies in flight operations. Airborne platforms operate in conditions as diverse as high humidity, mean sea level conditions to low humidity

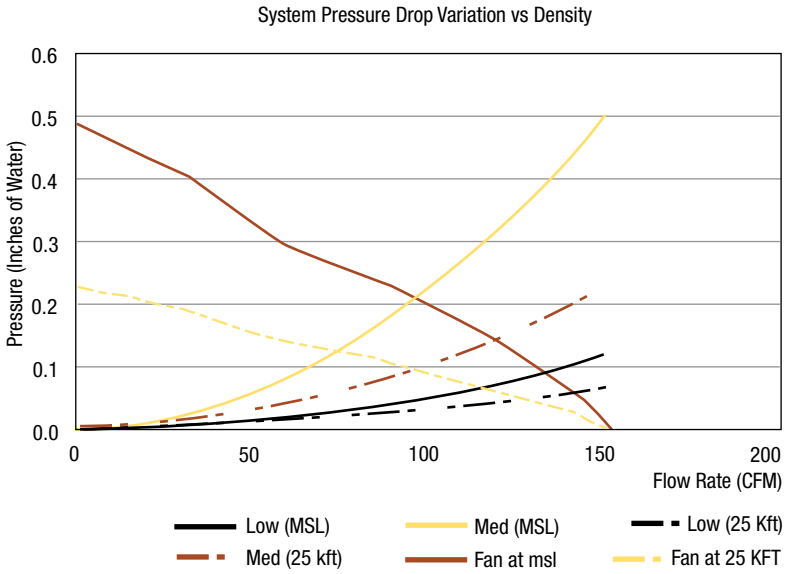

Figure 5

Shown here is the comparison of operating points for systems when the fluid density is changed.

cold air at operating altitudes. During the process of going from mean sea level conditions to operating altitudes, the platform will be traveling through multiple air layers that are caused by normal weather patterns and atmospheric conditions. Airborne platforms travel through and in the clouds, where 100 percent relative humidity is capable of wetting all surfaces exposed to the air, including enclosure air passages and enclosure surfaces. Good design practices for enclosures account for this when selecting the materials and surface finishes for the thermal management system to ensure that corrosion products, which will degrade the performance of the thermal management system, do not have a chance to form.

Particulate and chemical pollution content in the air where airborne systems are operating also varies extensively. Airborne platforms operate in conditions as diverse as high humidity, marine conditions with high chloride conditions to low humidity cold air at operating altitudes with possible sulfur, bromine and nitrous oxides. Again, good design practices for enclosures take these into account.

Cleaning Compounds

Airborne platforms operate in diverse conditions where aggressive cleaning methods may need to be applied to remove contaminates from all surfaces where the system was operating. These contaminates can be in the form of dust, nuclear, biological or chemical (NBC) compounds that end up in the system. These also must be taken this into account.

There are multiple challenges in designing enclosures for airborne applications, including increasing power dissipations of VPX-based systems, low weight requirements and higher operating altitudes. The primary challenge is the thermal management challenge centered on an understanding of the multiple ways that air density impacts the thermal management system in air-cooled electronic systems. Knowing this variation and managing it in the system development leads to a robust and reliable system enclosure design. In addition to this, other environmental factors also must be taken into account when designing electronic systems for airborne applications. ▮▮

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Technology Focus

Solid-State Disk Drives

SSDs Gain Capacity and Embrace SATA Interface

Solid-state drives continue to gain momentum in the military embedded realm. The correct crop of SSD products has moved to the Serial ATA interface.

Jeff Child
Editor-in-Chief

Because they have no moving parts, flash-based solid-state disks (F-SSDs) are able to operate under harsher conditions than magnetic hard disk drives. And since F-SSDs targeted for military and aerospace apps use the same fundamental flash components as the consumer realm, the price advantages can be leveraged across all markets. Any downside associated with flash-based disks is quickly falling by the wayside. Random access speeds rival and now beat other media, retention and rewriting cycles have dramatically increased, and many systems offer a single-control erase-all function with or without power for security-sensitivity applications. Those factors have moved F-SSDs closer to the forefront as the lead option for rugged mass storage.

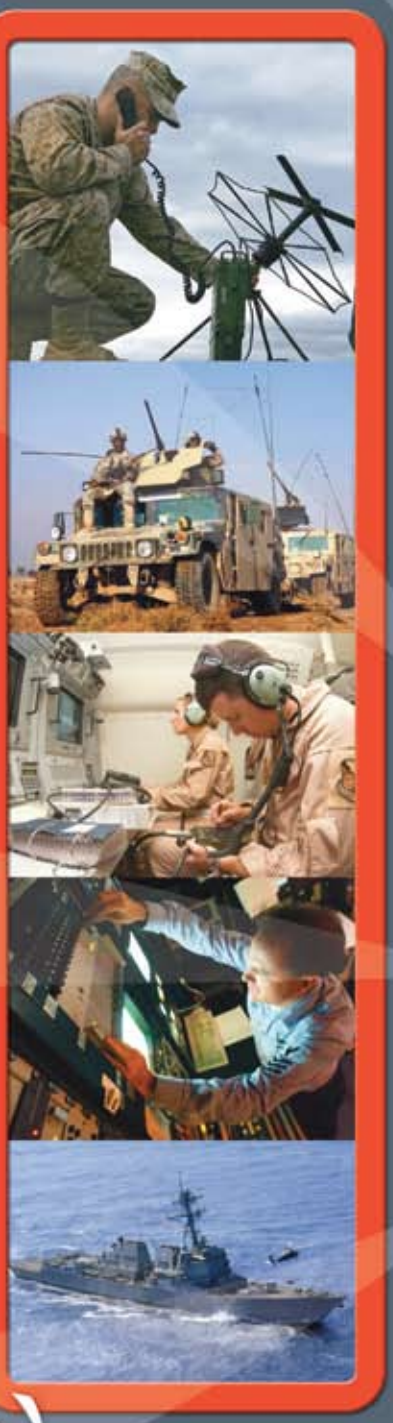
In a rugged environment, the rotating mechanisms of a hard drive can fail, and are subject to partial and sometimes even total loss of data. Severe conditions including high shock, vibration, altitude, humidity and extreme temperature ranges increase failure rate percentages of hard disk drives, which is unacceptable for mission-critical systems. Responding to the growing demand for F-SSDs, the major vendors of F-SSD products continue to ramp the capacity, performance and security features of their products. An example along those lines is the Series 4 Data Transfer System (DTS) (Figure 1a) from L-3 Targa Systems. The unit is used as removable storage for the Moving Map Display aboard the UK's Tornado combat aircraft (Figure 1).

On the interface side, serial interconnect schemes have been steadily pushing aside parallel buses over the past several years, and that trend has impacted the memory and storage realm just as it has every other facet of military embedded computing. And as military systems continue to rely more and more on compute- and data-intensive software, the interface to memory and storage subsystems can't risk becoming a bottleneck. Serial ATA appears to be on its way to becoming the dominant interface technology for new storage subsystem designs. SCSI and Fibre Channel in contrast seem to be waning—although far from retreating. The redundancy of RAID architectures is still a preferred way to ensure reliable mission-critical operations.

Figure 1

A Royal Air Force Panavia Tornado GR4 fighter, No. XV (Reserve) Squadron, based at RAF Lossiemouth (Scotland, UK), over Iraq during a combat mission in support of Operation Iraqi Freedom.

For many military systems, the current thinking is to move from parallel to serial interface to increase system performance, lower the cost and simplify the integration. Anticipating this trend, there are a plethora of SSDs available with interfaces ranging from USB, small cards (SD and MMC products) and SATA interface products for the military embedded market. When the application requires more storage, the most suitable choice is a pure SSD with Serial or Parallel ATA interface. Single chip drives are also reaching densities large enough for storing code and large amounts of data in any application where space is limited and durability and reliability matters. ▮▮



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Technology Focus:
Solid-State Drives Roundup

Serial ATA Flash Drive Boasts Stacking Technology

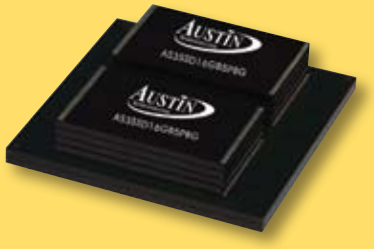
Serial ATA is quickly becoming the dominant storage interface technology—in both flash and rotating disks. Apacer has launched its new Serial ATA Flash Drive (SAFD) 254 for industrial and embedded applications. Apacer's latest SAFD 254 employs its proprietary stacking technology, which supports the widest range of operating temperature by as much as 128 Gbytes compared to all other available industrial SSD solutions in today's market. With the highly reliable NAND SLC memory, the SAFD 254 is capable of read/write speeds of up to 150/130 Mbytes/s.

Apacer's SAFD 254 uses global wear leveling technology, which manages the uneven "wear" on the sectors of a flash media memory by distributing the writes through whole sectors of the flash media to extend its life cycle. The built-in S.M.A.R.T technology (Self-Monitoring, Analysis, and Reporting Technology) provides users with an interface that allows instant display of key information including spare blocks and erase counts, which reduces the risk of sudden disk damage and proactively notifies customers to back up system and data. Also, the built-in low-power detector initiates cached data saving before the device's power supply is too low. Such intelligent power failure recovery function prevents the system from data damage or data error due to sudden power outage, providing superior data security.

Apacer Memory America
Milpitas, CA.
(408) 586-1291.
[www.apacer.com].

IDE Ruggedized SSD Measures a Mere 7.5 cm^3

Ultra-small "chip-sized" solid-state drives have transformed the kind of processor-based mobile military applications that are now possible. Taking that trend a step further, Austin Semiconductor has introduced a smaller, more compact 7.5 cm^3 (31 mm sq x 7.8 mm max height) ruggedized SSD. The newly redesigned SSD supports an embedded IDE, PIO/4 interface, has MTBF of more than two million hours and is ideal for harsh environment operation. The unit offers 0° to 70°C operation with future -40° to +85°C in the future.



The solid-state disk is based on a proprietary package (die) stacking technology to create an extremely space-conscious, robust Solid-State Disk. The SSD is capable of operating in harsh, vibration-prone product platforms. The device has a SLC NAND flash controller and two stacks of NAND flash, each containing 1, 2 or 4 NAND components. Each NAND component, either a 4-, 8- or 16 Gbit device, is based on the use of single silicon and stacked silicon solutions. Total bit density is either 4, 8 or 16 Gbytes. Fast ATA host to buffer transfer rates support True IDE, PIO/4 modes. Sector buffers are 512 bytes, and ECC correction is configured as 6 bytes within a 512 byte sector. The device supports flash memory power-down logic and Automatic Sleep Mode. Wear leveling technology is built in. Burst transfer rate is 16.67 Mbytes/s and sustained transfer rate is 6.7 Mbytes/s.

Austin Semiconductor
Austin, TX.
(512) 339-1188.
[www.austinsemiconductor.com].

SATA Solid-State Drive Serves up 416 Gbytes

Solid-State Drives have rapidly captured market share away from rotating disks dives. SSDs are also much more rugged than traditional HDD solutions. The E-Disk Altima from BitMicro Networks is a robust SATA. A 2.5-inch, flash-based solid-state drive is capable of storing up to 416 Gbytes of data, sustaining transfer rates of up to 100 Mbytes/s and can withstand shock and vibration up to 1,500G and 16.4G rms respectively. Mobile computing applications are set to benefit from these features since the 2.5-inch E-Disk Altima E2A3GL solid-state drive is a drop-in replacement for disks used in business laptops or rugged portable PCs. It is among the new generation of E-Disk SSDs supported by the EDSA DMC and LUNETA MFI ASICs.

With the ongoing transformation of the personal computing market from desktop PCs to laptops, the 2.5-inch E-Disk Altima SATA solid-state drive easily meets the SSD requirements of mobile computer users. It can also be used as an SSD upgrade for business-critical, enterprise-class applications that require scalable and resilient solid-state storage solutions.

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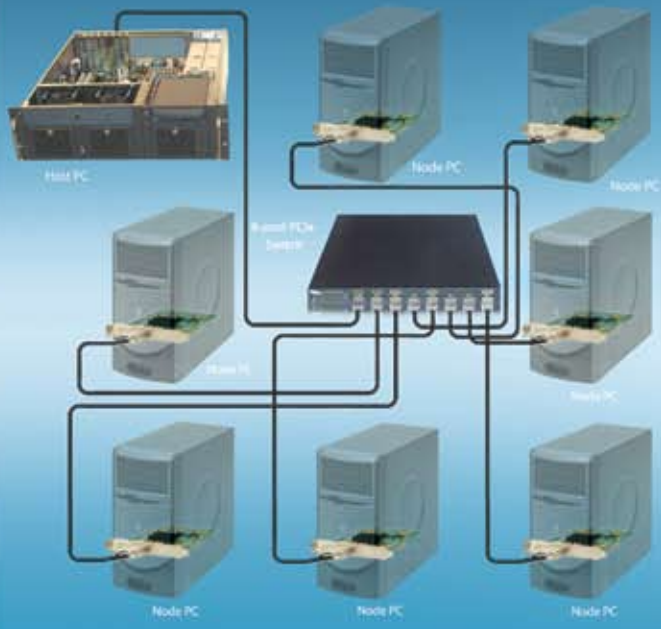

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64 Gbyte RAID SSD Rides PCI-104

Small, space- and weight-constrained military applications are a natural fit for SSDs. The PCI-104 form factor—which is basically PC/104-Plus sans the ISA bus—continues to grow its territory, feeding the military's hunger for compact, stackable systems. 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. Since the adapter houses all SSD memory, the LT-PCI-104-CF provides a 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. For endurance, the unit offers 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. Striping mode transfers data to all four channels simultaneously while mirror mode transfers data on both channels.

Lauron Technologies
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[www.laurontech.com].

VME SAS/SATA SSD Works at 80,000 Feet

VME remains a popular form factor for military platforms, and that includes storage. Phoenix International's VS1-250-SSD Serial Attached SCSI (SAS)/Serial ATA (SATA)-based Solid-State Disk VME blade delivers high-capacity, high-performance data storage for military, aerospace and industrial applications requiring rugged, secure and durable mass data storage. This 6U, single-slot module houses one or two each 2.5-inch SAS or SATA SSDs of up to 256 Gbytes per device, and can be interfaced through its front panel connector or its P2 connector. The high-speed module will sustain read/write data rates of 120 Mbytes/s with an access time of 0.5 msec.

The VS1-250-SSD has an operating temperature range from -40° to 85°C and functions at an altitude greater than 80,000 feet. The VS1-250-SSD also complies with current defense department security standards providing multiple levels of secure erase techniques. As a drop-in replacement for a traditional hard disk drive, the VS1-250-SSD offers significantly lower power consumption and eliminates seek time, latency and other electromechanical delays commonly associated with conventional rotating media. The VS1-250-SSDs performance and versatility is enabled by Phoenix Internationals state-of-the-art technology, which provides very high transfer and I/O rates, enhanced endurance and maximum data integrity. A conduction-cooled version of the unit is also available.

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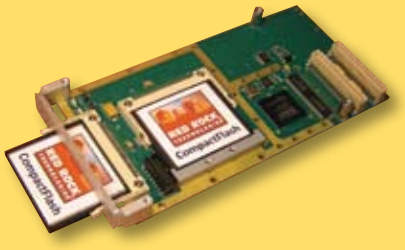
(800) 203-4800.
[www.phenxint.com].

Conduction-Cooled PMC Delivers 32 Gbytes of SSD Storage

Mezzanine technologies like PMC offer a tried and true means of mixing and matching functionality on a slot card board. Now, complete mass storage subsystems can reside on a PMC rather than occupying a full slot in the backplane. Serving just this need, Red Rock Technologies provides a conduction-cooled PMC Compact Flash Module. The card uses CompactFlash Solid-State Drives to achieve capacities of up to 32 Gbytes in a single PMC slot. The board is ruggedized for extreme temperature, shock and vibration environments. A 32-bit PCI bus at 33 MHz/66 MHz is provided and the card is 3.3V and 5.0V PCI interface-compliant and compliant with ATA/ATAPI-6 PIO Mode 4 transfer rates.



The boards have an ambient temperature range of -40° to 85°C and operate at a relative humidity of 8 to 95 percent non-condensing. Shock rating is 1000G per MIL-STD-810F, with a vibration rating of 16G peak to peak. The card operates at altitudes of up to 80,000 feet. Mean Time Between Failures (MTBF) for the base modules is rated at an estimated 500,000 hours and 25°C, with the MTBF for the onboard drives estimated at 4,000,000 hours at 25°C. Maximum weight is 4.5 ounces.

Red Rock Technologies
Scottsdale, AZ.
(480) 483-3777.
[www.redrocktech.com].

Embedded SSD Sports 4-Channel SATA-II Interface

One area where SSDs shine over rotating hard drives is in space-constrained applications. SSDs can be implemented in much smaller volumes than HDDs, and that trend will only continue. SMART Modular Technologies' Xceed iSATA embedded SSD features a four-channel 3 Gbit/s SATA-II module level interface. This RoHS-compliant industrial-grade Xceed iSATA SSD is designed specifically for space-constrained embedded applications where traditional 1.8- and 2.5-inch hard disk drives and SSDs are too large. Measuring just 55.88 mm x 30.48 mm with a height of 11.38 mm (non-stacked NAND flash components) or 12.01 mm (stacked NAND flash components), the iSATA SSD equates to an overall reduced footprint of 60% (1.8 inch) and 75% (2.5 inch), all while offering significant advantages in power consumption and data throughput. Featuring initial capacities ranging from 2 to 32 Gbytes, the Xceed iSATA SSD provides a four-channel flash interface that enables the drive to offer sustained read performance of up to 86 Mbytes/s and sustained write performance of up to 55 Mbytes/s.

Similar to other products in the SMART Xceed SSD product line, the iSATA SSD uses single-level cell (SLC) NAND flash technology, advanced onboard error detection and proven correction and static wear-leveling algorithms to offer high reliability. Reliability is further enhanced through the Xceed iSATA SSD's support for Self-Monitoring Analysis and Reporting Technology (SMART) as well as improved shock and vibration performance. The SMART Xceed iSATA SSD is available now in production volumes.

SMART Modular Technologies
Newark CA.
(510) 623-1231.
[www.smartm.com].

SSD Suited for Harsh Environment Use

Military applications demand a higher level of reliability for their SSD needs than other applications. Serving those needs, STEC offers its MACH8 family of solid-state drives. At the heart of the MACH8 family of Solid-State Drives is STEC's leading-edge flash controller able to address multiple flash components simultaneously to achieve 100 Mbyte/s sustainable read/write speeds. This same controller allows the MACH8 MLC to achieve 90 Mbyte/s reads and 60 Mbyte/s writes. The MACH8 product embeds Full Data Path Protection, STEC's proprietary set of algorithms capable of protecting data anywhere within the SSD, from cache to flash.

An IOPS-intensive version is available for transactional heavy applications. The unit is a drop-in replacement for traditional 1.8-inch and 2.5-inch drives. The drive supports both Serial ATA and PATA and has optional support of purge and encryption. Superior data protection is provided through Total Drive Wear Leveling to ensure drive endurance. Two operating temperatures are supported: Commercial temperature from to 0° to 60°C and industrial temperature from -40° to 85°C.

STEC
Santa Ana, CA.
(949) 476-1180.
[www.stec-inc.com].

1.8-Inch Micro-SATA SSDs Target Rugged Laptops

The military much prefers solid-state drives over rotating disks. SSD are not only inherently more rugged, they also are much easier to erase secure data from when needed. Super Talent Technology has released a new line of 1.8-inch Micro-SATA SSDs. At merely 5 mm thick, these Micro-SATA SSDs are slimmer than most 1.8-inch hard drives and hold up to 120 Gbytes of data. In terms of performance, power consumption and shock and vibration resistance, the MasterDrive KX is substantially better than hard drives. As a result, the MasterDrive KX makes for an excellent upgrade for military laptops that need greater reliability or to accelerate boot-up and load times

Built with MLC NAND flash, the MasterDrive KX is offered in 30, 60 and 120 Gbyte capacities. With 0.1 ms access time and 120 Mbyte/s and 40 Mbyte/s max sequential read and write speeds, these SSDs provide lightning fast access to files. The Micro-SATA connector in a 1.8-inch form factor makes these SSDs an ideal upgrade for UMPCs (Ultra Mobile PCs). Prices range from $299 to $679 depending on capacity.

Super Talent
San Jose, CA.
(408) 934-2560.
[www.supertalent.com].

Rugged SSDs Offer Removable Solutions

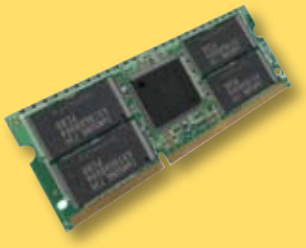
For some applications, a complete ruggedized removable SSD solution is the best option. Along just those lines, Targa Systems Division of L-3 Communications offers two versions of its SATA Data Transfer Systems for the Military and Aerospace markets. The Series 3 PC Card SATA DTU boasts capacities to 32 Gbytes. And the Series 4 Removable Disk SATA DTU (shown) has capacities to 256 Gbytes with transfer rates to 50 Mbyte/s.

The Targa Series 3 PC Card SATA Data Transfer System is suited for airborne platforms. Typical airborne platform application systems include flight management, cockpit instrument display, terrain awareness and warning, map systems, radar systems, cockpit/ground communications, navigation positioning and satellite communications. The removable PC Card feature of the Series 3 product line allows for easy updating of files. In those applications requiring higher storage capacity and/or greater read/write speeds than PC Cards can offer, Targa offers its Series 4 Removable Disk SATA DTUs. The Series 4 SATA DTU offers capacities up to 256 Gbytes in a compact, rugged and removable 2.5-inch flash disk. The removable disk feature of the Series 4 product line allows for easy updating of files. Data Transfer rates up to 50 Gbytes/s are available.

Targa Systems, L-3 Communications Canada
Ottawa, Ontario Canada
(613) 727-9876.
[www.targasystems.com].

Module Marries SATA SSD and DDR DRAM

For a variety of military applications, small integrated computing functionality is a critical requirement. Now system designers can get a complete memory subsystems—main memory and mass storage—on a single component. Offering exactly that is Virtium Technology's SSDDR SODIMM product. SSDDR is the memory and SSD board design that combines Serial ATA Solid SATA SSD and Double Data Rate Synchronous Dynamic Ram (DDR SDRAM) technologies in a single SODIMM socket for SBCs, ETX, COM Express and ATCA applications.



This SSDDR product solves the storage design challenge facing many SBC designers in search of SATA SSD module solutions for embedded SSD applications. SSDDR serves two independent functions. The NAND flash module provides localized SATA SSD storage for the operating system, and DDR SDRAM provides the main memory for the CPU. Virtium's SSDDR solution can be easily adapted and implemented as both the storage and memory functions share the existing JEDEC standard socket. Basically, the SSDDR module and Standard DDR module are interchangeable within the same SODIMM socket. With this SSDDR SODIMM solution, data throughput dramatically increases two to four times over other embedded SSD and interfaces such as USB (Universal Serial Bus), CF (Compact Flash with IDE interface) and SD (Secure Digital). SSDDR SODIMM is the higher performance SATA disk on module for embedded applications. The product line ranges in price from $150 to $800 depending on density, configuration and volume.

Virtium Technology
Rancho Santa Margarita, CA.
(949) 888-2444.
[www.virtium.com].

SATA/PATA SSD Family Does 100 Mbyte/s Reads

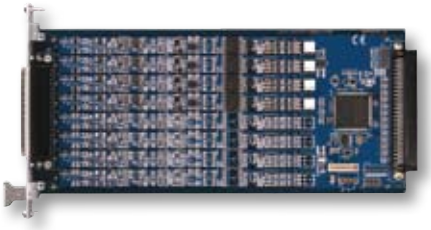
Military system developers used to have to suffer a lot of trade-offs when deciding on flash-based storage versus traditional rotating disks. That gap has narrowed considerably in recent years. Exemplifying that trend, Western Digital (WD) has begun shipping its new SiliconDrive III SSD product family based on technology from its acquisition of SiliconSystems. The company's new SiliconDrive III products feature faster read/write speeds and increased capacities, and offer mechanical scalability, making them a perfect storage solution for embedded system and data streaming applications such as multimedia content delivery systems and data center media appliances.

SiliconDrive III SSDs include 2.5-inch Serial ATA (SATA) and Parallel ATA (PATA) and 1.8-inch Micro SATA products featuring native SATA 3.0 Gbits/s or ATA-7 interfaces with target read speeds up to 100 Mbytes/s and write speeds to 80 Mbytes/s in capacities up to 120 Gbytes. SiliconDrive III has been designed and optimized for high performance and high reliability in demanding 24x7 applications in the harsh environment markets like the military. The company's patented and patent-pending PowerArmor, SiSMART and SolidStor technologies address critical OEM design considerations such as the elimination of drive corruption due to power anomalies, the ability to monitor a SiliconDrive's useable life in real time and integrated advanced storage technologies that ensure data integrity and SSD life for multi-year product deployments.

Western Digital
Lake Forest, CA.
(949) 672-7000.
[www.wdc.com].

Products

Data Acq Card Does 4 Channels of 1.25 MS/s Sampling



Military test and data acquistion gear used to require racks of boards for any complex systems. Now that same functionality is possible on a single card. Along those lines, Microstar Laboratories offers a 4-channel signal interface (SI) module, part number MSXB 082, with four onboard analog-to-digital converters and channel-to-channel isolation. The four analog-to-digital converters on the new SI module are synchronized to within a few nanoseconds of each other, and each one can convert an analog signal to a 16-bit data stream at up to 1.25 Msamples/s. All inputs are differential, and each analog channel is isolated from all the others and from any other system component. Users can set the gain of each channel to 1, 2, 5, or 10 in software, and channels can have different gains.

The MSXB 082 design allows each of the four channels to sample at 1.25 Msamples/s. Initially the per-channel maximum is reached if only one channel is in use. With two channels in use, the maximum is 1M samples per second; with three, 667k samples per second; and with four, 500k samples per second. The company provides evaluation hardware at no charge. MSXB 082 costs $1,195 and is available now.

Microstar Laboratories, Bellevue, WA. (425) 453-2345. [www.mstarlabs.com].

PICMG 2.16 Ethernet Switch for CompactPCI

Ethernet, probably more than any other interconnect technology, has become a "must have" technology for any military embedded system. The PICMG 2.16 standard marries Ethernet to the CompactPCI platform. Diversified Technology has introduced a new member of its CompactPCI line, the CSB4624 switch. This 6U blade is a PICMG 2.16-compliant CompactPCI managed Ethernet switch with full IPv6 support, twenty-four 1GbE link ports and three 10GbE connections. When fully integrated into one of DTI's CompactPCI chassis, the CSB4624 switch and CPU board systems offer a cost-effective solution for applications that require high-end performance in a wide range of computing environments.

DTI's CSB4624 6U, PICMG 2.16 CompactPCI switch provides fully managed L2/L3 switching and routing capabilities to high-bandwidth CompactPCI applications. The CSB4624 provides the backbone to any CompactPCI implementation, delivering 24 ports of auto-negotiating 1G Ethernet. Up to 19 ports are delivered to payload slots within the chassis, with the remaining 5 lanes available through ingress/egress ports on the switch. The CSB4624 is available now in beta stage with product shipments coming Q4 of 2009. Pricing for the switch starts at $1,995 with quantity discounts available.

Diversified Technology, Ridgeland, MS. 1 800-443-2667 [www.diversifiedtechnology.com].

Rugged PMC Does MPEG4 Compression

MPEG compression is a vital technology for systems like video distribution and/or recording in applications such as military systems that provide situational awareness. Curtiss-Wright Controls Embedded Computing has announced the PMC-281, its first MPEG4/H.264 high-definition video capture/compression PMC interface card. The rugged conduction-cooled PMC-281 joins the recently introduced XMC-280 JPEG2000 compression module, and the earlier Orion PMC, to expand the company's embedded COTS video compression capabilities.

The PMC-281 supports two channels of MPEG4/H.264 video compression at resolutions up to 1920x1080 facilitating the distribution of multiple channels of high-definition video over standard Gbit Ethernet networks and storage on modestly sized media. The card features two video Inputs—each can be Digital DVI, Analog RGB or PAL/NTSC composite. Support is provided for one channel of 1080p60 or two channels of resolutions up to and including 1080i60. The board is available at Curtiss-Wright Controls Level 0 and conduction-cooled Level 200 environmental specifications. Pricing for the PMC-281 starts at $3,500. Availability is Q4 2009.

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

Dual PMC Expansion on Core2 Duo VME Carrier Card

Many long-life military VMEbus systems require high performance expansion using PMC or XMC modules. Xembedded has announced the XVME-9076 dual-PMC 6U carrier module. The XVME-9076 single-slot dual PMC carrier provides support for two additional PCI/PCI-X sites to the Xembedded XVME-6200 Core2 Duo VMEbus processor. The XVME-9076 expands the XVME-6200 processor to support up to three PMC modules or two PMC modules and one XMC module for functions such as FPGA, Ethernet, SCSI, serial port, digital I/O, analog I/O and special-function PMC modules. The PCIe x4 is a high-speed connection in each direction between the XVME-9076 and the XVME-6200 processor.

The XVME-9076 is compatible with PMC 2.0 specifications for IEEE P1386 modules. The XVME-9076 offers two 32/64-bit, 66/133 MHz sites, one with rear I/O out P2 of the carrier and the other site with rear I/O out the optional P0. Both PMC sites are capable of providing 14 watts of power. The XVME-9076 expansion module is available in commercial and air-cooled versions.

Xembedded, Ann Arbor, MI. (734) 975-0577. [www.xembedded.com].

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Box-Level System Is Based on ATOM Processor

The ATOM, Intel's low-power, PC-compatible processor, has found its way onto nearly every embedded form factor. And now, Advantech is using it on a rugged box-level system. The ARK-6310-3M04E features an Intel ATOM processor and the Intel 945GSE chipset on an integrated Mini-ITX motherboard. This fanless design operates silently and works reliably in harsh environments. With all electronics well-protected in a rugged, cold-rolled steel housing only 232 x 65 x 232 mm in size, the ARK-6310-3M04E performs flawlessly in the harshest environments. The all-in-one embedded computer features rich I/O connections, including two Gigabit Ethernet ports, four USB 2.0 ports, three COM ports, VGA and PS/2.

The cushioned anti-vibration design secures one 2.5-inch SATA HDD/SSD with maximum reliability. Also, the user-friendly bottom cover makes it easy to access the CompactFlash socket on the back of the embedded motherboard. The Advantech ARK-6000 series provides a complete solution for space-limited industrial applications.

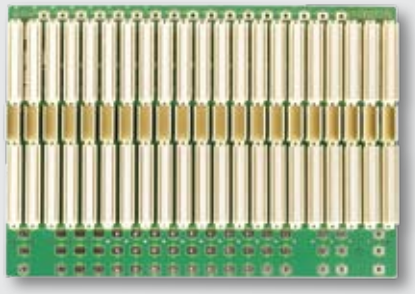
Advantech, Irvine, CA. (949) 789-7178. [www.advantech.com].

FPGA and TigerSHARC Climb Aboard 3U VPX Board

FPGAs and DSPs have different strengths when it comes to the signal processing muscle they provide. BittWare has brought together the best of those worlds with a hybrid system sporting both a high-end FPGA and the TigerSHARC DSP with the release of the GT-3U-VPX (GT3X) board. The GT3X features a large Altera Stratix II GX FPGA and one cluster of four ADSP-TS201S TigerSHARC processors from Analog Devices. The front panel provides high-speed SerDes, 10/100 Ethernet and RS-232; and the extensive back panel interface supports PCI Express, Serial RapidIO, GigE and 10 GigE. The GT3X can achieve simultaneous on-board and off-board data transfers at rates exceeding 2 Gbytes/s via BittWare's ATLANTiS FrameWork implemented in the Stratix II GX FPGA.

The GT3X provides a hybrid signal processing architecture that takes advantage of both FPGA and DSP technology, creating a complete solution for applications requiring flexibility and adaptability along with high-end signal processing, all on a ruggedizable platform. BittWare will begin shipping Early Access Units to its lead customer in Q4-2009, with OEM quantities available Q1-2010.

BittWare, Concord, NH. (603) 226-0404. [www.bittware.com].



6U and 7U VME64x Backplanes Offer Multiple Slot Sizes

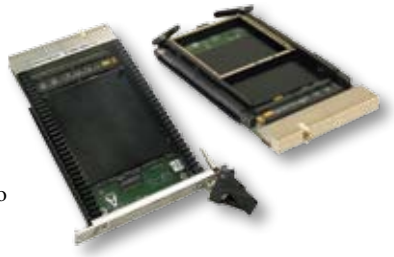
While new slot card form factors seek acceptance, the military still relies on tried and true solutions like VME64. Elma Bustronic Corporation has 6U and 7U VME64x backplanes in over 30 slot sizes and hundreds of standard configurations. Bustronic offers all of the common slot sizes for its 6U and 7U backplanes, which range from 2-21 slots. With various power, connection pintail size, shroud, P0 connector,and other options, there are hundreds of standard configurations available. The 7U backplanes have an extra 1U of height for extra power bugs to accommodate higher power requirements. In some configurations, this taller backplane acts as an air baffle to redirect the airflow path to aid cooling. In other chassis designs, the 6U height is required due to space restraints or airflow considerations.

The Bustronic VME64x backplanes come with power bugs for +5V, +3.3V, +/-12V, +/-V1, +/- V2, and GND. Compliant to ANSI/VITA 1.1-1997 VME extension standard and ANSI/VITA 1-1994, the VME64x line features a controlled-impedance stripline design. The backplanes have an active BUSGRANT, IACK daisy chain and optional stiffeners. Pricing for Bustronic's VME64x backplanes start under $200 depending on size, volume and configuration.

ELMA Electronic, Fremont, CA. (510) 656-3400. [www.bustronic.com].

3U cPCI Couples Sports Core 2 Duo Processor, SATA SSD

CompactPCI, particularly in its 3U flavor, has carved out a large chunk of adoption in the military realm. Aitech Defense Systems has released a new rugged 3U single-slot CompactPCI SBC that offers up to 8 Gbytes of onboard SATA flash disk storage. The C800 combines the latest low-power Intel Core 2 Duo technology featuring data processing capabilities of 1.67 GHz or 2.20 GHz and Intel's Speedstep dynamic frequency switching that provides multiple lower power and cooling options with highly integrated on-chip L1 and L2 caches as well as the Intel GM965 Express Graphic Chipset.



The C800's extensive I/O capabilities include automatic system/peripheral detection, two Gigabit Ethernet ports, two serial communication ports, two USB 2.0 interfaces, one SATA II interface, a high-definition stereo audio output and up to eight single-ended general-purpose discrete I/O channels that are independently configurable as input or output. An industry-standard PMC slot further extends the board's I/O functions. The C800 SBC is available in five software-compatible versions including a commercial air-cooled version for lab development, two extended temperature air-cooled formats (per PICMG 2.0 Rev. 3.0) and two extended temperature, rugged conduction-cooled formats (per ANSI/VITA 30.1-2002). OEM quantity pricing for the C800 SBC starts at $4,985.

Aitech Defense Systems, Chatsworth, CA. (888) 248-3248. [www.rugged.com].

Atom-Based COM Express Module Boasts Compact Size

For military applications ranging from small UAVs to portable communications gear, compactness is a leading embedded computing requirement. With just that in mind, ADLINK Technology's Express-ATC is the newest member of its Computer-on-Module (COM) family. The Express-ATC is a "Compact" COM Express module measuring only 95 x 95 millimeters, and is fully compatible with the Type 2 pin-out of the PICMG COM Express specification.

Based on the ultra-low-power Intel Atom N270 processor and Mobile Intel 945GSE Express chipset, the Express-ATC comes with integrated support for high-resolution CRT, single/dual channel LVDS and TV out (SDTV and HDTV). The Express-ATC supports up to 2 Gbytes of DDR2 533 MHz memory on a single SODIMM socket. The module supports three PCI Express x1 lanes via the Intel I/O Controller Hub 7-M (ICH7-M) Southbridge, one Gbit Ethernet connection and two SATA channels. Legacy support is provided for a single Parallel ATA channel, 32-bit PCI and Low Pin Count bus (LPC). The Express-ATC supports onboard IDE-based Solid-State Drive (SSD) up to 8 Gbytes, and comes standard with an integrated Trusted Platform Module (TPM 1.2). The Express-ATC COM Express module is currently available at a list price of $850.

ADLINK Technology, San Jose, CA. (408) 360-0200. [www.adlinktech.com].

High-Speed Digitizer Rides ExpressCard

The transition toward highly compact and portable data acquisition gear has revolutionized the kinds of field testing military system developers can do. Along just those lines, Signatec has released the EC14150 wideband signal acquisition card for commercial laptop computers. The compact, low-power form factor offers a 150 MHz sampling rate on two channels, 14-bit resolution and 512 Mbytes of onboard RAM, yet consumes only 4.5W, ideal for mobile data acquisition applications.

The EC1450 is a 54 mm-compliant ExpressCard board equipped with standard "Plug and Play" features common in PCI systems. In either Continuous Record Mode or Data Transfer Mode, Signatec's EC14150 is capable of sustaining 180 Mbyte/s transfers over the ExpressCard PCI Express (PCIe) x1 data link bus interface. Significant test data show recordings with the EC14150's large 512 Mbyte FIFO buffering the recording process can be sustained continuously at up to 90 Msamples/s, even when operating in traditional non-real-time environments such as the Windows operating system.

Signatec, Newport Beach, CA. (949) 729-1084. [www.signatec.com].

Bus Converter Steps Down 270V to 28V for Avionics

Wide input voltage ranges are a high priority in avionics systems. Serving such needs, VPT has introduced a new bus converter module: the VPTHVM-270 Series. With up to 200W of output power, this regulated bus converter module operates from a 270V bus to step down the power to create a regulated 28V bus for avionics power systems. A wide input voltage range accommodates MIL-STD-704 input power requirements for avionics and other applications. The high-efficiency design reduces input power requirements and eases thermal management, thereby increasing the overall system reliability.

With a footprint of just 2.35 inches (59.69 mm) by 1.550 inches (39.37 mm) and weighing in at 85 grams, the VPTHVM-270 Series saves valuable space and weight in a power system. Output power is up to 200W, with an efficiency up to 91 percent. Input voltage range is from 160 to 500 volts per MIL-STD-704. The unit is tested to JESD22, MIL-STD-810 and MIL-STD-883. A rugged six-sided all metal package improves performance reliability through the harsh environments of vibration, shock and temperature cycling.

VPT, Blacksburg, VA. (425) 353-3010. [www.vpt-inc.com].

Family of Rugged Enterprise Servers Boasts Quad-Core Xeons

1U and similar-sized servers are becoming a mainstay for compute-intensive military applications. Themis' rugged family of XR3 servers provide multicore processing, extensive I/O and storage options for high performance in compact, rackmountable 1U, 2U and 3U designs. Themis' new XR3 series of Rugged Enterprise Servers (RES) combine the latest Intel Quad-Core Intel Xeon processors with the ruggedized design features of the Themis RES server family. Designed to perform in environments where other systems fail, the new RES-12XR3, RES-22XR3 and RES-32XR3 (shown) servers blend the latest processor technologies with Themis' proprietary thermal and mechanical design to deliver outstanding performance and reliability.

Offered in compact, 1RU, 2RU and 3RU in short, light (20 inch aluminum) chassis, these new servers feature more memory—up to 144 Gbytes—and up to eight lockable and removable drives, hot swappable fans and hard disk drives, single or redundant power supply options, and optional front panel filters for increased reliability in field deployments. These new systems combines the Quad-Core Intel Xeon 5500 series processors (Intel Nehalem Microarchitecture), with Themis' advanced thermal and mechanical design techniques to provide users industry-leading SWAP (Size, Weight and Power), RAS (Reliability, Availability and Service), storage and I/O configurability.

Themis Computer, Fremont, CA. (510) 252-0870. [www.themis.com].

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Rugged CompactFlash Card Boasts SMART Option

In military systems, data is often mission-critical and sometimes highly classified. A new CompactFlash (CF) card from Swissbit—the new C-300 Series—includes the latest enhanced firmware as well as the option to support the Self-Monitoring, Analysis and Reporting Technology (SMART) standard. Using this technology, the C-300 CF card can report its detailed lifetime status, which allows users to predict imminent failure to avoid data loss. Various lifetime relevant statistics are available for analysis, such as the usable flash spare blocks and remaining guaranteed flash write life. The lifetime statistics information is collected online while operating, and the SMART status will change to warn when critical values are reached.

Swissbit has also developed an easy to use Windows (Win2000, XP & Vista) or Linux application to interpret the lifetime statistical data. The applications also allow users to collect data in the background and display historical charts of all relevant values. This allows for detailed control over the lifetime statistics and aids in early failure prediction. It is also possible for the customer to seamlessly integrate the lifetime monitoring in a custom application. Swissbit has available Windows and Linux software libraries along with an easy to use application programming interface (API).

Swissbit, Bronschofen, Switzerland, +41 71 913 03 03. [www.swissbit.com].

cPCI Development System Handles Both 3U and 6U

CompactPCI has earned its place as an accepted technology in military systems. SIE Computing Solutions offers a compact and portable development system designed for CompactPCI backplane architecture, which offers a modular test and development platform that supports both 3U and 6U CompactPCI cards. The 522 Development System is suitable for lab and desktop use, but also rugged enough to withstand transporting to and from the field.

The 522 Development System features a versatile design for CompactPCI hardware and software developers. The system provides unobstructed access to both system and rear transition boards for device monitoring. It is available with CompactPCI backplanes for a variety of CompactPCI configurations. The 522 Development System is designed with features like high-performance cooling with speed-controlled fans that provide distributed cooling to both the front and rear card modules. The system is available with front mounted test points and LEDs for all DC voltages, as well as an optional LCD for displaying system voltages and both fan and temperature monitoring functions. The 522 Development System can also accommodate VME64x, VXS and VPX boards, both in 6U and 3U form factors. Modular in design, the system is available in both standard and custom configurations.

SIE Computing Solutions, Brockton, MA. (800) 926-8722.

[www.sie-computing.com].

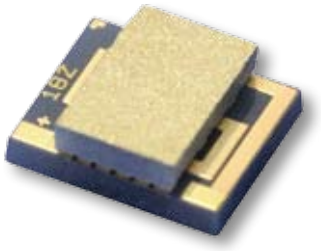
COM Express Module Sports GM45 Express Chipset

COM Express has taken its place as the new standard for bus-less embedded computing. COM Express safeguards development investments and lowers total cost of ownership by enabling designers to partition commodity host-processor COM Express modules from proprietary, value-added platform building blocks, including FPGAs and specialty I/Os on custom baseboards.

The latest offering from American Portwell is a Type II COM Express Basic (small footprint) that has a footprint of 125 mm x 95 mm (4.92 x 3.74 inches). The compact PCOM-B213VG includes the GM45 and ICH9M-E chipset and integrated GMA 4500HMD graphic engine that supplies extreme 3D performance for media applications such as high-definition 1080p imaging. Active Management Technology (AMT) 4.0 and Trusted Platform Module (TPM) support effective remote management and enhanced security. Two SO-DIMM sockets support DDR3 SDRAM up to 8 Gbytes and the board has both EIDE and SATA as well as one Gigabit Ethernet. I/O expansion (via the Com Express carrier board) includes one PCI-E x16 multiplexed with SDVO interface, five PCI-E x1, four PCI, LPC interface and high-definition audio interface, and a PCOM-C210 Developer COM Express Type II carrier board.

American Portwell, Fremont, CA. 510-403-3399. [www.portwell.com].

Microscale Heat Pump Does Pinpoint Thermal Management



The military wants to use the latest and greatest fast processors, but managing their heat dissipation is no easy task. Nextreme Thermal Solutions offers a high-voltage, low-current thin-film thermoelectric cooler (TEC) targeted at laser diode cooling. The unit achieves a 60°C temperature difference between its cold and hot sides. This temperature difference, known as the deltaT, reflects the ability of the device to pump heat efficiently. For customers in the optoelectronics and telecommunications industries, this translates to improved cooling performance, lower input power requirements and greater efficiencies for solving thermal management issues in electronic packages.

The OptoCooler HV14 thermoelectric cooler from Nextreme Thermal Solutions is the first module in a new class of high-voltage and high heat pumping thermoelectric coolers that operate at low currents and are optimized for standard circuitry and power requirements. The device can pump up to 1.5W of heat at 85°C and operates at a maximum voltage of 2.7V with a maximum current of around 1A—with a footprint of only 2.8 mm2. Due to the micro-size and power-pumping capabilities of the HV14 module, manufacturers of LEDs and other semiconductor chips can now integrate cooling and temperature control functionality directly into the package during assembly, resulting in a high-volume, lower-cost thermal management solution.

Nextreme Thermal Solutions, Durham, NC. (919) 597-7300. [www.nextreme.com].

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Vision System Applies Multicore to Multiple Cameras

The multicore processing trend has swept across the embedded market, and military embedded system designers are riding the wave. National Instruments offers a new embedded vision system that gives manufacturing engineers and system integrators the ability to build high-speed real-time machine vision systems. The NI EVS-1464RT Embedded Vision System from National Instruments is a high-performance, multicore controller capable of processing images from multiple IEEE 1394 and GigE Vision cameras. For harsh environment applications, the system features an extended temperature range, a real-time operating system, a solid-state hard drive and a fanless design, making it suitable for use in harsh industrial environments.

The EVS-1464RT features a variety of camera connectivity options so engineers can use many different types of cameras to perform simultaneous inspections ranging from high-resolution area scan to high-speed line scan and from color to infrared. The EVS-1464RT also includes a wide range of digital I/O and communication options that make it possible for the system to communicate and integrate with automation devices such as programmable automation controllers, programmable logic controllers, human machine interfaces, sensors and actuators to perform faster inspections.

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

128 Gbyte and 64 Gbyte Solid-State Drives

Solid-State Drives offer an edge over rotating hard drives in terms of reliability—thanks in part to the fact that they use no moving parts. Two new solid-state drives from Corsair clock in with maximum sequential read speeds of 220 Mbytes/s and maximum sequential write speeds of 200 Mbytes/s. The Corsair P128 from Corsair memory delivers the same 220 Mbyte/s read speeds and 200 Mbyte/s write speeds as its higher capacity cousin, the P256, at a lower cost.

The P64 is one of the highest-performing, lower-density SSDs available. Both drives utilize the same technology including a Samsung controller IC with 128 Mbytes of cache memory and NCQ support to deliver stutter-free performance. The P128 is extensively validated in major computing platforms. The unit has a 100+ Year Life Expectancy (MTBF).

Corsair Memory, Fremont, CA. (510) 657-8747. [www.corsair.com].

Compact Modules Simplify GPS Design-Ins

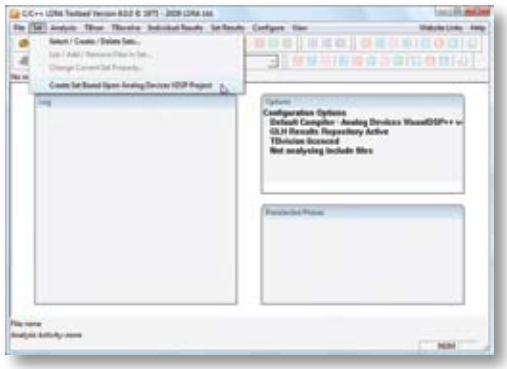
GPS technology was invented by the military—DARPA in fact—and now it's a critical technology in defense systems. Two easily applied GPS modules from Linx Technologies use a SiRF StarIII low-power chipset to minimize power consumption and provide high sensitivity, even in dense foliage and urban canyons. The receivers feature an onboard LNA and SAW filter, as well as an integrated antenna in the SR Version or an external antenna for the SG Version, which further lowers cost and reduces complexity. No other RF components are needed and the modules' standard NMEA data output makes them easy to integrate, even by engineers without previous RF or GPS experience.

In addition to the SiRF Star III chipset, the GPS modules feature 20 channels, 200,000+ correlators, a power consumption of only 46 mW and a sensitivity of -159 dBm. The modules use a direct serial interface, include a power-down feature. For getting designs up and running, the Linx MDEV-GPS Master Development System contains everything needed to evaluate the SG or SR Series GPS modules and implement them. MDEV-GPS Master Development Systems are immediately available and are priced at $249 for the SG version and $289 for the SR version.

Linx Technologies, Merlin, OH. (541) 471-6256. [www.linxtechnologies.com].

Tool Suite Supports VisualDSP++ Environment

In the military market, software tools need to overcome the complexity of advanced systems, while at the same time providing access to details. Along those lines, the LDRA tool suite, which provides automated software testing and verification across all stages of software development, has now integrated the Analog Devices VisualDSP++ (VDSP++) software development environment. VDSP++ creates a software development environment for engineers working with Analog's embedded processors. This offering enables seamless testing of user code at both the unit and system levels, coupled with enhanced error detection to speed up the overall software development process.



The LDRA tool suite is able to distinguish between the differing files that form a VDSP++ project, ignoring the source files that do not need to be analyzed. When the program executes, the LDRA tool suite can drill down to the captured results and then use these results for unit tests and structural coverage analysis. In this manner the LDRA tool is able to support the analysis needed to demonstrate structural coverage analysis up to and including DO-178B Level A. This integration covers all devices supported by VDSP++.

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Special Feature: New Small Form Factor Board Products and Standards. Complete computing systems can now easily fit on the area of a coaster or a napkin. These small single board computers—in both standard and non-standard form factors—are finding a growing niche in applications characterized as extremely space- or weight-constrained or where traditionally only a fully custom solution would do the job. Small UAVs, robotics, mission-specific handheld systems, and even intelligent munitions are prime examples along those lines. Boards in form factors such as mini-ITX, StackableUSB, COM Express, MicroETXexpress along with a variety of small non-standard boards are broadening the choices available to system designers.

Tech Recon: MicroTCA and AMC in Military Systems. MicroTCA is gaining interest as a compact, integrated solution, using the growing selection of AMC mezzanine cards essentially as slot cards. Article s in this section examine the latest trends along those lines, as well as an update on efforts to ruggedize MicroTCA.

System Development: 1U Blade Servers Invade Military Designs. 1U Blade Server computing solutions are rapidly finding a niche in a variety of military applications such as SATCOM-On-the-Move systems. Now that complete server-level computers are available in a 1U blade, it's possible to pack a lot of computing in a convenient rack-based space along side off-the-shelf 1U network routing and advanced communications boards.

Tech Focus: PXI, VXI and LXI Boards. For complex, high-performance military systems, the PXI bus form factor and its older cousin VXI have become staples as instrumentation and test solutions. Now the LAN-based LXI form factor is the latest stepchild in this space to emerge on the scene. This Tech Focus section updates readers on the latest trends in these technologies along with a focused product album of representative boards in these architectures.

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Editorial

Jeff Child, Editor-in-Chief

ATCA and MicroTCA Paving Their Way

Compared to any other realm of engineering and design, there are numerous ways that the defense industry remains unique. One of them is this: a clear aversion to risky technologies that have uncertain futures. To gain acceptance in military systems, a technology—whether it be an embedded computing form factor, an interconnect fabric, a networking protocol or a processor architecture—must prove itself not only as a good fit for the demanding of military environments, but must also show some market "staying power."

There's good reason for that level of conservatism. Because of the decades-long design cycles in the defense arena, it's too risky to base any long-term development project on technologies that won't be around in a few years. CompactPCI, for instance, took quite a few years before the military began to use it for deployed programs. VPX, meanwhile, although it's faced its own set of hurdles, has had the benefit of being a technology targeted specifically for the military from the beginning. Fast forward to today, and AdvancedTCA (ATCA) and MicroTCA are two of the most recent computing architectures that could now be said to be passing through the "tunnel of scrutiny" in search of solid acceptance by the military.

The ATCA spec, developed in 2003 by the PCI Industrial Computer Manufacturers Group (PICMG), was created to serve the needs of next-gen carrier grade telecom gear. I was at the industry event where ATCA was originally announced, and I recall being impressed at how quickly it went from concept to complete specification in about one year. And unlike standard computing architectures I'd seen before, ATCA started off with a complete system design guide. In contrast, VPX suffered from a lot of design ambiguity early on. In fact, this year's OpenVPX initiative has the goal of a System Design Guide that will include predefined system profiles for 3U and 6U VPX-based systems, and the OpenVPX organizers specifically have cited the successful PICMG ATCA Design Guide work as a good model for what the group wants to get to in terms of system specifications for VPX. A significant announcement on OpenVPX's progress is expected to happen at next month's MILCOM show in Boston.

Because ATCA was initially conceived to address the high-availability and reliability requirements of telecomm, it is a natural path for ATCA platforms to be adapted for use in mission-critical military and aerospace communications systems. Companies involved in ATCA span the range of communications infrastructure focused board suppliers that have looked to expand into the military, to defense-oriented companies that provide ATCA to their existing defense customers. I've heard about a number of projects and programs by primes like BAE Systems, Lockheed Martin and Northrop Grumman that have been using ATCA—for beamforming, real-time mission-critical networking, C4ISR, secured network appliances, general-purpose communications nodes and so on. Like the tip of the iceberg, I'm certain there's a significant amount of ATCA development work going on that's been keep under wraps.

The demand for ATCA as a large format, blade-based computing architecture is very real. Its niche is very different and narrower than that of VPX—no one expects it to encroach on VPX's potential market share. ATCA is more suited to programs that don't require full battlefield survivability and are more "fixed-mobile" in nature—as compared to the "operationally mobile" computing needs where VPX shines.

Meanwhile, MicroTCA occupies a much less distinct market position than its ATCA cousin. While MicroTCA can leverage the same ecosystem of processor AMCs and comms/networking AMCs that ATCA uses, it overlaps more with VPX in terms of size and low-power advantages. Like ATCA, MicroTCA boards and systems are designed to meet NEBS Level 3 requirements, addressing demands such as thermal margins, fire suppression, emissions and the ability to continue working even during a severe earthquake. That makes MicroTCA rugged enough for environments for military ground installations and so on.

But where MicroTCA will be most interesting is in the rugged implementations of the standard which are underway by a committee of the PICMG standards body. Among those are a rugged air-cooled MicroTCA (MTCA.1) (ratified back in May), hardened MicroTCA for military applications (MTCA.2) and conduction-cooled MicroTCA (MTCA.3). These new standards leverage the ANSI/VITA 47 specification to define environmental requirements. MicroTCA will reportedly be used in portions of the DoD's WIN-T program. MicroTCA offers native support of Internet-protocol-based network topologies, which makes it a natural for WIN-T since the program requires mobile networking rugged enough to maintain the highest levels of situational awareness through battlefield conditions.

Where different embedded computing architectures find success is in some ways an "apples and oranges" question. Moreover, today's defense industry is ever reluctant to accept technologies that won't be around for the long haul. At this point in each of their evolutions, both ATCA and MicroTCA are still in the race. The fact that both are inherently suited for communications and networking doesn't hurt either. Such programs probably rank among those that will escape deep budget cuts in coming years. That's not a certainty, of course, but the Defense Department's trend toward ramping up the communications, networking and computing portions of its overall budget hasn't altered in decades. ▮▮

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