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Military EMBEDDED SYSTEMS

VOLUME 5 NUMBER 1
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Ongoing obsolescence

NASA applies rocket science to components

A different obsolescence perspective

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Military EMBEDDED SYSTEMS

January/February 2009 Volume 5 Number 1

COLUMNS

DEPARTMENTS

ON THE COVER:
Space is still the final frontier, and countries including the European Union, America, Japan, Canada, China, India, and Russia are all looking (and spending) aggressively to the heavens for civilian and military purposes. Yet beyond the radiation challenges of LEO and deep space, a more down-to-Earth problem vexes space-based electronics: obsolescence. Repairs to the ISA and Hubble notwithstanding, most space platforms can't be repaired and take three to five years to develop. Components becoming obsolete *before launch* is a weekly occurrence. In our special report on obsolescence, a vendor and government program office weigh in on mitigation strategies. See articles starting on page 36. (Image courtesy of NASA Goddard Space Flight Center.)

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Military & Aerospace Group

Chris Ciufo, Group Editorial Director
cciufo@opensystemsmedia.com

Don Dingee, Contributing Editor
ddingee@opensystemsmedia.com

Jennifer Hesse, Senior Associate Editor
jhesse@opensystemsmedia.com

Sharon Schnakenburg, Associate Editor
sschnakenburg@opensystemsmedia.com

Terri Thorson, Senior Editor (columns)
tthorson@opensystemsmedia.com

Monique DeVoe, Copy Editor

Hermann Strass, European Representative
hstrass@opensystemsmedia.com

Konrad Witte, Senior Web Developer

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David Diomede, Art Director

Phyllis Thompson
Circulation/Office Manager
subscriptions@opensystemsmedia.com

Sales Group

Dennis Doyle, Senior Account Manager
ddoyle@opensystems-publishing.com

Tom Varcie, Senior Account Manager
tvarcie@opensystemsmedia.com

Doug Cordier, Account Manager
dcordier@opensystemsmedia.com

Andrea Stabile
Advertising/Marketing Coordinator
astabile@opensystemsmedia.com

Christine Long, E-marketing Manager
clong@opensystems-publishing.com

International Sales
Dan Aronovic, Account Manager – Israel
daronovic@opensystemsmedia.com

Sam Fan, Account Manager – Asia
sfan@opensystemsmedia.com

Regional Sales Managers
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dseger@opensystemsmedia.com

Sydele Starr, Northern California
sstarr@opensystemsmedia.com

Ron Taylor, East Coast/Mid Atlantic
rtaylor@opensystemsmedia.com

Reprints and PDFs

Nan Lamade
800-259-0470
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Editorial/Business Office

16626 E. Ave of the Fountains, Ste 203
Fountain Hills, AZ 85268
Tel: 480-967-5581 ■ Fax: 480-837-6466
Website: www.opensystemsmedia.com

Publishers: John Black, Michael Hopper, Wayne Kristoff

Vice President Editorial: Rosemary Kristoff

Vice President Marketing & Sales:
Patrick Hopper
phopper@opensystemsmedia.com

Business Manager: Karen Layman

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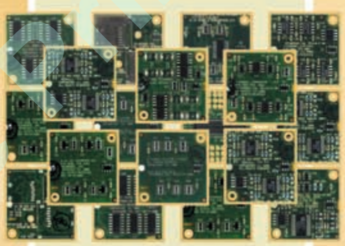

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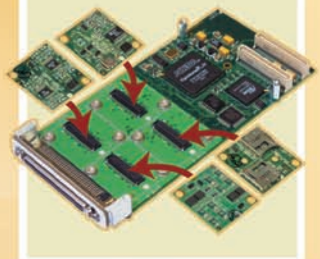

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Field Intelligence

Network attached data acquisition leads to configuration freedom

By Duncan Young

Multichannel, low-frequency signal processing architectures used in test and measurement, vibration analysis, and acoustic processing (sonar) are undergoing revolutionary changes and diverging from equivalent high-frequency military applications such as imaging, signals intelligence, digital radio, or radar. Recent implementations – particularly of sonar systems in larger submarines with their vast arrays of hull-mounted or towed acoustic sensors – have introduced the concept of network attached data acquisition. Data is acquired and packetized at groups of sensors, then passed via Ethernet to signal processing servers forming the main sonar signal processing computer. This freedom from direct attachment of sensors to signal processing creates opportunities to configure systems that are easier to integrate, perform better, and offer both form factor and processor independence.

High- and low-frequency applications

Directly attaching the A to D will continue in high-frequency applications, often using PMC/XMC mezzanine modules to provide compatibility with popular VMEbus, VPX, or CompactPCI systems. These use PCI-X or PCI Express to transfer data samples at very high rates, directly into the signal processor's main memory. High-performance processors such as Freescale's dual-core 8641D PowerPC CPU are often used in multicomputing configurations, performing floating-point FFTs on blocks of data as they are assembled into memory. In addition, FPGAs can be used for preprocessing where many repetitive algorithms must be performed in parallel on the incoming data. Data flow is an important characteristic of these high-performance systems, and switched fabrics form high-bandwidth connections between processing nodes. This creates a complex heterogeneous architecture that is difficult to implement, manage, and integrate, requiring specialized knowledge plus sophisticated modeling and testing tools.

On the other hand, for low-frequency applications, this level of complexity has been rendered unnecessary by the widespread availability of GbE, with its ability to transfer data at rates in excess of 30 MBps. It offers the bandwidth to support many low-frequency acoustic channels through a single cable. This allows colocated data acquisition with the sensors via self-contained data concentrators accessed and controlled by standard network protocols such as SNMP. By effectively using point-to-point data transfers, bus contention and determinism issues are eliminated. Separating the acquisition in this way offers many advantages. Data acquisition modules can be configured in purpose-built packaging to suit the application and its environment. They can be mounted close to the sensors and, by being remote from signal processing, will not be subjected to the noisy electrical environment of clocks, bus switching, or power supply chopping.

> "The flexibility and ease of integration offered by network attached devices is changing the way military embedded systems are being architected and implemented."

This data acquisition separation gives many more choices in architecture, form factor, and signal processor type. If the packaging meets the environmental requirements, off-the-shelf PCs, embedded workstations, file servers, and the familiar 6U format, PowerPC-based multicompute engines can be used to meet the needs of the application. A leading example of a network attached data acquisition system is daqNet, offered by GE Fanuc Intelligent Platforms (Figure 1). Packaged in a 1U high, 19-inch rack-mounted enclosure, daqNet incorporates up to 192 channels plus an FPGA for network protocol processing. It is also capable of front-end preprocessing.

Figure 1

Network attached devices

Network attached functionality of all types is growing rapidly. For example, Network Attached Storage (NAS) is a rapid growth area for shared network applications. In nonmilitary markets, instrumentation systems are migrating from the well-established VMEbus eXtensions for Instrumentation (VXI) standard to the newer LAN-based eXtensions for Instrumentation (LXI), based on similar concepts of network attached data acquisition. 10 GbE is the next evolutionary step, giving more latitude in network topology and enabling more low-frequency channels or a smaller number of video channels to be carried, for example. A sonar signal processor is a very tightly controlled network environment. Other instances of attached data acquisition such as instrumentation and analysis of a gas turbine aero engine might need the flexibility of a number of shared local network applications today, but could migrate to being entirely Web based.

The flexibility and ease of integration offered by network attached devices is changing the way military embedded systems are being architected and implemented. Multichannel, low-frequency data acquisition is already part of the inventory and looks set for extension into many other application areas as 10 Gb (and faster) Ethernet rapidly becomes more widespread.

To learn more, e-mail Duncan Young at young.duncan1@btinternet.com.

Mil Tech Insider

More power to ground vehicle systems

By John Wemekamp

As the roles and missions of ground vehicles become more complex, the demands placed on their electrical power generation and distribution systems have increased dramatically. Even light, high-mobility vehicles, such as the ubiquitous High Mobility Multipurpose Wheeled Vehicle (HMMWV), are being mounted with sensor, weapon, and communications systems requiring much greater generating capacity than they were originally designed to provide. Most existing vehicle electrical systems are based on 28 VDC, but this does not scale well in size or weight when asked to deliver the tens of kilowatts needed to meet future expectations.

In addition to weapons, sensors, and mission electronics that are becoming part of the regular vehicle fit, dismounted soldiers are heavy consumers of electrical power. This is particularly true when they are away from base overnight, needing lighting and heating plus recharging of the many portable electronic devices they are obliged to carry. The traditional solution is to trailer-in mobile generators and fuel, but significant savings in logistics and cost could be leveraged using in-vehicle generating capacity.

> "Even with its inherent benefits, 600 V is still a potential safety hazard and requires extra insulation, conductor spacing, and personnel protection ..."

Electrical requirements

The electrical needs of a typical light utility vehicle such as an HMMWV can be met with a 28 V, 50 A alternator providing all that is needed for driving, lighting, crew comfort, and battery charging. But future needs, including support for dismounted soldiers, can already be anticipated in the order of 10 kW, requiring 400 A or more at 28 V. Unless exotic, expensive materials are used in its construction, a 400 A alternator becomes disproportionately large and heavy and will, therefore, dissipate much extra heat. The weight and cost of cabling to distribute this amount of power within the vehicle also become prohibitive; even if discrete bites are taken from the 400 A to distribute it to individual subsystems, the total, if distributed over any distance, will still add up to the same weight and cost. For these reasons, many new or upgrade vehicle programs are considering generating and distributing power at a much higher voltage, such as 600 V.

But it is still most likely that automotive systems will continue to be based on 28 VDC, hence 600 V will need to be down-converted to a number of other voltages. Power conversion units such as the example shown in Figure 1 can be positioned at as many locations as required within the vehicle and can be designed to be the most cost-effective or efficient for each intended application. For example, 28 VDC automotive components are very tolerant of regulation and electrical noise. However, power for the electronic systems and dismounted soldiers will need to be better quality and converted more efficiently to reduce overall heat dissipation. There is probably no intrinsic reason why 600 V could not be distributed directly to the vehicle's electronics architecture. But much COTS-based equipment – whether designed for rugged military or commercial use – will operate from 110 VAC, 60 Hz, making this an obvious choice for additional conversion. The 110 VAC will also be required by the dismounted soldier, offering the scope to convert within the vehicle or even remotely outside the vehicle at the point where it is required.

Future systems

Even with its inherent benefits, 600 V is still a potential safety hazard and requires extra insulation, conductor spacing, and personnel protection in addition to the extra logistics, maintenance, and training that any new technology introduction will bring. There is also the potential for unintended electromagnetic emissions at the chopping frequencies of the converters due to the size of the voltage swings. Power system architecture and physical layout will require continued refinement to avoid the creation of any unwanted electromagnetic signature.

Figure 1

Generating power at 600 V will help to resolve many SWaP issues of new vehicles, allowing the extension of their capability and mission envelopes. This will be applicable not just to light, high-mobility vehicles, but also to many other land vehicles with large power generation and distribution requirements. An advantage is the ability to share common converter, distribution, and power management technology across a range of vehicle sizes. Just as the weapon, sensor, and mission systems will become more powerful and dissipate more heat, so will power and heat management systems need to evolve with them. This will then lead to the possibility of new cooling technologies such as liquid cooling in order to make further gains in efficiency, weight, and space saving. Curtiss-Wright Controls Embedded Computing (CWCEC) is using its experience in developing armored vehicle power systems to introduce the new technologies and distribution solutions needed to apply this next generation of efficient, high-voltage, power generation systems.

To learn more, e-mail John at john.wemekamp@curtisswright.com.

Legacy Software Migration

By Steve Blackman

Secure virtualization technology can extend the life of legacy systems

By combining the concept of virtualization with security, one can consolidate multiple legacy systems running on heterogeneous operating systems onto a single host system with high-assurance security and extend the life of legacy systems.

In computing, *virtualization* is a broad term that refers to the abstraction of computer resources. Platform virtualization separates an operating system from its hardware and enables multiple operating systems to run concurrently on a single computer. Virtualization technology provides an avenue to continue the life of legacy systems on newer hardware and reduce hardware costs in systems by consolidating systems onto fewer physical computers. Additionally, the defense and intelligence communities need to keep these systems in different security domains. This means secure virtualization – maintaining isolation of information and information flow control between systems running on a single computer – is required. Secure virtualization is available from COTS vendors today in the forms of separation kernel/hypervisors.

The military utilizes systems that are "proven" (a euphemism for "old"). Maintaining these systems is an absolute necessity to keep our military fully operational. Too many of these systems run on older hardware that is becoming increasingly unavailable. They were designed as one-of-a-kind systems that must be maintained by the original provider and are based upon proprietary technology. The cost to maintain these systems is too high for even the DoD, which is one reason for their emphasis on open systems/open architecture in new acquisitions. While the migration to open systems makes sense, modernizing all these systems takes a lot of time and money. In the meantime, the military must continue operations, and so extending the life of legacy systems is a requirement. Take, for example, the Navy's Consolidated Afloat Networks Enterprise Services (CANES) program, which is attempting to modernize and consolidate the networks on ships. Even this new program cites the requirement to support legacy OSs including Windows 2000, Windows 2003, XP, Solaris 9, Solaris 10, and multiple Linux versions.

"The military utilizes systems that are "proven" (a euphemism for "old"). Maintaining these systems is an absolute necessity to keep our military fully operational. Too many of these systems run on older hardware that is becoming increasingly unavailable."

The commercial world has found that virtualization permits reduction in the amount of hardware (computers) required by running multiple systems concurrently on a single piece of hardware. Virtualization also takes advantage of the increased processing power of new silicon. The systems run the same as if they were installed on stand-alone hardware platforms. In computing, a hypervisor is a virtualization platform that allows multiple operating systems to run on a host computer simultaneously.

Traditionally, the military used separate hardware and networks to isolate systems of different security levels. It is common to see multiple computers under workstations and multiple displays on desks. While virtualization can consolidate multiple systems from a computer perspective, it does not address security requirements. In fact, most commercially available hypervisors are too large to be evaluated for high-assurance systems.

Secure systems need guaranteed separation of domains of information and a controlled flow when information is exchanged between domains. Cross-domain systems rely on *guards* to control the transfer of information between domains in secure systems. High-assurance systems are moving to the distributed security model pioneered by John Rushby in the 1980s. Rushby introduced the concept of a separation kernel whereby the OS is small and executes a limited set of security functions (separation of domains and information flow control), but executes the set extremely well. Today a Separation Kernel Protection Profile (SKPP) provides the functional and assurance requirements for high-assurance systems using this model.

By combining the concept of virtualization and security, one can consolidate multiple legacy systems running on heterogeneous operating systems onto a single host system with high-assurance security. Legacy systems' lives are extended by running on new hardware with their existing (old version) operating systems while maintaining secure separation of domains of information.

***Steve Blackman** is director of business development for military and aerospace at LynuxWorks, Inc. With more than 25 years of embedded industry and technology experience, Steve has managed sales and marketing organizations addressing applications from networking to safety-critical avionics to security. He holds a B.S. degree in Applied and Engineering Physics from Cornell University and a Master's in Management from Boston University. He can be contacted at sblackman@lnxw.com.*

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Daily Briefing: News Snippets

By Sharon Schnakenburg, Associate Editor

www.mil-embedded.com/dailybriefing

Green Hills earns EAL6+

Is the Internet with its inherent lack of security a blessing or a curse to individuals, governments, militaries, nations? … While some are postulating and even pontificating on the matter, Green Hills Software spent the past decade laying the groundwork to achieve what its execs say is the solution: the EAL6+ High Robustness certification of its INTEGRITY-178B operating system. The certification was spurred into action by the National Security Agency (NSA) and recently ratified by the NSA's National Information Assurance Partnership (NIAP) initiative. INTEGRITY-178B, the only COTS RTOS to have achieved EAL6+ status, provides users the ability to defeat hostile cyberattacks by foreign defense agencies, corporate spies, and sophisticated criminals and provides the enterprise with military-grade security. *(Also see Editor's Choice section.)*

Helicopter consortium speaks DGA's lingo

An industry consortium is speaking the French Defence Procurement Agency's (DGA's) language – to the tune of an additional 22 NH90 Tactical Transport Helicopters (TTHs). The agreement between the DGA and the NHIndustries consortium – an NH90 joint venture of Agusta Westland, Eurocopter, and Stork Fokker – requests the new crop of helicopters in addition to the 12 ordered by DGA last November. All 34 vehicles are slated for delivery to the French Army beginning in 2011, and will be manufactured at Eurocopter's Marignane, France locale. NH90 falls under the 9 to 10 metric ton umbrella, works in conjunction with anti-submarine combat and tactical transport fleets, and features forward-looking IR and weather radar. NH90, which flies as fast as 300 km/h, is touted as Europe's most complex military helicopter program, with 23 variants in production.

Photo courtesy of Eurocopter

Turkish and U.S. Navies get some support

Photo by U.S. Navy

What do the U.S. and Turkish navies have in common? For one thing, they are both beneficiaries of a recent \$6.3 million U.S. Navy's Naval Sea Systems Command (NAVSEA) contract modification. The modification to 2004's Design Agent Contract stipulates that Lockheed Martin (LM) render engineering support services for its MK 41 Vertical Launching System (VLS), found on both the Turkish navy's MEKO Track IIA and IIB frigates and in the U.S. Navy's Ticonderoga Class guided missile cruiser's regime of modernization. The MK 41 VLS, incarnated in the 1980s by LM, has undergone many baseline improvements and system upgrades in subsequent years to lower ownership costs and utilize new missile technology. In the present day, the below-deck MK 41 multi-missile launcher helps militaries in ballistic missile defense, ship self-defense, and anti-submarine and anti-air endeavors. Twelve navies worldwide have 186 ships with MK 41 VLS systems on order or in service.

PrismTech's source code opens up

In today's economy, many will take what they can get for a good deal, or better yet: free. While either scenario appears dismal for the grantor, PrismTech just might see things differently: The company recently released its low-latency OpenSplice DDS software into the open source code arena under Lesser General Public License (LGPL). "LGPL permits users' commercially licensed applications to use the Open Source OpenSplice DDS without their applications becoming subject to the LPGL terms," according to information provided by PrismTech. The reasons behind OpenSplice DDS's transfer to open source include customer demand for product uptake in new industry sectors and applications, along with the ability to fast-track user-led innovation and conquer the innate risks of mission-critical deployments. OpenSplice DDS will be downloadable in early Q2 2009; however, immediate evaluation opportunities are also available by contacting PrismTech at www.opensplice.com.

New standard hastens software porting, development time

Power.org recently released its Embedded Power Architecture Platform Requirements (ePAPR) standard, which accelerates software porting and reduces development expenses for Power Architecture CPU-based embedded systems. ePAPR defines the interfaces between client programs and boot programs, including bootloaders, boot firmware, hypervisors, and OSs. Key to the equation is a "device tree" that lists characteristics and properties of a system's physical devices and is loaded into client program memory. Consequently, the system can dynamically detect and access system hardware that likely would be otherwise undetectable. The abstraction level thereby afforded also speeds the design process by shielding designers from the complexity often associated with the underlying hardware. ePAPR additionally stipulates mechanisms to boot a system comprising multiple Power Architecture CPUs.

One-stop-shop increases its scope

One Stop Systems, Inc. recently bought from Ciprico, Inc. the sole rights to manufacture three of the data storage company's product lines: Talon 4, DiMeda, and MediaVault. Ciprico, which filed for Chapter 11 bankruptcy last July, will also transfer the three product lines' existing inventory and order backlog to One Stop Systems. Talon 4 is a rugged military RAID system suitable for C4ISR streaming data acquisition; DiMeda is a Network Attached Storage (NAS) appliance designed for the digital cinema market; and MediaVault is a direct attached storage device that fares well in video imaging and commercial TV and radio broadcasting apps.

Industry bids farewell to ACT/Technico

Many industry participants would agree that the adage "all good things must come to an end" is true for ACT/Technico, recently acquired by Elma Electronic. The 30-year-old ACT/Technico now joins Elma's nomenclature, and the move melds Elma's electronic packaging know-how with ACT/Technico's repertoire of embedded integration knowledge. In a statement to the media, ACT/Technico's VP, Ken Grob, said, "By providing a more extensive set of computing products and services, our combined companies can further assist our customers in developing completely integrated system platforms." Meanwhile, commonality between the now-unified companies (or really, "company") includes their VITA- and PICMG-based savvy in the defense and communications markets.

DoD contracts protect troops in Iraq, Afghanistan

The U.S. DoD and Boeing recently put pen to paper once again, signing two contracts aimed at keeping soldiers in Afghanistan and Iraq out of harm's way. The first contract totals $106.9 million and orders continued (Lot 13) production of Joint Direct Attack Munition (JDAM) tail kits to be delivered to the U.S. Navy and U.S. Air Force in 2010 and 2011. Meanwhile, the second contract stipulates that Boeing continue to provide the U.S. Air Force with more than 2,500 Small Diameter Bombs (SDBs) and their carriages in 2010 at a price tag of $110.2 million (Lot 5 production). The "low-cost" JDAM guidance kits transform existing unguided 500, 1,000, and 2,000 pound free-falling bombs into "smart" guided weapons. In contrast, SDB is known for its size and accuracy, multipurpose warhead, and standoff range of more than 40 nautical miles, Boeing reports.

Helmand Province, Afghanistan, photo by Cpl. Pete Thibodeau, U.S. Marine Corps

U.S. Air Force photo by Staff Sgt. Aaron Allmon

DO-178B and DO-254: A unified aerospace-field theory?

By Vance Hilderman

Though some progress has been made toward a unified field theory, relating the physics of heavenly bodies to subatomic particles, another type of unification is having more measurable success: the unification of military and commercial avionics through increasing utilization of the DO-178B and DO-254 safety standards.

The last century saw great strides toward a unified field theory, which attempts to relate the physics of heavenly bodies to subatomic particles. The first part of this century has seen similar unification progress within avionics by combining commercial software and hardware standards with those from the military. For physics, the desired unification is proving elusive, because the existing theories for large structures and subatomic particles are currently incompatible. However, previous incompatibilities between commercial and military avionics are being resolved at a rapid pace, leaving ultimate unification more a matter of "when" than "if" via the DO-178B and DO-254 avionics safety standards.

But, this path to unification has not always been as clear-cut as it is today. Only a few short years ago, embedded military projects eschewed key commercial safety standards for software and hardware development. Military projects were deemed "different" because they fulfilled critical tactical and defensive missions, whereas commercial avionics projects emphasized safety and cost-effectiveness.

However, consider some of the similarities between today's military and commercial avionics:

- Both utilize high-complexity integrations
- Both require access to leading-edge commercial technologies
- Both require safety with a reasonable cost
- Both are increasingly concerned with reusability, quality, and increased cost-effectiveness

Originally on different flight paths, commercial avionics used the DO-178B standard for software, with success measured by schedule, cost, and reusability while emphasizing passenger and user safety. Military industries worldwide took note and gradually adopted much of DO-178B as the *de facto* standard for aerospace software. Next, the commercial world applied a similar standard, called *DO-254,* to hardware and again the military establishment took note.

Today, DO-178B and DO-254 are increasingly required for almost all commercial and military aerospace projects throughout the world (see sidebar below). Fighter and cargo jets, unmanned airborne systems, and even space exploration vehicles are adopting or mandating DO-178B and DO-254. But differences in the military's mission and perception remain strong and hinder unified adoption of these standards. Over the next year, DO-178C will replace DO-178B (see sidebar opposite page), and DO-254 will become mandatory on virtually all commercial and military projects. This "unification" poses many challenges and raises new questions, for which the author postulates a unified aerospace-field theory: Commercial and military avionics' previous incompatibilities are increasingly resolved with DO-178B and DO-254 adherence, and key metrics include technology complexity, cost, FAA oversight, and MIL-STD compatibility.

DO-178B and DO-254 resolve a complex chain

The DO-178B (software) and DO-254 (hardware) standards presume that hardware and software must operate in harmonic unison, each with proven reliability. Previously, hardware was considered "visible" and tested at the system level with integrated

DO-178B and DO-254: American, but "worldwide"

DO-178B and DO-254 are the respective American software and hardware standards for airborne electronics. These standards have European counterparts via the European Aviation Standards Agency (EASA) and are managed via international committees. Asia, South America, and Africa also develop and deploy airborne electronics to these DO-178B and DO-254 standards. The general rule mandates that commercial avionics equipment used within North America and Europe must comply with these standards, and the rest of the world similarly follows suit. DO-178B and DO-254 mandate processes for safety, specification, design, implementation, correctness, data, and certification of airborne electronics.

software; hence hardware was exempt from DO-178B quality attributes. But that exemption resulted in functionality being moved from software to hardware for the purpose of avoiding software certification. Also, hardware complexity has evolved such that hardware is often as complex, or more so, than software due to the embedded logic within PLDs, ASICs, and FPGAs. In the present day, everyone recognizes that hardware and software comprise an inextricable chain with the quality equal to that of the weakest link, hence the mandate to also apply DO-254 to avionics hardware. Figure 1 shows the scope of DO-178B and DO-254 and confirms that each avionics component comprises one link within this complex chain.

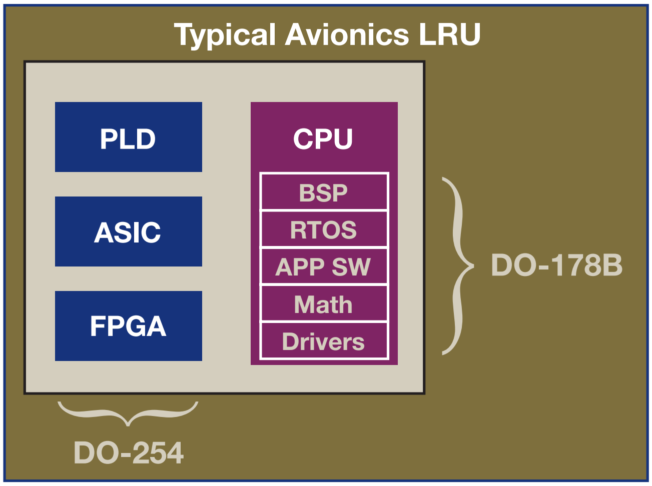
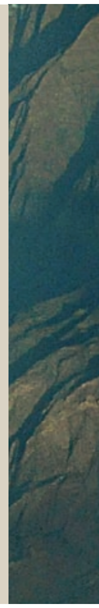


Figure 1



DO-178B versus DO-178C: Becoming "unified"

DO-178C, the first update to DO-178 in almost two decades, will be released later this year. By 2010, the updated DO-178C will be required on all military and commercial avionics. DO-178C will better address software technologies such as modeling, object-oriented software, formal methods, and COTS software; these technologies are increasingly applied within military avionics. DO-178C will also contain enhanced details on software tool qualification, an area of previous underutilization within military avionics. For example, military aircraft cockpits are increasingly designed with formal graphics modeling tools such as VAPS or QCG, which have been qualified to DO-178 just as their commercial counterparts have been for a decade. With these updates and the mandate for commercial and military usage on new projects starting in 2010, DO-178C will further unify military and commercial avionics development.

Costs versus benefits: A military "surprise"

For decades, military organizations have developed hardware and software using a variety of specialized, defense-oriented standards including 2167A, 498, 882, and others. As military organizations, they were highly motivated to use hardware and software standards that differed from the commercial sector since it was perceived that military applications had their own unique requirements. Military's utmost concern was primarily "mission," which took precedence over safety and long-term cost reduction.

As recently as a few years ago, military organizations believed a popular myth that DO-178B and DO-254 doubled or tripled the cost of avionics development and deployment. This inflated myth delayed the adoption of DO-178B and DO-254 within military establishments because of the belief that doubling or tripling avionics development costs could not be justified. Indeed, a quick review of DO-178B and DO-254 seemed to add onerous planning, requirements detail, process controls, and rigorous low-level testing. However, these additional attributes are the very characteristics that actually reduce long-term costs while increasing safety. After the military studied, then adopted DO-178B and DO-254, it became apparent that the actual cost increases, while not trivial, are much more palatable. In most cases, the direct benefits outweigh the added cost, a fact that has spurred recent acceptance of DO-178B and DO-254 by the military community. Figure 2 shows a typical project development cost increase relating to DO-178B and DO-254 by criticality level, where Level E is a noncritical system and Level A is the most critical system with stricter certification requirements.

DO-178B and DO-254 can improve quality, maintainability, reusability, schedule attainment, and safety. The apparent 10 to 40 percent cost increase is thereby justified. And from a pure safety standpoint, it is no secret that commercial aircraft fatalities have been steadily declining for decades, in no small part due to DO-178B and DO-254.

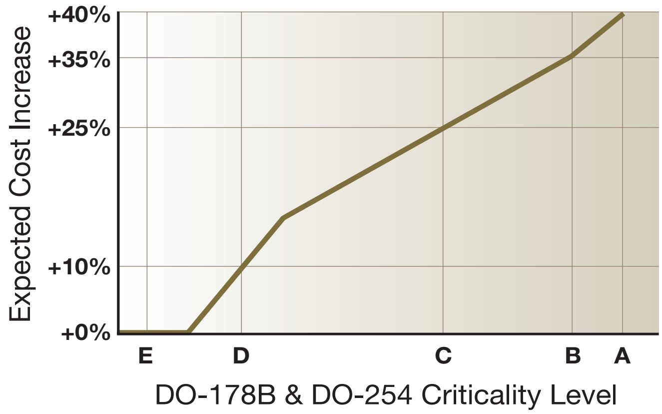


Figure 2

Military and FAA: Not seeing eye-to-eye

The military did not want to relinquish oversight to the Federal Aviation Administration (FAA), nor did the FAA have the bandwidth or authorization to intervene within military projects. For decades, U.S. military forces largely operated autonomously from commercial counterparts. Airports, air traffic control, and airspace were separate; it was only natural that avionics development and certification were separate as well. Today, the FAA and military are closely cooperating via new avionics certification initiatives within Homeland Security, unmanned aerial systems, and FAA Designated Engineering Representative (DER) reviews of military avionics. However, military agencies self-certify their own systems, generally without formal FAA approval.

MIL-STD and DO-178/254: Compatible?

Military organizations were once unfamiliar with DO-178B and DO-254 specifics, hence applying widely varying and subjective criteria. Truth be told, DO-178B and DO-254 can be terse and vague; specialized training by experts or years of experience are typically required to apply them in the real world. The military standards used in avionics were primarily contractual mechanisms applied to ensure industrial compliance with technical specifications and interoperability. Military aircraft safety and commercial avionic interaction were desirable goals but not enforced.

Eventually, worldwide militaries became surprisingly aware of numerous advantages held by their commercial counterparts: reduced costs and accident rates. However, militaries often further complicated DO-178B/DO-254 adoption by requiring simultaneous adherence to their own MIL standards. While well-intentioned, this mix is counterproductive since the standards differ and conflict with each other in key areas: DO-178B and DO-254 already have ample ambiguity and subjectivity that is grossly complicated when requiring corollary adherence to MIL standards. Therefore, military organizations have increasingly adopted DO-178B and DO-254 and mandated their sole compliance on an increasing number of projects.

The reality of unification

Commercial and military software/hardware are proceeding with unification via DO-178B and DO-254 despite key differences. Like different branches of the armed forces, they have learned that integration and commonality benefit everyone despite such differences. Industry is behind such unification as it increasingly develops products for combined commercial and military applications. Militaries are adopting common processes and oversight mechanisms to unify DO-178B and DO-254 and increasingly mandating compliance for all airborne electronics.

Worldwide industry groups for DO-254 and DO-178B are active at www.do254site.com and www.do178site.com. Similar airborne hardware and software online blogs are active at www.do254blog.com and www.do178blog.com. Worldwide commercial avionics certification agencies are working increasingly closely with military organizations to maximize commonality and interoperability. Winston Churchill once famously stated, “Democracy is the worst form of government except for all those others that have been tried.” Similarly, some may paraphrase: “Military and commercial avionics unification is the worst form of standardization in the world … except for all those others that have been tried.” Unification: here today and here to stay.

Vance Hilderman *is cofounder of HighRely Incorporated and coauthor of the book “Avionics Certification: A Complete Guide to DO-178 & DO-254” (2007). He was also the principal founder of TekSci in the 1990s. In a 20-plus-year career, Vance has served as consultant for most of the world’s largest aerospace companies and provided training in avionics software development and certification. He can be contacted at vance.hilderman@highrely.com.*

HighRely Incorporated
602-443-7359
www.highrely.com

U.S. Air Force photo by 1st Lt. Nathan D. Broshear

Maximizing GPGPU computing for embedded systems

By Alan Commike

Though GPUs began as commodity chips for consumer video games, the current generation of GPUs enables General-Purpose computing on the GPU (GPGPU), thereby providing rapid algorithm acceleration across many areas of deployable military systems. After years of evolution, performance, memory and power, and software tools are now available so engineers can start mixing GPUs into full, deployable systems alongside CPUs and FPGAs.

Traditionally, Graphical Processing Units (GPUs) have been thought of as commodity chips used to drive consumer video games. But the push for realism in such games and the expanding capabilities offered through ever-increasing transistor budgets have created GPU feature sets with a more programmable nature instead of a strict and fixed rendering pipeline. Consequently, GPU vendors have noticed a trend toward utilizing GPUs for computation and started adding features explicitly for General-Purpose computation on the GPU (GPGPU). Therefore, the GPU became capable of acting as a floating-point coprocessor. In other terms, it became possible to have an algorithm accelerator in the guise of a commodity GPU by utilizing techniques that are now described as *GPGPU computing*.

Accordingly, now is the time to start investigating how well the traditional GPU (and its future capabilities) fits within a mix of traditional CPUs and FPGAs – with the objective of accelerating algorithms for the next generation of deployed systems. The historical progression of GPU architecture has brought us to the point where we can now focus on memory and performance, power consumption, and software tools and standards – so that GPUs can meet the needs of vehicle, robot, or man-wearable embedded computing systems, for example.

History of GPUs, computational performance

From a computational perspective, the GPU is a very different chip than it was just a few years ago. Today's GPUs are capable of 32- and 64-bit IEEE-like[i] floating-point operations, have high bandwidth links to the host processor via 16-lane PCI Express Gen2, provide up to 4 GB onboard memory, and have a peak performance of more than 1,200 GFLOPS of floating-point performance. The programming languages, compilers, and hardware are all improving rapidly to close the gap between peak performance and sustained performance. GPU performance curves have not yet hit the peak that we've seen with CPUs. A comparison is seen in Figure 1 (image from NVIDIA CUDA Programming Guide 2.0, compliments of NVIDIA), which shows the peak GFLOPS performance of GPUs and CPUs in the past six years.

In the traditional parallel computing taxonomy, at first glance today's GPU can be considered a Single Instruction Multiple Data (SIMD) parallel machine. This means that there are many processing cores, each of which executes the same instruction on different pieces of data.

But upon closer inspection, the modern GPU architecture is actually a hybrid parallel machine that should be viewed as a Single Program Multiple Data (SPMD) architecture where groups of processors are ganged together. Within each gang of processors, the instruction stream executes similarly to traditional SIMD execution, with the same instruction running on all processors. Looking back to the multimillion-dollar massively parallel machines of the early 1990s, one sees many similarities to today's single-chip

[i] There are some differences between IEEE-754 floating point and the GPU implementations surrounding the handling of denorms, exceptions, and other portions of the standard.

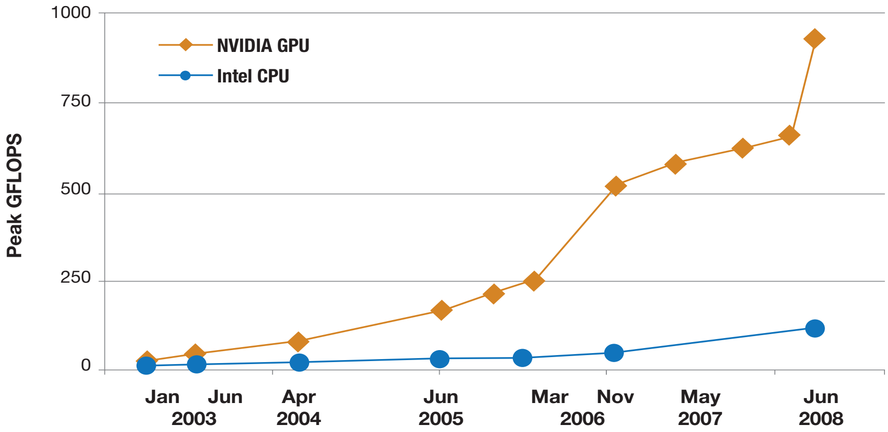


Figure 1

GPU, which instead sells for only a few hundred dollars. These early machines had hundreds of simple processors tightly coupled to a custom-built interconnect fabric. Figure 2, courtesy of AMD, shows a diagram of a modern GPU from AMD with the gangs of SIMD processing groups clearly visible, along with other peripheral components such as memory controllers and 3D graphics-specific features. Concentrating on the large SIMD core, one can see that each SIMD group contains 16 multistream processing units, which in turn contain five individual processing elements, totaling 800 individual ALU processors. This architecture could have easily represented a massively parallel machine of 20 years ago.

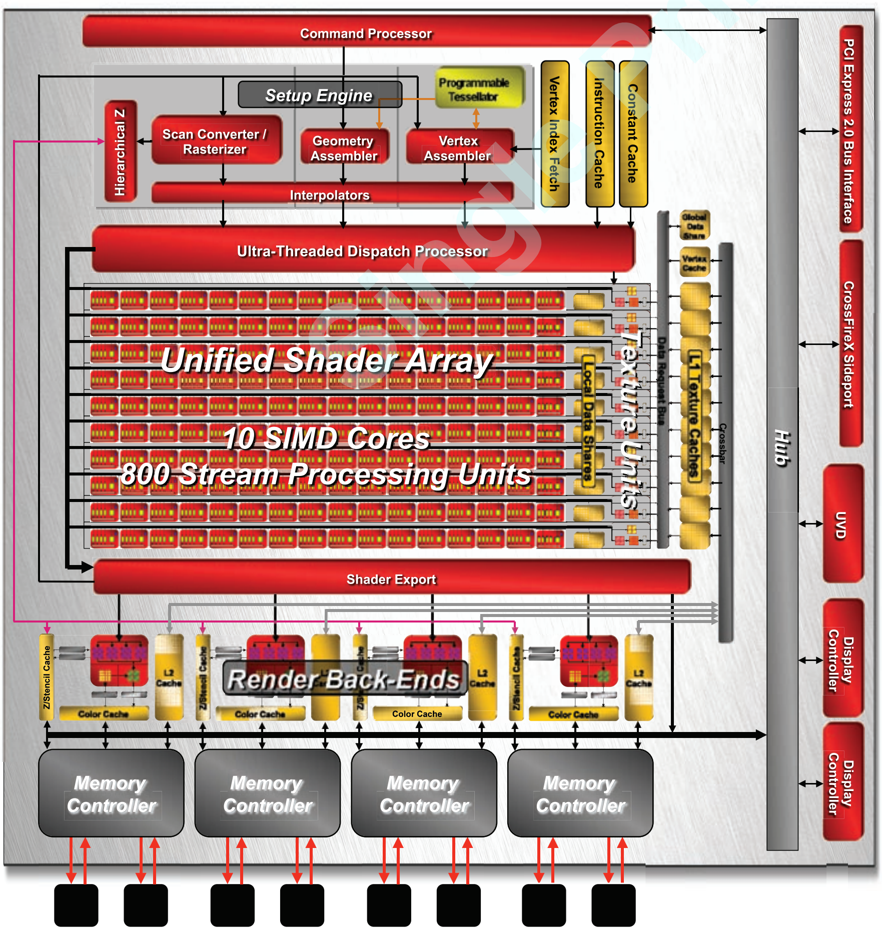


Figure 2

At the lowest level, Processing Element (PE) design differs between vendors. AMD's current architectures have been utilizing Very Long Instruction Word (VLIW) PEs, whereas NVIDIA has been utilizing single-instruction PEs. The PEs are mixed between simple ALUs (predominant) and special-purpose ALUs that handle transcendental functions and other more complex operations. Unlike a traditional CPU where the base datum is a single integer or float, the base datum on a GPU is a four-element vector corresponding to the red, green, blue, and alpha color vectors predominant in 3D graphics. GPGPU code ported from CPUs can often obtain nearly 4x speedups by utilizing these four-vector operations versus using a single element.

Fortunately, many of the algorithms of interest in the embedded market have arithmetic intensities that run well on a GPU. General image processing filters for electro-optical sensors are a perfect fit for GPUs; FFTs and other core signal processing algorithms that are part of a radar stack also map well with a GPU.

"GPGPU code ported from CPUs can often obtain nearly 4x speedups by utilizing these four-vector operations versus using a single element."

In addition, video codecs are generally built into modern GPU hardware to allow video encoding/decoding without additional hardware. Many algorithms that once required dedicated hardware coded for FPGAs or parallelized across many CPUs can now be run efficiently on a single GPU.

Melding memory and power

Due to hundreds of processing elements and thousands of in-flight threads, memory easily becomes a bottleneck on GPUs. Memory bandwidths to off-chip memory on modern GPUs exceed 100 GBps with large buses feeding high-performance memories. Even with very high memory rates, the performance hit of cache misses is generally higher than those seen on CPUs. Thus, algorithms that run most efficiently on GPUs are those with high arithmetic intensity, that is, where the number of operations per datum are high. This capability comes naturally from the 3D graphics heritage of GPUs, filling triangles mapped to the screen and providing for high levels of pre-fetching.

As stated previously, raw peak performance for today's leading-edge GPUs exceeds 1,200 GFLOPS by utilizing 800 on-chip processing elements. Unfortunately, at that level of performance, a GPU plus memory and other logic can exceed 226 W. For embedded applications where power consumption is a key constraint, this is a problem. The burgeoning list of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military applications alone – video processing in airborne systems, real-time 3D graphics in man-wearable training systems, spatial awareness in tanks, or location computation in unmanned vehicles – forces us to increase the efficiency of tomorrow's GPUs.

Fortunately, more miserly mobile GPUs can reduce the power draw while still maintaining high performance levels. For example, Quantum3D's Sentiris 5140 XMC GPU (using the ATI Radeon HD 3650 GPU), pictured in Figure 3, can draw less than 25 W and still deliver performance levels of 100 GFLOPS. The next-generation AMD mobile part is expected to nearly double this performance with a similar power envelope. The ATI Radeon HD 3650 contains 120 processing elements with a bandwidth of 25 GBps between main memory and the processing elements. This level of power conservation and performance can reduce the power, size, and weight needed for next-generation computational algorithms.

Figure 3

New software type needed for GPGPUs

The most elaborate hardware is only as good as its software and programming environment. In the early days of GPGPU programming, the OpenGL graphics language was used to coerce the GPU into performing computation. This required translating computational algorithms into a graphics language centered on triangles, textures, and frame buffers. Data structures needed to be mapped to 2D "textures" as red, green, blue, and alpha elements – and then rendered as a 3D graphics application. This was mostly the realm of university researchers due to the difficulty of mapping algorithms and the innate knowledge of the underlying graphics architecture needed to efficiently take advantage of the hardware.

As GPUs became more and more capable of computation, GPU vendors saw a nascent market for algorithm acceleration using GPGPU techniques. As a result, they began providing languages (and accompanying low-level Instruction Set Architectures, or ISAs) to explicitly target data parallel computation on the GPU. Similar to x86 hardware architectures from Intel and AMD, the GPU's ISA is abstracted from the actual hardware so that, as the underlying architecture changes, the ISA can remain constant. Just as x86 architectures differ, the ISAs provided by AMD and NVIDIA differ, but they are based on a similar conceptual framework.

There are many academic research projects developing various data-parallel programming languages. A new industry consortium[1] is also poised to develop a common GPGPU language that can be used across multiple GPU vendor cards. Challenges arise because each GPU vendor has its own proprietary GPU language, and other vendors have started entering the foray. The commonality behind all these languages is that they are extensions to the familiar C language, thus providing an easy path for developers to migrate to GPGPU programming. The objective of these efforts is an important one: Once successful, the embedded industry will have access to a common GPGPU language that will allow algorithms to be easily accelerated without spending man-years of effort developing and tuning for custom hardware systems.

Reference:

[1] OpenCL: www.khronos.org/news/press/releases/khronos_launches_heterogeneous_computing_initiative

***Alan Commike** is principal HPC architect at Quantum3D, Inc. For the past 15 years he has designed high-performance computing and visualization systems. He currently leads Quantum3D's efforts to develop the next generation of high-performance embedded platforms. He can be contacted at acommike@quantum3D.com.*

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The Defense Electronic Product Source
Jan/Feb 2009

In This Issue

Mechanical Mania: Chassis, connectors, cables, cooling, and more

Happy New Year to y'all. Could our world be any more uncertain this January in 2009? That's why it's particularly comforting to start the year with a *MIL/COTS DIGEST (MCD)* supplement that focuses on real products that one can touch and bang about. What's better than the taken-for-granted mechanical devices and products that comprise every embedded military system? They're sturdy, rugged, and made of metal, plastic, and epoxy. They have a sense of purpose and *permanence* in these uncertain times.

I've selected for you a collection of some of the most interesting and unique new products added by vendors into the OpenSystems Media product database (www.mil-embedded.com/products/search/index.php). As we expected, there are lots of packaging products ranging from ready-to-populate chassis in rack-, air-, or conduction-cooled flavors, to special-purpose versions such as rugged "shoeboxes." There are also a number of backplanes, carrier boards, and backplane extender boards.

But I am particularly thrilled to include cable assemblies, connectors, EMI shielding, special purpose I/O devices, and even media converters. Finally, this "Mechanical Mania" *MIL/COTS DIGEST* includes fans and controllers, heat sinks and cold plates, and even the power supplies that give "life" to electronic assemblies.

I hope you enjoy thumbing through our first *MCD* of 2009. Please also check out the Executive Speakouts from our five sponsor companies – they help make this supplement possible.

Chris A. Ciufo, Editor

2U MIL/COTS chassis

DXL Enterprises' SBS214 2U MIL/COTS chassis enables secure installation of Trenton Technology's 32 GB System Host Boards (SHBs) in 19-inch racks. Built in adherence with PICMG 1.3/SHB Express industry standards, the SBS214 chassis is 20 inches deep and features six fans, CD/DVD and floppy drives, three SATA hard drive removable carriers, two front-mounted USBs, and other standard peripheral hardware. Its slim 2U chassis allows vertical or horizontal mounting in space-constrained shipboard applications. All single board systems SBS214 chassis are provided with extended memory (32 GB) SHB cards built to customer specifications to provide the best fit for server class or graphics class for PICMG 1.3 applications. Each SBS214 chassis features three 80 mm, 34 CFM removable system fans; one 60 mm, 20 CFM exhaust fan; and two 60 mm, 20 CFM memory cooling fans. A 500 W power supply is standard, and redundant power is optionally available.

www.dxl.com **DXL ENTERPRISES**

Rugged MicroTCA chassis

Hybricon Corp.'s full ATR long Rugged MicroTCA chassis featuring a shock-mounted MicroTCA card cage is suitable for all rugged environments. Designed to meet MIL-STD-461E, CE102, CS101, CS116, RE101, and RE10, the chassis measures 10.5" (W) x 10.625" (H) x 19.62" (D) and includes top-load MicroTCA/AdvancedMC cards. Additionally, the MicroTCA card cage supports a front 150 mm section and rear 75 mm section, with air flowing through the two series front to back. The chassis has an AC/DC front-end power supply supporting 110/220 VAC operation with 48 VDC output to the DC MicroTCA power module. Meanwhile, chassis slot configurations include 150 mm front row, three full-size double-width (150 mm) slots for 150 mm AdvancedMC modules, and two full-size double-width slots with conversion module to convert to two single-width slots, along with many more configurations. The chassis is designed to cool 80 W per double-width full-height slot and 40 W per single-width full-height slot at 10,000 feet altitude. Rugged MicroTCA chassis accommodates a temperature range of 0 °C to +50 °C.

www.hybricon.com **HYBRICON CORP.**

1U pizza box-style microchassis

Triple E's 1U Microchassis is a pizza box-style microchassis that addresses inherent problems associated with electronic systems configured for military, aerospace, and industrial harsh environments. The 1U Microchassis meets IEEE 1101.10 and IEEE 1101.11 mechanical requirements. Configured with VME64x, CompactPCI, or PICMG 2.16 backplanes, the unit accommodates up to two 6U x 1.6 mm x 160 mm size boards in front, and two 6U x 1.6 mm x 80 mm direct plug-in rear transition boards. Weighing 10.75 lbs., the unit measures 19" rack-mount (L-R) x 1.73" (H) x 11.25" (D). A 3U, 300 W, PICMG 2.11-compliant power supply fits compactly within the 1U rack aperture. The power supply has nominal input of 115 to 240 VAC, operational input of 90 to 264 VAC, and output of +5 V/30 A, +3.3 V/40 A, and +12 V/1 A within operating temperature ranges from -5 °C to +55 °C. Eight 12 VDC 11.00 CFM fans via push-pull method provide cooling. The unit complies with UL and CE safety specifications, in addition to conducted and radiated EN Class B and EN ratings.

www.tripleEase.com **TRIPLE E**

Elastomer EMI shielding gasket

Parker Hannifin Corporation's Chomerics Division's CHO-SEAL 1270 is a very soft molded elastomer EMI shielding gasket. Typically at 35 ± 5 Shore A durometer hardness, it offers a 9 percent compression set and superior mechanical performance, electrical conductivity, and long-term stability. It renders reduced assembly costs as compared with higher hardness shielding materials. Additionally, shielding effectiveness is greater than 70 dB from 100 MHz through 10 GHz. CHO-SEAL 1270 is available in various product forms including compression-molded sheets, die-cut parts, and custom-molded shapes with available thicknesses ranging from 0.010 to 0.125 inches (0.25 to 3.18 mm).

www.chomerics.com
CHOMERICS

Mini SCSI cable assembly

The 3M MiniSAS System is a Mini Serial Attached Small Computer System Interface (SCSI) external cable assembly. It provides performance for SAS storage and is capable of a data rate of 6 Gbps per channel. Tested to SAS specification SAS-2, it also conforms to the SFF 8086, 8087, and 8088 standards as well as the current SAS 1.1 specification. A metal latch design promotes retention, while a pull-tab ring provides easy unmating. Two levels of EMLB are available for hot plugging.

www.3M.com **3M**

Extended-temp PoE splitter

The EKI-2701PSI industrial Power-over-Ethernet (PoE) splitter is connected between a standard Ethernet device and a PoE-powered connection. It separates the PoE connection into a standard RJ-45 Ethernet port and a removable screw terminal block supplying nearly 13 W at 24 VDC. It is ruggedized for demanding applications, with 4,000 VDC Ethernet ESD protection, power line surge (EFT) protection of 3,000 VDC, power isolation, and output power short circuit protection. For maximum uptime in unattended and remote locations, it features an extended operating temperature range of -40 °C to +75 °C. Utilizing unused wires in a 10/100BASE-T cable or by overlaying power on the data connections, PoE supplies 15.4 W of power at 48 VDC. The splitter supports both standard 10/100BASE-T and gigabit 1000BASE-T connections.

www.eAutomationPro.com **ADVANTECH eAUTOMATION GROUP**

Rugged 3U VPX enclosure

The ATR-3500 is a rugged enclosure that allows the use of standard conduction-cooled 3U VPX modules. It accommodates a six-slot VPX backplane consisting of one power module slot and five 3U VPX slots. The enclosure features a completely sealed electronics compartment. It is designed and engineered with extremely tight tolerances along with precision-machined card guides to ensure proper board seating and a reduction in connector stress. ATR-3500 is compatible with standard front panels or Dawn's special rugged panels. The enclosure comes complete with RuSH system health monitor, and ensures correct system operation by monitoring temperatures, voltages, humidity, and fans, as well as controlling fans for optimum system performance.

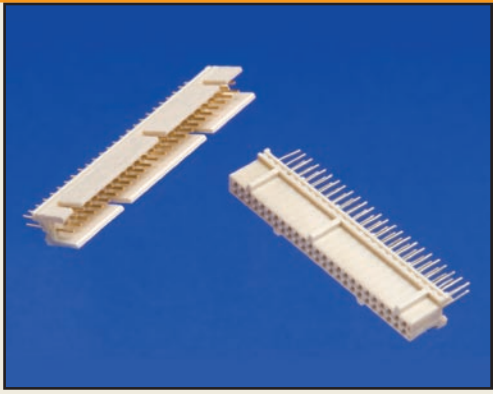
www.dawnvme.com **DAWN VME PRODUCTS, INC.**

Circular custom cable assemblies

Electro Standards' MIL Custom Cables are circular MIL connector custom cable assemblies designed to endure the harsh environments surrounding military and shipboard applications. Multiple connectors and pin arrangements are provided, and wire gauges range from 0 to 26 AWG. Contact gender is not limited by gender of connector housing, and high-density contact arrangements in miniature circular shells are available. Designed for especially demanding requirements of high-performance military and commercial applications, MIL Custom Cables are built in accordance with MIL-STD-2003 (Latest Rev). They are tested per MIL-STD-202G Method 301 (Dielectric Withstanding Voltage) and Method 302 (Insulation Resistance). In addition, they are labeled per ANSI AS5972 (replaces MIL-M81531).

www.electrostandards.com **ELECTRO STANDARDS**

Ultra-high rel connector



The Hypertronics KFT is a high-density, ultra-high reliability connector designed for demanding military and aerospace applications. It provides low-profile, dual-row in-line interconnection ideally suited for stacking and use in areas where board real estate is at a premium. KFT has fine pitch 0.050" (1.27 mm) spacing and a 0.343" (8.71 mm) stacking height and works with through-hole PCB up to 0.125" (3.18 mm). Manufactured with 30 percent glass-filled Liquid Crystal Polymer (LCP) insulators and potted contacts, KFT connectors withstand the high temperatures associated with soldering. Its LCP insulators also exceed NASA space requirements for outgassing and have inherent keying features to prevent improper mating. The connector has a 0.40 mm Hypertac hyperboloid contact and is immune to shock and vibration fretting. Fifty-, 100-, and 140-way versions are available, as are optional snap-on mounting brackets.

www.hypertronics.com **HYPERTRONICS**

3U CompactPCI PMC carrier

Acromag's AcPC4610 PMC carrier card provides easy I/O expansion for air- or conduction-cooled 3U CompactPCI systems. It holds one PMC card and provides a 32-bit 33/66 MHz PCI interface and a transparent PCI/PCI bridge for data transactions from the PCI bus to a PMC module. Rear connection I/O access is afforded; meanwhile, the AcPC4610 supports both 5 V and 3.3 V signaling. A -40 °C to +85 °C version is available.

www.acromag.com **ACROMAG, INC.**

NEMA-4X rated enclosure

The NEMA-4X DC Supply is a NEMA-4X rated enclosure for water-cooled AC-to-DC power supplies. It allows customers to employ quality power conversion in all environments. Magna-Power Electronics' NEMA-4X enclosure is made entirely from Grade 304 stainless steel, isolating components from the environment. As rated by the NEMA-4X standard, this protection includes windblown dust and rain, splashing water, and hose-directed water. The enclosure also remains undamaged by the formation of ice on it. The NEMA-4X enclosure is available for all PQ Series III and TS Series II models, and it accommodates power ranges of 3.3 kW to 45 kW. A combination of high- and medium-frequency power processing technologies improves response, shrinks package size, and reduces cost.

www.magna-power.com **MAGNA-POWER ELECTRONICS**

Spread fin array heat sinks

Advanced Thermal Solutions' maxiFLOW/maxiGRIP spread fin array heat sinks are made of lightweight, extruded aluminum that maximize air cooling. They reduce device junction temperatures by more than 20 percent compared to heat sinks of similar volume. The system allows for use of high-performance phase-change materials that improve heat transfer and applies steady, even pressure to the device to eliminate the need for PCB holes. The heat sinks are offered in 16 off-the-shelf component sizes, from 17 x 17 mm to 45 x 45 mm, and three low-profile heights.

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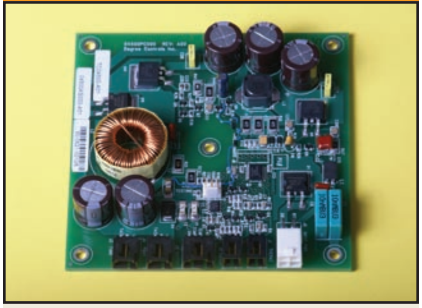
MIL-STD-461/-810F fan controllers



Degree Controls, Inc.'s Rugged Military Fan Controllers meet both MIL-STD-461 for EMI/EMC and MIL-STD-810F for environmental constraints. The controllers utilize microcontroller designs and DegreeC software to monitor system temperatures and adjust fan speed(s) accordingly. Programmable alarm thresholds can be set, along with speed curves that more precisely adjust temperatures to minimize thermal shock or deal with specialized ambient conditions.

www.degreec.com
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2009 Executive Speakouts

ATR expertise at Elma Electronic

By Justin Moll, Manager of Marketing

When it comes to customizing Air Transport Racks (Austin Turnbull Radio), Elma offers a unique level of experience. Elma has nearly 30 years of expertise in electronics packaging for mil/aero systems. Our range of standard and custom options for ATRs and rugged enclosures is second to none.

VPX is expected to be a big part of ATR designs in 2009 and beyond. Nobody in the industry has more VPX backplane/chassis experience than Elma. Nobody comes close. Elma has the widest selection of VPX backplanes in 3U, 6U, 6U hybrid and VXS/VPX hybrid in the industry. We've also led VPX innovation with VITA 46 load boards, extender cards, and SerDes test modules.

With Elma's Test and Validation lab, we can prove your custom ATR meets signal integrity, thermal management, EMI/RFI, power, and various other performance parameters. Whether it's convection-, conduction-, or liquid-cooled, Elma has an ATR solution for you. Come to Elma, the clear leader in ATR, VPX, and rugged packaging design.

ELMA ELECTRONIC **www.elma.com**

Systems engineered to perform

By David Lippincott, Chief Technologist

Chassis Plans is a recognized leader in manufacturing fully configured, long-availability computer systems for the rugged and military markets. Since 1985, we've provided 1U to 6U ATX and single board computer systems tailored exactly to customer mission requirements. We offer COTS, semi-COTS, and full custom designs because not all applications fit an off-the-shelf product. Every application is unique and deserves the appropriate solution.

For example, the M4U-19A semi-COTS solution (pictured), targeted to transit case and mobile installation, was designed and constructed for the rigors of desert warfare. Manufactured from high-strength but lightweight 5052 aluminum with a solid aluminum front panel, the M4U-19A, for this defense customer, provides two dual quad-core Xeon SBCs for 16 processor cores in a system just 4U by 19" deep. Using two COTS backplanes with a mix of PCI-X and PCI-E slots, nine mission-specific plug-in boards fit, in addition to the two high-performance SBCs. These systems and components are made in the USA for assured program-life availability, quality, and support. Chassis Plans' Systems are Engineered to Perform!™

CHASSIS PLANS **www.chassis-plans.com**

522 Series Test Station

By Jim Tierney, Vice President of Government Systems

The 522 Series product is a refresh of a product Carlo Gavazzi introduced to the industry over 15 years ago. Initially, the product was designed as a no-frills system that provided users unobstructed access to boards and components in a test and development environment. However, over time, boards and system components have evolved into a more complex product offering.

Carlo Gavazzi's rebirth of the 522 continues the heritage of accessibility to boards under test and development but adds features to enhance the functionality and user interface of the product. With the advancement of VPX as a formidable bus architecture for the future of military deployment, the 522 takes predecessor VME64x technology and brings together the emerging VPX architecture in one hybrid system. Integrated with intelligent system health monitoring functions and a digital display, it has become uniquely recognizable as a true rebirth product that Carlo Gavazzi pioneered back in the early '90s.

CARLO GAVAZZI COMPUTING SOLUTIONS **www.cg-cs.com**

Tyco connectors designed to meet latest VITA standards

By Gregory Powers, Market Development Manager

Tyco Electronics' Global Aerospace, Defense and Marine business unit is providing enabling technology to our customers via a variety of new product development efforts. Most participants in the embedded systems market know us for our game-changing VITA 41/46/47/48 standard MULTIGIG RT2 Connector. We are working with the VITA committee to continue to expand the capability of this rugged backplane connector system to include fiberoptic and RF modules (VITA 46.12 and 46.14, respectively). We are also developing the new MULTIGIG Extreme for environments above and beyond VITA 47, as well as supporting alternative architectures such as MicroTCA and Rugged MicroTCA with the latest in interconnect technology. Finally, to help enable the ideal state of "location-independent architecture," we are developing and producing input/output hardware to support the latest ruggedized high-speed copper, fiber optic, and wireless solutions to unleash the speed and bandwidth from inside the box.

TYCO ELECTRONICS **www. tycoelectronics.com/industry/aerospace**

Reduce development time with innovative new MicroTCA system

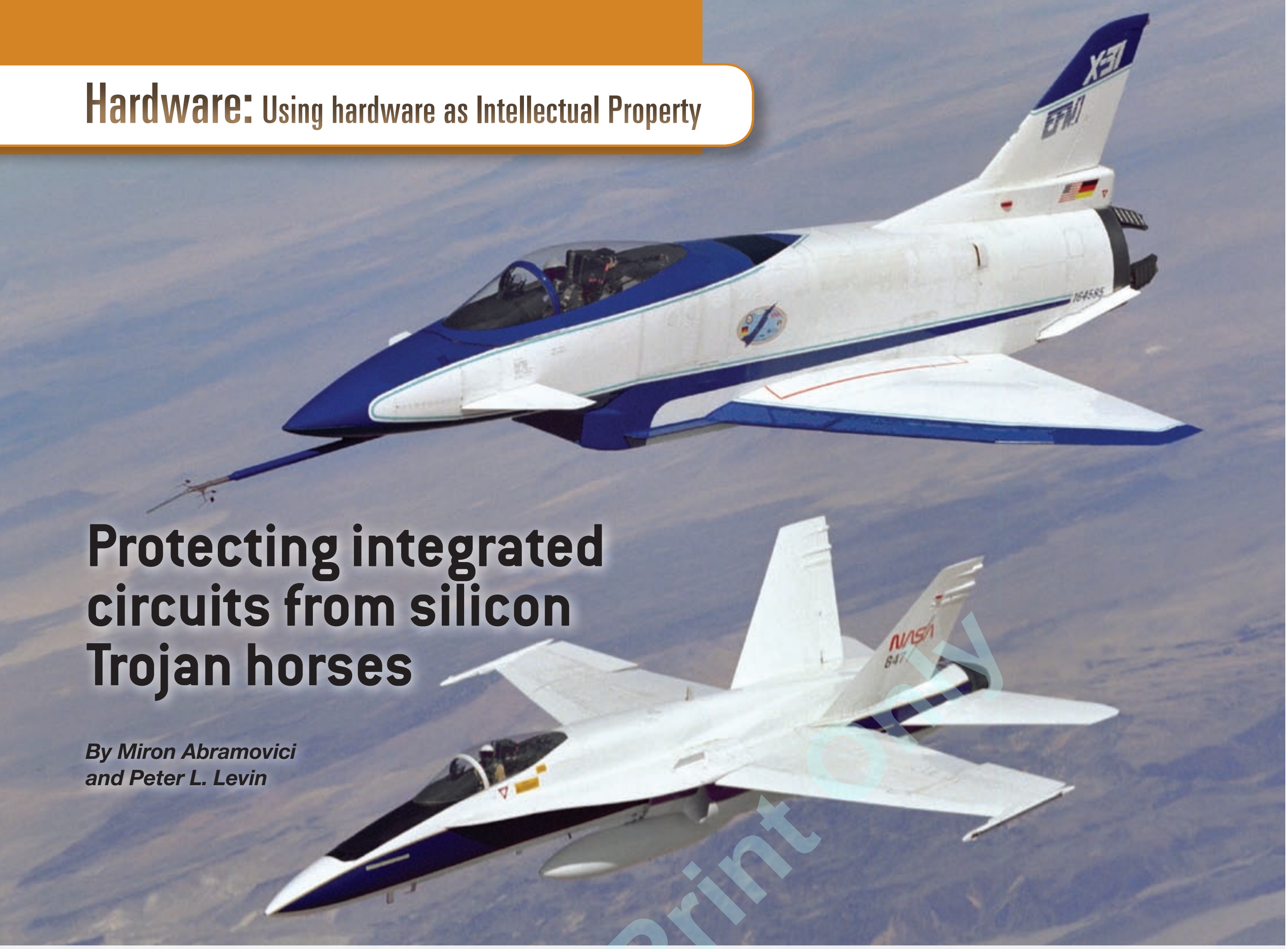
By Paul Virgo, Director, Vertical Marketing

The best-in-class Centellis™ 500 MicroTCA™ system from Emerson Network Power is a groundbreaking achievement in design that brings new dimensions of accessibility, mobility, and affordability to MicroTCA technology.

Featuring an innovative, economical system enclosure, the Centellis 500 has introduced MicroTCA to a host of new enterprise applications that may have deemed the technology too cost-prohibitive in the past. Constructed from lightweight and durable injection-molded plastic, the product's enclosure technology is designed to deliver unmatched mobility to a variety of deployment scenarios at a fraction of the cost of other MicroTCA systems.

The system arrives validated with Emerson's PrAMC-7211 module (with Intel® Core™2 Duo processor), three mid-size AMC payload slots, and world-class SpiderWare®M^3 platform management software for rapid deployment. Developed specifically for military and defense applications, SpiderWareM^3 software significantly reduces development time for a wide range of applications – including packet processing, VoIP, and access gateways – and offers remote management and monitoring capabilities.

EMERSON NETWORK POWER EMBEDDED COMPUTING **www.emersonnetworkpower/embeddedcomputing**



Protecting integrated circuits from silicon Trojan horses

By Miron Abramovici and Peter L. Levin

NASA Dryden Flight Research Center Photo Collection

Post-fab validation IP instruments apprehend harmful "Trojan-horse" logic that aims to undermine mission-critical operation of military SoCs.

With complex integrated circuits functioning in and around virtually all aspects of consumer, industrial, and military electronics, secure manufacturing of these devices has become a vital issue. For economic reasons, nearly all ICs are fabricated by foreign foundries and include Intellectual Property (IP) cores supplied by a wide range of third-party technology providers. IC development is often outsourced to design and test service vendors who use automated tools from many different vendors.

This common process from design to manufacturing provides wrongdoers with numerous opportunities to insert Trojan-horse logic – effectively a hardware hack aimed at sabotaging an IC's mission-critical functionality. Until now, no reliable methods existed to guarantee pre-deployment detection of this kind of rogue silicon attack. This problem raises national-security implications of staggering significance: A Trojan can wreak havoc in the basic civilian infrastructure (electric grid, communication, and banking networks), sabotage critical missions, disable weapon systems, or provide backdoor access to otherwise highly secure systems. However, new reconfigurable post-fab validation IP instruments are aiming to solve the Trojan problem.

Trojan attacks and possible defenses

Trojan attacks can occur in a variety of ways. For example, a Trojan might be inserted into an IP core provided as an RTL model. Such a Trojan could be designed to be activated in a field-deployed IC by a time-bomb mechanism (for example, "disable the core one month after system reset") or by a booby-trap mechanism (for example, "set the core in test mode after 100 billion packets have been processed"). Intrusions such as these ensure the Trojan will not be activated during pre-silicon verification (using simulation or emulation) or even during conventional silicon validation. Formal verification methods are not capable of dealing with the full functional range of today's SoC designs. If the Trojan is never activated during simulation or emulation, it could be identified by analyzing areas with low functional coverage during pre-silicon verification. But typically a complex IC is sent for tapeout with many areas still having incomplete functional coverage, as complete coverage cannot be achieved in practice.

In post-silicon testing, most proposed Trojan detection techniques analyze different physical characteristics of the IC (such as power consumption, timing variations, and layout structures) with respect to a perfect, and perfectly trustable, reference. However, the presence of a Trojan in the RTL model of the device precludes having a such a perfect "golden model"; this invalidates the basic assumption that is the cornerstone of most detection methods. Even if a golden model does exist, such a model covers only the functional logic. Insertion of infrastructure logic in the design for testability, reliability, manufacturability, and so forth provides many additional opportunities for hiding Trojans "in plain sight."

Detection technique	Main weakness
Logic analysis	Trojan not active pre-deployment
Formal analysis	Cannot handle complex circuits
Non-destructive physical analysis	Lack of golden reference model
Reverse engineering	Cannot be applied to all ICs

Table 1

Consider a two-stage attack that first inserts a Trojan in the layout model using spare gates without any connection to the functional logic, then follows up with a Focused Ion Beam (FIB) attack that connects the Trojan to the functional logic. Such a Trojan would be invisible until the FIB attack occurs. Destructive reverse-engineering techniques are not applicable since the FIB attack would target only a subset of the fabricated ICs. Today, we don't have any scalable non-destructive technique able to detect modifications introduced by a FIB attack. But even if we had such a technique, it would be extremely difficult to use it effectively on a large number of ICs.

Table 1 summarizes the analysis of the different types of pre-deployment Trojan detection techniques. The inescapable conclusion is that classic detection methods cannot guarantee that ICs deployed in the field are Trojan-free. (This does not mean that we should not use pre-deployment detection techniques. They are necessary but not sufficient.)

Clearly, today's complex IC designs need deeply embedded infrastructure logic to implement post-deployment security checks during normal operation. However, the amount of embedded logic required to comprehensively check the security of an entire IC may be prohibitively expensive. Plus, security requires that checking logic be invisible to attackers and to any embedded software running on the device in question. No efficient solution has historically satisfied these requirements, until now.

A new approach for detecting Trojan attacks in SoCs

A new approach for detecting Trojans in SoCs involves adding reconfigurable Design-For-Enabling-Security (DEFENSE) logic to the functional design to implement real-time security monitors. This infrastructure logic consists of embedded, software-configurable silicon "instruments" that can implement a range of security checks to monitor an IC's operation for unexpected or illegal behavior. Reconfigurability allows a large number and variety of checks to be implemented on shared IP-instrument hardware. Being reconfigurable, its function is not visible to reverse-engineering efforts that analyze the circuit. Additionally, unlike FPGA-like hard macros, the soft-reconfigurable logic cannot be distinguished from functional ASIC logic.

Reconfigurable IP instruments can be inserted at any stage in the design (RTL, netlist, layout, and silicon), do not rely on a golden reference model, and are application- and technology-independent. In this implementation, the "service" logic is indistinguishable from "mission" logic. "Service" logic is also invisible to the application and system software and therefore protected from software-based attacks. Figure 1 shows the architecture of an SoC with infrastructure logic inserted. The insertion is done at RTL, with the designer selecting the important signals to be monitored. The instrumented RTL model is then processed by standard chip design flow.

Signal Probe Networks (SPNs) are configured to select a subset of the monitored signals and transport them to Security Monitors (SMs). An SPN is a distributed pipelined MUX network designed to support multiple clock domains. An SM is a programmable transaction engine configured to implement an FSM to check user-specified behavior properties of the signals currently brought to its inputs to be analyzed. The Security and Control Processor (SECORPRO) reconfigures SPNs to select the groups of signals to be checked by SMs and reconfigures SMs to

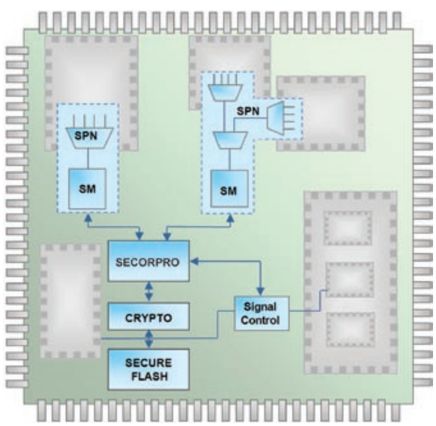


Figure 1

perform the required checks. The configuration of one SM does not interrupt the normal system operation or the checking activity of other SMs. All configurations are encrypted and stored in the secure flash memory, and all security checks are application- and circuit-dependent.

Instrument logic inserted in the IC performs two types of checks. The first type is a set of user-specified security violations such as:

- An attempt to access a restricted address space
- A control signal supposed to be inactive is activated
- Denial of service occurs
- A core responds to a request addressed to another core
- A core with a deactivated clock has output changes
- A core enters a mode of operation that is illegal in the current system state

The second type of checks consists of the general correctness properties of system behavior. The rationale for this is that an activated Trojan will make the system operate in an incorrect way. These checks might be the same that were performed in pre-silicon verification. For example, these could include the assertions used in simulation to verify the correct implementation of the standard communication protocols used on-chip (AMBA, PCI, and so on) or the behavior of a specific block.

Thus, tools are provided to define the "personalities" for the reconfigurable instruments. To define a check, a chip designer specifies the FSM to be implemented by a security monitor. All checks are prepared and verified pre-deployment in a secure environment, and their corresponding configurations are preloaded in the secure flash. The chip manufacturer does not have access to, and therefore cannot know, the contents of the flash memory.

In a powered-off chip, the reconfigurable logic is "blank" (unprogrammed), thus its function is perfectly concealed from attackers trying to reverse engineer the device. Similarly, the control logic of

> "The inescapable conclusion is that classic detection methods cannot guarantee that ICs deployed in the field are Trojan-free."

SECORPRO is configured at power-on from the secure flash, so its function is also invisible to an attacker. As shown in Figure 1, the security checkers are not accessible from either the functional logic or from the embedded software. Similarly, SECORPRO is invisible to the other on-chip application processors.

Countermeasures first

When an attack is detected, the first step should be to deploy countermeasures such as disabling a suspect block or forcing a safe operational mode. An intelligent infrastructure platform can implement countermeasures by controlling specified signals by the *Signal Control* block that enables SECORPRO to override the value of a signal (see again Figure 1). For example, if a core exhibits illegal behavior, SECORPRO may isolate that core by disabling its clock, powering it off, resetting it continuously, or forcing safe values on its outputs.

These represent only basic countermeasures that need to be integrated in a system-level solution for surviving detected attacks. System-level recovery may combine techniques such as provision of fail-safe states, spare logic to replace misbehaving logic, and returning to last safe checkpoint. These topics, however, are beyond the scope of this discussion.

Modern ICs get secure

Security for today's integrated circuits demands a reconfigurable infrastructure platform for post-deployment detection of Trojan attacks against ICs in mission-critical applications. Such technology exists as a natural extension of commercially available silicon-proven platforms designed by DAFCA, Inc., used for in-system silicon validation and debug to prevent wrongdoers from impairing or interfering with an IC's mission-critical functionality. The national-security issues solved by this approach can introduce a new level of protection against infrastructure disruption, weapon-systems sabotage, or other such security breaches.

Miron Abramovici *is cofounder and CTO of DAFCA, Inc. Prior to DAFCA, he was a Distinguished Member of Technical Staff at Bell Labs in Murray Hill, NJ. He coauthored "Digital Systems Testing & Testable Design," adopted worldwide as a standard textbook. He is author of more than 100 publications and designer of 29 issued patents. He was principal investigator on large projects funded by DARPA and NIST. He is a Fellow of IEEE. He can be reached at miron@dafca.com.*

Peter L. Levin *is president and CEO of DAFCA, Inc. Prior to DAFCA, he was a general partner in the Munich-based venture capital firm Techno Venture Management (TVM). Peter served as a White House Fellow and presidential appointee during the Clinton administration, serving as special assistant to the director of the Office of Management and Budget; assistant to the counselor to the President; and an expert consultant to the presidential science advisor. He began his academic career at Worcester Polytechnic Institute, where he received the National Science Foundation Presidential (G.H.W. Bush) Young Investigator Award for his work in high-performance computing. He can be reached at peter.levin@dafca.com.*

DAFCA, Inc.
774-204-0021
www.dafca.com

An interview with Ken LaBel at NASA's NEPP program:

Rocket science applied to components

EDITOR'S NOTE

Behind the scenes of its newsmaking technologies and missions – (how many can we name here? … we don't have that much ink) – the organizational side of NASA has continued to evolve as well, but much more quietly. One of the lesser-known sides of NASA's many faces is its NEPP components engineering program and its sister group, NEPAG. Group editorial director Chris Ciufo caught up with Ken LaBel, NEPP co-manager, at last year's Components for Military and Space Electronics (CMSE) trade show and again at the recent FPGA Summit to get the "411" on NEPP's multifaceted "mission": to analyze and test nascent (even commercial) technologies for radiation tolerance; develop qualification insurance guidance; and to make its testing results public (believe it or not). Edited excerpts follow.

MIL EMBEDDED: ***To start, can you provide an overview of the NEPP program?***

LaBEL: We have two sides of the program: The NASA Electronic Parts and Packaging (NEPP) program and its sister portion called NASA EEE [Electrical, Electronic, Electromechanical] Parts Assurance Group (NEPAG).

NEPAG looks at problems with electronics that are already currently in design or in systems, for example cracked capacitor or DC-to-DC converter issues on a device that's already deployed. They also hold weekly telecons with the community to share the latest information on tasks, failures, DSCC audits, GIDEP [Government-Industry Data Exchange Program], and so on. Once a month, they have an inter-national version of this telecon that includes the European Space Agency, Japanese Space Agency, Canadian Space Agency, and others.

MIL EMBEDDED: ***So the intention of NEPAG is to talk about component-related issues in deployed or in-design systems?***

LaBEL: That's a pretty accurate take on it. It's really part of our attempt to continue the infrastructure within the community. If you go back 10 years or so when we started having a big push for COTS and went away from MIL standards for parts and testing, the infrastructure program started falling away in favor of nothing but high technology and pushing the state-of-the-art envelope without really dealing with day-to-day issues where we bend metal.

MIL EMBEDDED: ***When you say, "bend metal," what are you really referring to?***

LaBEL: Build and design of electrical systems used in space. We are trying to ensure that the community stays together at least within the NASA side, and as best as we can within the entire aerospace community.

MIL EMBEDDED: ***So in essence, NEPAG is one big components engineering group?***

LaBEL: A virtual one across the agency, yes, and we're trying to make it into the community so we can say, "Hey, does anyone have a spare part," for example. Or "We need a spare to do this, that, or the other thing."

MIL EMBEDDED: ***Are you aware that NSWC [Naval Surface Warfare Center] Corona through GIDEP actually has the components working group for obsolescence? How are you different from that, other than the fact that your platforms fly higher than any others?***

LaBEL: Part of the NEPAG community includes NSWC in multiple forms. Another difference is that our sharing of what's available for parts is more to stock spares from flight programs within NASA as opposed to obsolescence.

MIL EMBEDDED: ***So you're focused on sourcing those components as opposed to cost avoidance and other sorts of things?***

LaBEL: Right. For NASA, obsolescence has only been a big issue for the shuttle and space station programs, where we're supposed to build "onesy-twosy" things.

MIL EMBEDDED: ***Getting those Am29050 CPUs for the shuttle cockpit is kind of tough when AMD obsoleted those 10 years ago. So tell us about NEPP.***

LaBEL: So the other half of the program is the NEPP side. And that's focused on research tasks, looking at new and emerging technologies and devices with the intent of gaining knowledge on failure modes within the technology or device, learning how to qualify, and developing guidance for qualification insertion.

MIL EMBEDDED: ***So you're referring to things like upgrading, SRAM derating, DRAM guard-banding, and so on, but over a wider temperature range while looking at various failure modes?***

LaBEL: Right – where you can and can't use these technologies. A hot question right now is: Are current radiation test methods adequate? And the answer is blatantly "no." We can't change them fast enough to keep up with technology.

But we're concerned with both the radiation and reliability sides, device temperature range, package outgassing – everything that goes through parts qualification.

MIL EMBEDDED: ***Does NEPP publish a database of components that you qualified?***

LaBEL: The NEPP program doesn't qualify components. We're just determining if something *can* be qualified or if something needs to be done differently for qualification. The NEPP website [http://nepp.nasa.gov] is public and has links to all the test reports my group has done on radiation testing, for example. And there are quarantined areas of the website that have ITAR concerns and are password protected. However, we try to make as much data as available as we can.

> "If you go back 10 years … the infrastructure program started falling away in favor of nothing …"

MIL EMBEDDED: ***Do you make recommendations to various users based on research?***

LaBEL: We'll say, "This is great in this temperature range but not in this one, so when you go for your application, make sure you utilize it only in this temperature range." Or we might say, "Radiation is the same for this total dose level but not this type of radiation effect."

MIL EMBEDDED: ***Do you have a newsletter that you publish or any frequent communiqué that goes out?***

LaBEL: That's a tougher question than it should be. In the past, we have had electronic newsletters. We are considering restarting those, looking to see how we can approach those and still try to keep our management sanity when trying to keep track of a program.

MIL EMBEDDED: ***Which types of technologies does NEPP consider in its testing and reporting, and what's the downside?***

LaBEL: Among the technologies we look at are strictly commercial technologies, so we do testing. But there is a sensitivity if we (speaking hypothetically) find something that's bad or find a part that fails.

MIL EMBEDDED: ***A company can come in and say, "How dare you say our part failed at such and such." You probably get threats of lawsuits, in which case you have to take it seriously.***

LaBEL: Right, especially within the governments. If private concerns scream at the government, it has to be taken seriously regardless of the claim. So we have this issue of trying to get approval for release of information in those types of conditions.

MIL EMBEDDED: ***Is that why most can't get information out of GIDEP – unless you're on a need-to-know basis?***

LaBEL: We have a softened version of GIDEP – the NASA alert system – which does less impact commentary but shares only with NASA and its immediate contractor family. We are working hard to get a better way of doing that, but we're not making lots of progress lately. Mike Sampson, NEPAG co-manager, is championing better information flow.

MIL EMBEDDED: ***Publically available information on NEPP is kind of revolutionary because every other branch of the service has its own database, but they don't make it public or share it with other services.***

LaBEL: There are things that obviously we do not put into public consumption, things that will have legal ramifications. But any data that is strictly performance data or scientific information, we put into the public domain. That's really our goal. If we take a data point and nobody sees it, that's not a good thing.

We tend to push the state-of-the-art of technology more so than others. And that's because NASA's scientific instrumentation by definition is pushing the state-of-the-art. So we have to take a few more risks, learn a few more things, and try to push it as best we can.

Ken LaBel *is co-manager, NASA Electronic Parts and Packaging program, and group leader, Radiation Effects and Analysis Group, NASA/GSFC. He has worked at NASA since 1983 after graduating from The Johns Hopkins University with a BES in EECS (minor in Mathematical Sciences). His career at NASA has included development of hardware/software for ground systems; advanced technology; flight hardware; systems engineering; and radiation hardness assurance/research for more than 50 NASA projects. Ken has published more than 100 papers as author/coauthor, has taught multiple short courses, and is a recognized expert in radiation effects systems engineering.*

NASA NEPP
http://nepp.nasa.gov

U.S. Air Force photo

Obsolescence management: Another perspective

By Jack Bogdanski and Mark Downey

Obsolescence is most effectively managed when it's considered from the beginning of product development at the design stage. Yet, solutions exist – at every level – that can save a project, an application, or even a program from redesign forced by obsolete components. Key factors include the lack of visibility in increasingly complex technology development, lengthy and costly redesign cycles, and fragmented communication channels.

A major consideration for both components and an overall systems design approach is obsolescence. Having a component or the materials it's made from go obsolete can have a dramatic impact on the long-term viability of a product life cycle. The component and its materials are critical in product design and development for the defense and aerospace industries where communications, aircraft, navigation, guidance, and radar systems require long-term reliability and upgradability.

Obsolescence management techniques can be categorized as either production engineering-based techniques (that attempt to control an existing situation) or design-based techniques (that attempt to minimize the initial problem). While there are no quick or easy solutions, using production- and design-based obsolescence management techniques can minimize the problems faced on long life-cycle programs. In particular, it's essential to anticipate and mitigate: the lack of visibility in increasingly complex technology development, lengthy and costly redesign cycles, and fragmented communication channels.

Visibility is important

Defense manufacturers are very small fish in the large sea of the semiconductor world. The defense market is less than 0.5 percent of the semiconductor industry and gains little attention or influence over the semiconductor suppliers (see Table 1, courtesy of the DoD and Databeans).

The defense budget grows just 1 to 2 percent per year and will likely never be significant enough to change its level of visibility in comparison to the commercial industry. Although the COTS initiative was put in place to save money, it often adds expense to a program because of the natural procurement focus on unit price; many solutions end up tied to commodity-driven parts with rapidly changing design cycles that drive fast obsolescence cycles. Worse, IC suppliers rarely provide change notifications to defense contractors or their suppliers; this creates unforeseen obsolescence management challenges when a problem finally ripples through to a military program.

Certain military programs, such as weapons systems, can be more affected than other programs by this lack of visibility. Obsolescence can severely impact weapons systems' supportability and life-cycle costs. It's a fact that it can cost from millions to *tens of millions* of dollars to replace, redesign, or requalify a product simply because a $30 part went obsolete.

When a major Korean semiconductor manufacturer announced the end-of-life for their Rev. C SRAM product and the beginning of production for their Rev. D component, it was an abrupt transition. There was no lifetime buy to be had, and that particular SRAM had been highly used in RAD-tolerant applications. The satellite market, poised to take Rev C, a $6 RAD-tolerant device, instead was suddenly forced to use a $6,000 RAD-hardened component. Clearly there was minimal or no visibility provided to the vendor that was forced to fund a 1,000x price increase.

Navigating by silicon road map is a production engineering-based approach to manage this obsolescence issue. Large semiconductor manufacturers release road maps that extend 12 to 24 months.

Category	2007	2008 (est)	2009 (est)
DoD Budget for IC ($billions)	$3	$3	$4
Worldwide IC TAM ($billions)	$255	$262	$323

Table 1

These road maps detail the products that are going EOL and the new products that are scheduled for delivery. These road maps can be reviewed for new products that can fill the role of the ones that are going EOL, allowing modifications to certain systems or subsystems with minimal disruption.

For example, consider a 32M x 72 DDR2 DRAM FBGA component specified in a design (Figure 1). With road maps, one can design in the additional address lines and control signals in order to prepare the way for the next two generations of replacement products. In addition, the road maps can often provide proper design floor planning for any additionally needed package space for those upgrades. Even in cases where the die information is not available that far in advance, a team with established memory experience can provide very strong suggestions based on past trends. There's a huge cost savings in the long run. The entire design doesn't need to be requalified or respun, and often the qualification takes place at the component block level. With advance notice of the next generation, one can plan ahead for upcoming changes.

Redesign cycles can be minimized

Microelectronics obsolescence is most often the result of basic economics: When it is no longer economical to produce a certain product, the semiconductor manufacturer stops producing it. Design-based techniques can alleviate obsolescence management challenges. It's a matter of changing the perspective to save the design. For example, an established functional schematic with diodes and transistors in a discrete solution experiences an unanticipated EOL issue with one of its components. Oftentimes that portion of a system design can be segregated as a functional block and can be supported by bringing the entire block onto an FPGA. By replacing old technology with new technology, the change frees up board space and also often utilizes programmable devices to achieve a longer product life. It will look like a different board, but from an electrical perspective, the overall functional block is the same to the application. One can change or consolidate the components into a new functional block without changing the form, fit, or function of the overall system, and essentially keep the design.

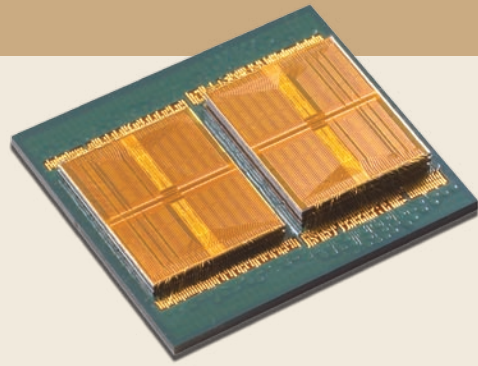


Figure 1

Die Redistribution Layer (DRL) can also be implemented to allow the die pads that fit that die to move into a package it was never designed to support. A DRL allows solder paste bumping of legacy die that can transform off-chip connections from chip scale to board scale, providing a design-based solution that can support the form, fit, and function of a previous requirement and save the system from a costly redesign.

With die shrinks, in many cases, the electrical parameters change and thus force a redesign. Military microelectronics manufacturers might do a lot of die banking. For instance, White Electronic Designs banks up to 30 percent of its die inventory – especially flash and SRAM – so the company can complete a program, though repairs and maintenance might still be a problem. Both customer-specific and generic die are banked. If a flash product is going away and it's used on 20 different programs, 100,000 parts might be banked just to have on-hand.

A large military OEM requested that a 5 V flash that goes into a custom module in a GPS guidance system be die-banked for them so that they would not be forced to use the next-generation die, which has a lower operating voltage that is not supplied on the board. If they did not make this request, the OEM would have to requalify at the board level, the box level, and then the system level, creating extra expense and delaying implementation.

Clear communications channels are essential

There's an ongoing problem with EOL notification that permeates the industry and requires attention from the highest levels. As an example, a component is built for an OEM application and delivered to one of their plants, where it's built into an assembly. Then they send it on to another plant to be assimilated into another assembly. From there, it might go on to another one or two locations for further integration and assembly.

However, the component that was designed-in for a two-year production order goes out of production in the second year. So an EOL notice is sent to the procurement office contact who bought the part. Maybe the contact is still there, maybe not, and the notice never goes on to the other four facilities in which the product was assembled. There's a lack of incentive on the part of either the supplier or the purchaser to notify others down the line. This example is illustrated in Figure 2, where it results in a redesign.

“... The component that was designed-in for a two-year production order goes out of production in the second year. So an EOL notice is sent to the procurement office contact who bought the part. Maybe the contact is still there, maybe not ...”

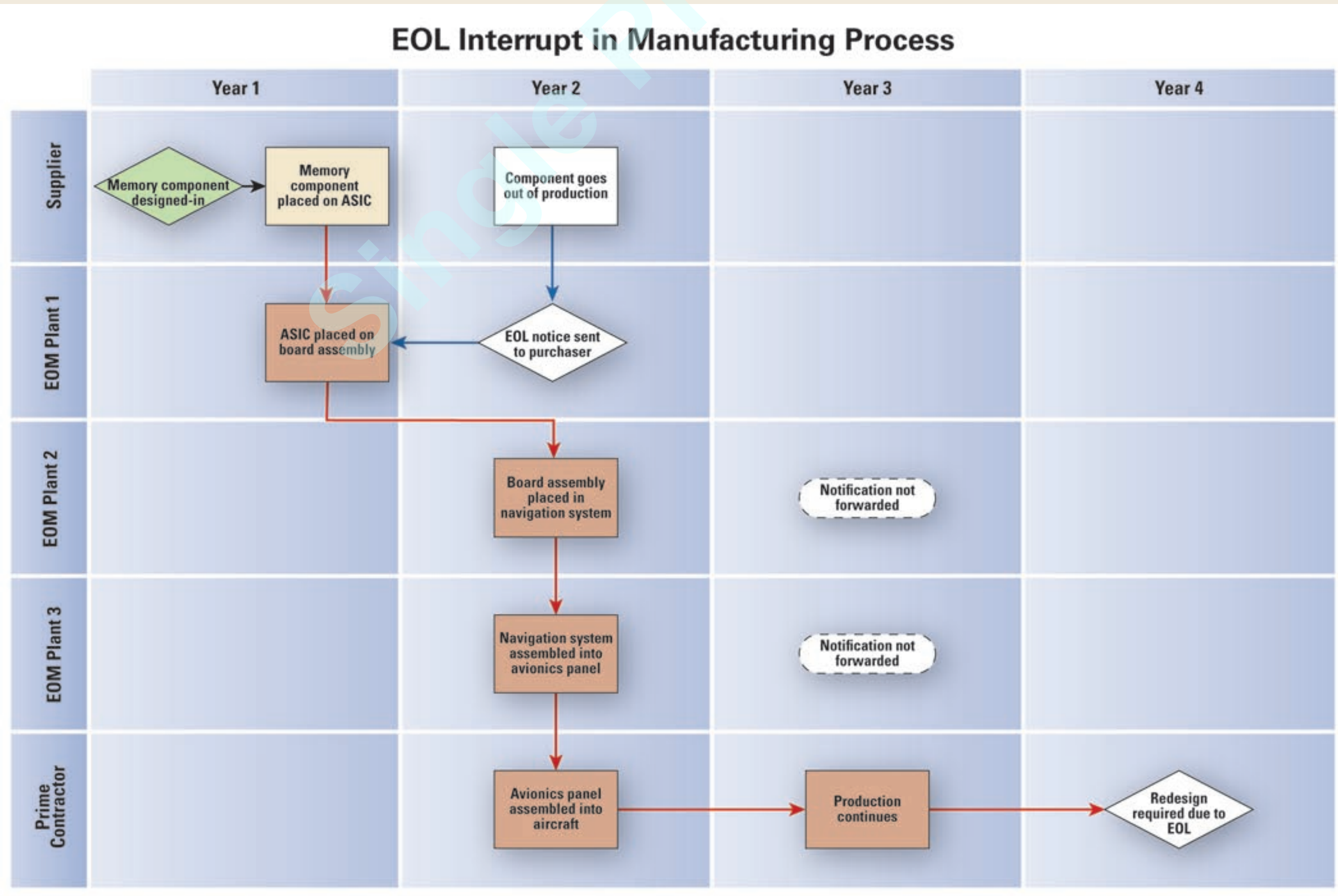
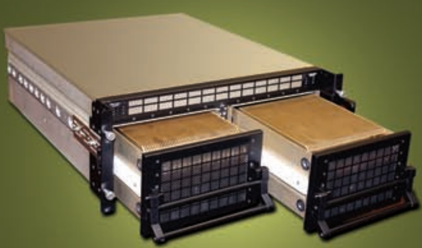
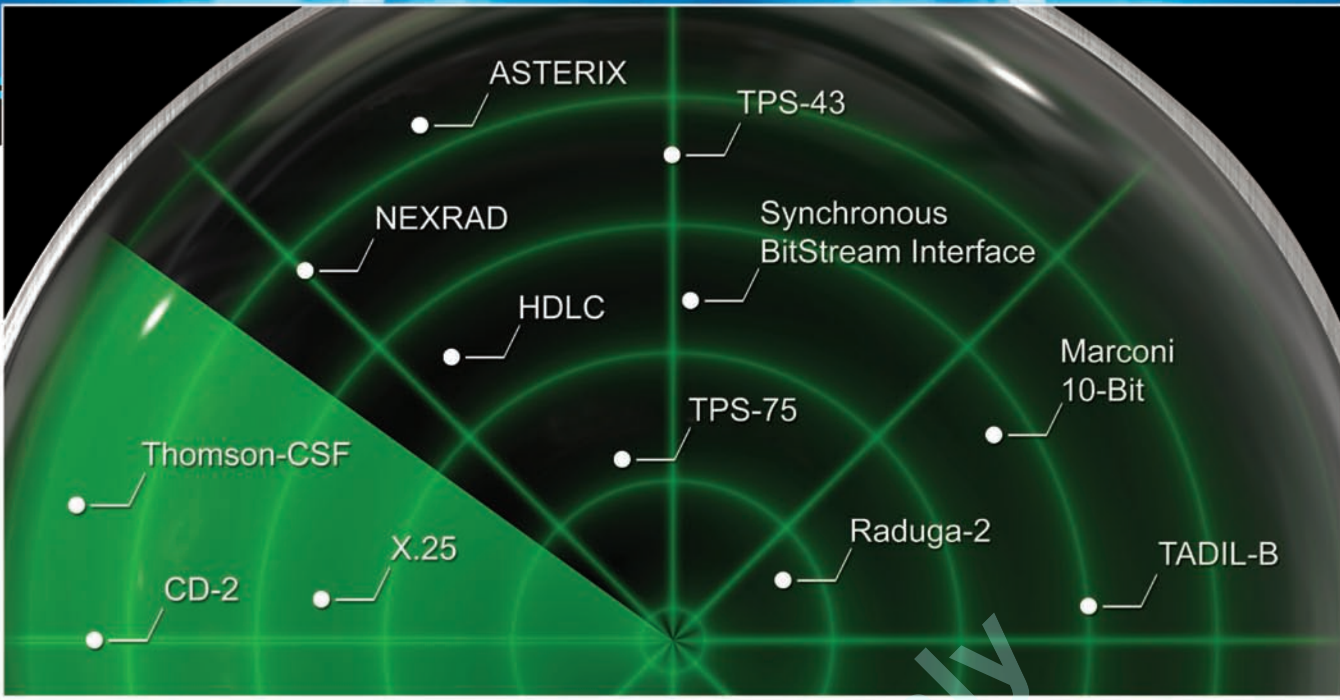


Figure 2





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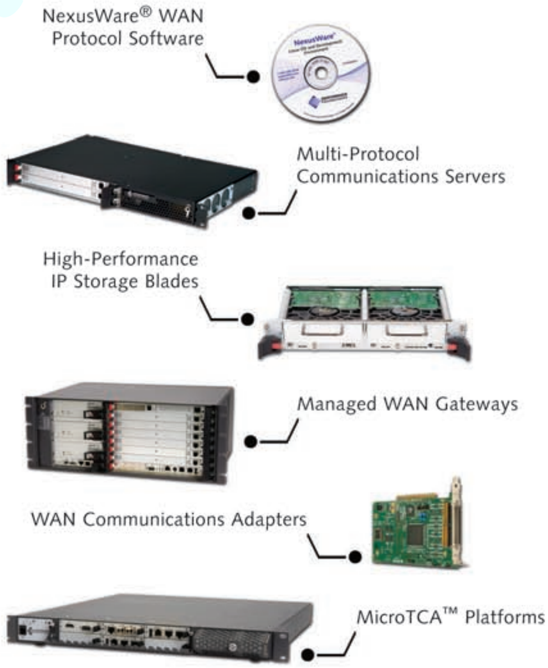

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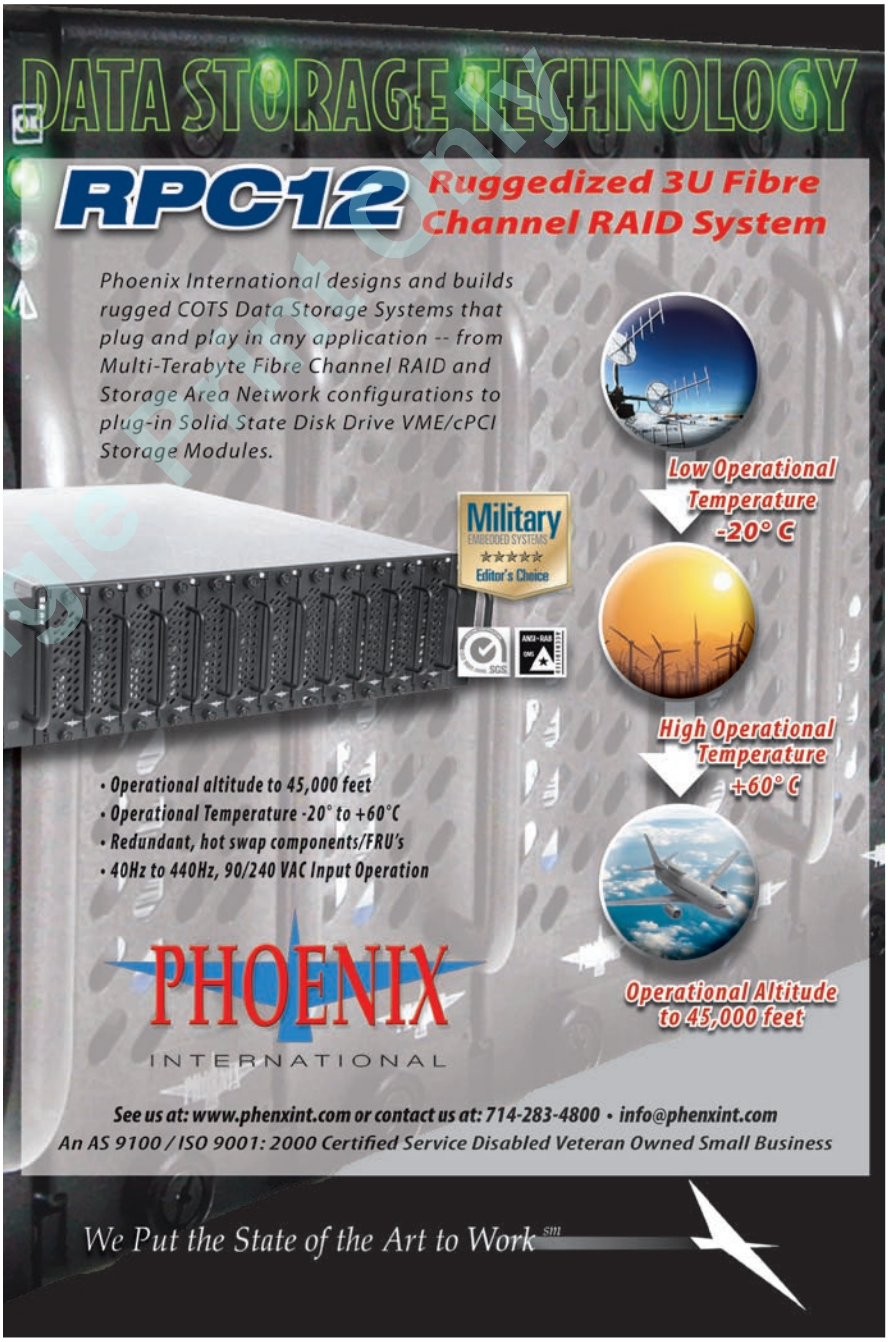
Critical military programs are scheduled so far in advance that by the time they're built, parts designed-in might already be at the end of their supported product life. For example, the Eurofighter was initially designed in the 1980s, but production didn't occur until the late 1990s. The program has technology refresh schedules for most components, every year or two, with major refresh schedules at each manufacturing lot. The F-35 is also constantly being upgraded. Most of the systems in the F-35 Joint Strike Fighter (JSF) were designed seven years ago and just went into production. It will already need upgrades in 2009 and 2010 – *only a year after it entered service!* With lengthy military design cycles and no clear communications channel, an OEM doesn't have much to rely on to get critical EOL information.

Both commercial and government websites provide military semiconductor device information and services to help alleviate technological obsolescence management pressures. TACTech Inc.'s databases and libraries contain the nomenclature and general description for more than 133,000 individual military semiconductor devices. TACTech's military library generally includes all standard microcircuits and discrete devices with catalog specifications. TACTech software provides a description and general specifications of each microcircuit and discrete device in the TACTech library, thereby allowing the user to identify functionally interchangeable devices from various manufacturers and to upgrade and rank devices according to packaging, quality levels, projected production life cycle, and availability based on changes in technology and supply sources.

The Defense MicroElectronics Activity (DMEA) also offers obsolescence management services through the continual active monitoring of a system's parts to stay ahead of the obsolescence curve and plan ahead for mitigation activities through production engineering-based obsolescence management techniques. The DMEA's Advanced Reconfigurable Manufacturing for Semiconductors (ARMS) facility can produce any quantity, small or large, of microelectronic devices. Managers of weapons systems can use ARMS as a single solution or as part of a comprehensive supportability solution. If a large number of components is approaching obsolescence, a program manager can use ARMS to develop these microelectronic replacement parts as a temporary measure while redesigning and fabricating an entirely new system or subsystem.

The offerings from TACTech and the DMEA do not solve all the underlying obsolescence issues, however, because these efforts are still fragmented. Because fragmented communications channels impact the entire defense industry, the time might be right for the government to engage in more proactive obsolescence management activities using both a production- and design-based obsolescence management approach. There could be a government-controlled centralized website where all semiconductor manufacturers provide notice of EOLs. Military contractors could have master data systems with BOMs linked to this site so that they have instant notice at any time of a part going EOL. Vendors would post their notices to one centralized location



for all military contractors to view. When the military contractors were tied into the database, they could elect to be automatically notified for all the programs with an EOL part. It would be managed electronically and handled by those most affected. A centralized obsolescence notification system could save the United States millions of dollars in just plain resource hours.

Identifying effective and manageable solutions

Technology creators in the defense industry should combine production engineering- and design-based obsolescence management techniques into an integrated approach to effectively and efficiently meet the challenges associated with obsolescence management: extended product life cycles, preplanned product improvements, modernization, technology refresh, and operational system development. These designers could use production engineering-based techniques for the first development phase, finding EOL buys, while at the same time employing design-based techniques, then planning for technology insertion system enhancements to be integrated later in the product life cycle. This is a good compromise for many applications, providing the benefits of the two techniques while minimizing the problems associated with each of them.

Custom semiconductor packaging that leverages commercially available die technology also combines the best of both techniques. Leveraging volume-driven silicon provides flexibility by opening up effective alternatives for handling obsolescence concerns. For example, a design might call for four plastic COTS discretes in packages with lead-free terminations that are prone to "tin whisker" growth. Instead, four die can be put in one package with lead-based terminations, thus saving cost by reducing the cost of failure. It would also conserve board space while providing a product in a package that has been proven mechanically reliable according to military requirements.

Also, it's wise to use the most recent part available. The cost difference, even if significant at the time of development, will surely be minimal or even advantageous by the time of the program's production release. Push for the highest density. Then look for the upgrade path – that's critical.

While obsolescence is an issue for all of us in this industry, solutions do exist, and by working together with improved visibility, engineering creativity, and relevant and actionable communication programs, together we can minimize its impact.

Jack Bogdanski *is Director of Strategic Development, Defense & Aerospace, at White Electronic Designs. He has 30 years' experience in the electronics packaging industry, including multichip modules, memory, and microprocessor devices, flip chip assembly, bump metallurgies, alternative alloys, and flexible circuits and laminates. He holds a BSEE and an MBA from Arizona State University. He can be contacted at jbogdanski@wedc.com.*

Mark Downey *is Director of Strategic Development, High-Performance Computing at White Electronic Designs. He has 16 years' experience in the electronics industry in the areas of high-speed memory bus architecture, electrical design and simulation, thermal management, multichip module packaging, and process development. He co-holds a U.S. patent in the area of Dense Memory Module Packaging. Mark also holds a BSEE from the University of Massachusetts at Lowell. He can be contacted at mdowney@wedc.com.*

White Electronic Designs
602-437-1520
www.whiteedc.com

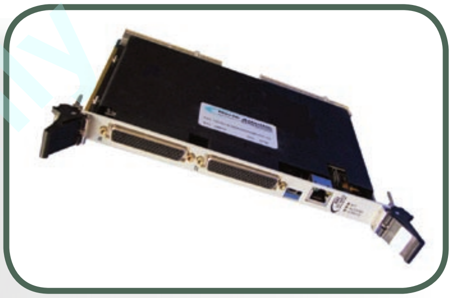
Automatic data scrubbing for portable devices

Sadly, it's become fodder for late-night comedy routines: A tired civil servant or military official leaves a USB stick, portable hard drive, or laptop in a café and suddenly next month's battle plans are posted on the Internet. But it's no joke. At press time, White Electronic Designs was getting ready to announce their ZoneLoc Security for data storage devices. Though details are still a bit sketchy, *Military Embedded Systems* got enough early access for us to enthusiastically report what might be game-changing technology. Implemented on multiple flash formats – including CompactFlash, USB, SSD, or other flash media – ZoneLoc does away with crypto keys and automatically purges data when the device is removed from its defined "area."

The technology is compatible with the following military specifications: NISPOM DoD 5220.22-M, NSA-130-2, Air Force AFSSI-5020, Army AR380-19, and Navy NAVSO P-5239-26. The scalable solution can be designed for one type of device, then migrated into other flash-type formats, maximizing both code reuse and security procedures. The designer specifies a zone *proximity boundary* and a pre-established set of parameters for each application. The boundary can be tied to a fixed location such as a workstation, or made portable in the case of USB sticks. In all cases, if the device is removed, no human involvement is required and the data is purged. Configurable features include audible warnings, programmable response times (in case one forgets before yanking out an SSD), and even wireless, autonomous remote data purging.

White Electronic Designs • www.wedc.com • RSC# 40973

All the I/O you'll ever need



Designing military development systems can be simpler using CompactPCI, especially when a lot of communications interfaces and protocols are involved. But throw in the typical military I/O such as ARINC 429, myriad serial ports, and discrete TTL, and your CompactPCI COTS choices diminish. North Atlantic Industries seeks to change all that with their 78CS2 6U CompactPCI multimodule I/O card. By placing configurable I/O on *function modules,* the board can be outfitted with five modules and a plethora of I/O. Moreover, the board is available to operate over -40 °C to +85 °C.

Besides a built-in GbE port that allows the board to be used as a stand-alone sensor (without a separate SBC), 78CS2 also includes continuous BIT with transparent programming and operation. Included are: ARINC 429/575 (6 channels); RS-232/422/485 (4 channels); D/S (2 channels); D/LVDT (2 channels); S/D (4 channels); LVDT/D (4 channels); A/D and D/A (10 channels, each); AC synchro reference generator, discrete I/O (16 channels); TTL (16 channels); transceiver I/O (11 channels); and . . . wait for it . . . RTD (6 channels). Incredible. If CompactPCI is your format of choice, the 78CS2 deserves a close look.

North Atlantic Industries • www.naii.com • RSC# 40947

XMC transmitter with true 1 GSps at 16 bits

Choices abound in SDR and wireless front-end *receivers*, but try moving data the other direction and the offerings become more sparse. Capitalizing on the reality of an analog world, FPGA design expert Innovative Integration has developed the X5-TX PCI Express XMC module, providing four 500 MSps, 16-bit DAC outputs and a Xilinx V-5 FPGA core. But what's equally impressive is that the channels can be aggregated to provide what Innovative Integration calls dual channels of "true 1 GSps, 16-bit rate" data without interpolation.

Designed for radio, radar, and direct RF digitizing applications, the mezzanine module is equipped with either a Virtex-5 SX95T or LX155T FPGA, 512 MB of DDR2 DRAM, and 4 MB of QDR-II *SRAM* for DSP functions. The architecture supports 300 GMAC/s, and 1 GBps sustained data transfer over PCIe (eight lane). There are also Serial RapidIO links for private data transfer. Most importantly, Innovative Integration has included a MATLAB BSP for hardware-in-the-loop development, which ties to Xilinx Simulink, and IP cores for multichannel PSK and FSK Software-Defined Radios. C++ libraries, plus drivers for Windows and Linux, are also included. The comprehensive software complement is based upon Innovative Integration's 20 years of system design expertise.

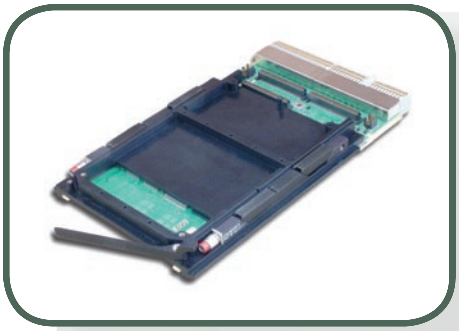
Innovative Integration • www.innovative-dsp.com • RSC# 40974

Total-ACE strikes 1553 bulls-eye

MIL-STD-1553 is a reality in military systems, right alongside Ethernet, multicore processors, and even Wi-Fi. But with all these newer, bigger, and hotter devices, there's little room left for the lowly – albeit essential – 1553 devices. The BU-64843T "Total-ACE" from Data Device Corporation (DDC) understands the designer's dilemma. At only 0.6" x 1.10", the 312-ball (24 x 13 matrix) PBGA package is so small that it'll fit almost anywhere.

Combining dual transceivers, dual *transformers*, a protocol engine, and 4K words of internal RAM, the Total-ACE runs on a single 3.3 VDC source. It operates over an industrial temperature range of -40 °C to +100 °C, is DO-254 certifiable, and can be made available in RoHS-compliant versions. Most importantly, DDC, as a recognized leader in integrated MIL-STD-1553 devices, renders this latest device as hardware and software compatible with the company's earlier devices such as the Mini-ACE.

Data Device Corporation (DDC) • www.ddc-web.com • RSC# 40975



"Nap mode" slows down this rugged, 3U CompactPCI SBC

Admit it: Naps are a luxury on the weekend after the lawn's been cut or the e-mails have all been dispositioned. Same thing holds for Kontron's conduction-cooled CP3210, which boasts a mere 10 W consumption when its PowerPC 750FX is slowed down and put into "nap mode." This 3U CompactPCI SBC is ideal for retrofits into small spaces such as avionics bays, UAVs, or portable systems. Operating over -40 °C to +85 °C, the board doubles the amount of system and user flash over its predecessor, the Thales PowerEngineC7. (Kontron purchased Thales Computers in 2008.)

Operating at 733 MHz, the PowerPC G3 is fed by 512 MB of DDR SDRAM with ECC, 128 MB of system flash, and 256 MB of user flash. There's also 128 KB of nvSRAM with a real-time clock. Even on this small 3U board, you'll find two serial ports, along with 10/100 and 1000 Gbps Ethernet ports and a 33/66 MHz PMC expansion connector set. An optional PMC carrier board for an adjacent slot accommodates a second PMC mezzanine. The CP3210 boasts PowerOn BIT, an open source U-Boot loader, VxWorks BSP, ElinOS embedded Linux, and is DO-178B and ARINC 653 certifiable when running Sysgo's PikeOS.

Kontron • www.kontron.com • RSC# 40977

Half rack is better than a whole rack

If you've ever wandered around a defense tradeshow such as MILCOM or AUSA, you've seen all kinds of COTS chassis bolted into TOCs or lashed down to HWMMVs. So when we saw the DNR-6-1G HalfRACK from United Electronic Industries (UEI), we immediately saw the similarities. The six-slot, stackable, portable I/O chassis consumes only half a rack at 5.25" x 6.2" x 17.5" and is ideal for purpose-built, space-constrained rugged temp I/O installations.

The base configuration consists of two 10/100/1000 Ethernet interfaces, Freescale 8347 32-bit CPU, RS-232, 128 MB of memory, status LEDs, and power supply. Users can add any 6 of more than 30 I/O boards available from UEI, providing a jaw-dropping "5 quadrillion possible combinations." Folks, we don't have that much room here to list them all – but suffice it to say that a typical HalfRACK can hold up to 150 A/D, 288 DIO, 192 D/A, 72 ARINC 429, and more. The chassis withstands 3 *g* vibration, 50 *g* shock, and -40 °C to +70 °C. It also has a carry handle and cute little feet for desktop use.

United Electronic Industries (UEI) • www.ueidaq.com • RSC# 40976

Continued on page 49

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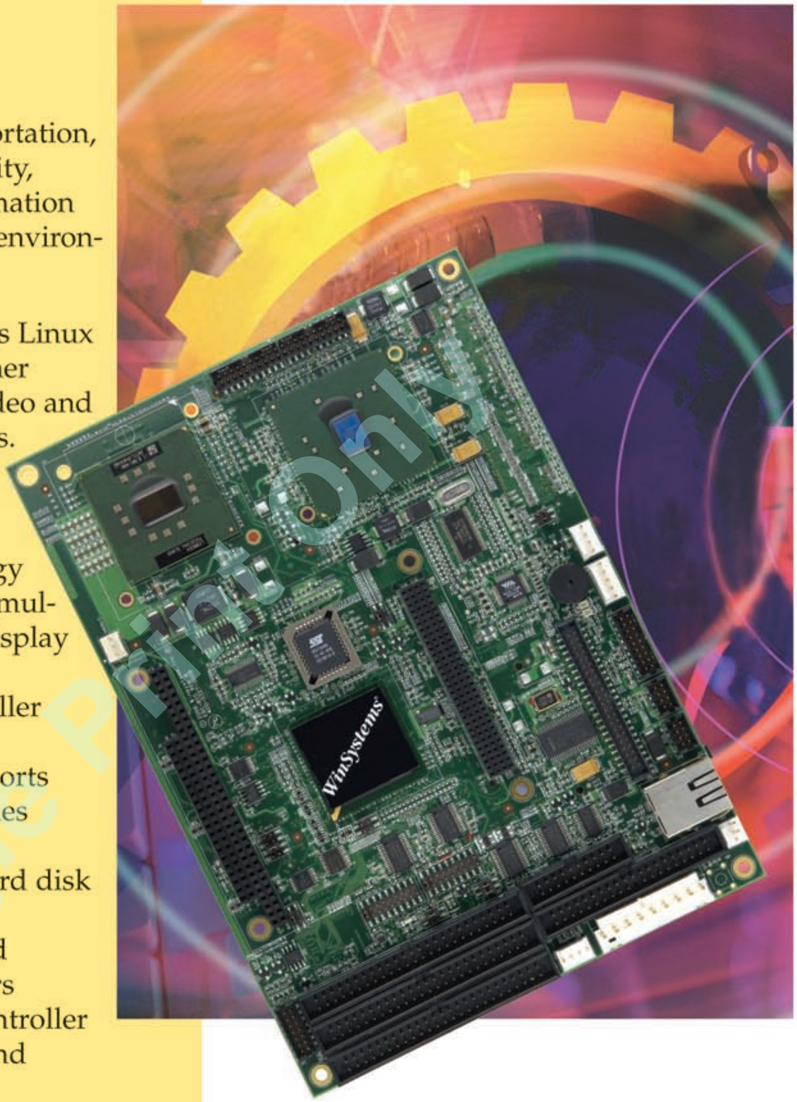

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 – Continued from page 47

Industry first: INTEGRITY RTOS achieves EAL6+ certification

Although not technically a "new" product, Green Hills Software's INTEGRITY-178B has earned a coveted *Editor's Choice Award* from *Military Embedded Systems* magazine for being the first major software product to achieve NIAP certification to EAL6+. INTEGRITY is COTS RTOS technology that has been deployed for more than a decade. This certification sets a new standard to which other vendors of security-critical software products can aspire. The certification is unquestionably an industry milestone event.

The NSA's National Information Assurance Partnership (NIAP) certifies software to Common Criteria Evaluation Assurance Level (EAL) ranked from 1 to 7, with 7 being the highest. INTEGRITY-178B achieved 6+ "High Robustness" and is certified to "protect classified information and other high-value resources at risk of attack from hostile and well-funded attackers." INTEGRITY-178B also achieved its first safety certification to DO-178B Level A in 2002. It's no understatement that the company and its DoD sponsors have invested considerably in achieving the EAL6+ certification. Already, Green Hills is rolling out other related high-robustness products for mission, safety, and information assurance critical applications.

Green Hills Software • www.ghs.com • RSC# 40972

Single-chip FIR filter loses nothing

Intended for brilliant but low-cost sound in consumer audio applications such as iPod-like devices and PC speakers, QuickFilter Technologies claims its QF1Da512 SavFIRe (rolls off the tongue, doesn't it?) is the first audio-specific FIR filter to include an integrated gain and compressor stage. The point of the device is to boost audio quality to *low-cost* speakers and headphones. While the typical war fighter might be using an MP3 player only while on R&R, myriad tactical battlefield situations could definitely benefit from improving poor quality voice audio played over less-than-ideal speakers and headsets. The SavFIRe (pronounced "sapphire") doesn't require a separate gain stage device after the audio enhancement function; it's built right in.

By including the gain stage on-chip, overall design complexity and audio distortion are reduced, while end-to-end performance is increased. The built-in compression feature performs sample by sample and has an instant attack and release, with a curve slope that changes with gain. The gain block provides up to 24 dB of positive digital gain, resulting in maximum dynamic range without distortion. The FIR supports up to 512 taps with 32-bit coefficients and a user-defined word width of 12-24 bits. The device performs the equivalent of 50 MMACs and supports 1 Hz to 500 KHz sample rates – smack dab into higher-price DSP territory. The SavFIRe is packaged in a 3 x 3 mm QFN package and consumes only 2.8 mW – ideal for battery-operated radios or headsets.

QuickFilter Technologies • www.quickfiltertech.com • RSC# 40978

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Crosshairs Editorial

The worst of times, the best of times

A 2009 market and technology view

By Chris A. Ciufo, Editor

"Happy New Year."

Doesn't feel that way, does it? On this day in January 2009, we have a new president, but world economic and stateside embedded market events point to a brewing crisis facing our country, our companies, and our personal off-hours lives. Hopefully you are one of the lucky many who are keeping their heads down and staying busy. Perhaps you're one of the unfortunate few who is out of work. For that, I am sincerely sorry.

The Navy uses the expression "Battle stations!" when exigent circumstances threaten the vessel. Immediately all routine tasks and operations stop and priorities change in an instant – galvanizing sailors and officers into protecting the vessel from sudden, unexpected danger. But even amidst shouts of "Battle stations!" by pundits, there are opportunities for many companies that could actually precipitate the best of times. Here are some of my views on the market and on key technologies for 2009. But first a big caveat: No one has ever seen anything like this before, so keep your wits about you.

DoD budget, programs, and funding

You'd be a fool not to recognize that the Bush administration overspent massive amounts of money on defense and prosecuting the Global War on Terror (GWOT) over the past eight years. According to information published by *Aviation Week* based upon data from Standard & Poor's and Thomson Financial, U.S. cumulative national debt was $10 trillion on Sept. 10, 2008 – a staggering *$33,000 per person* – and that was before the economic bailout packages. The DoD's budget (excluding plus-ups) has been growing 4 to 5 percent above inflation since 2001. The current FY2009 DoD budget is $515.4 billion with another $70 billion estimated for the GWOT (www.whitehouse.gov/omb/budget/fy2009/defense.html), although it's anyone's guess what President Obama will do to former President Bush's budgets.

Still, it's unlikely much will change in the next 12 to 18 months. DoD budgets have tremendous inertia, and the slope of the curve – up or down – takes several cycles to move. While Obama redeploys troops out of Iraq and into Afghanistan, ongoing operations (O&M) will continue, and any technology that has a quick benefit for war fighters will likely survive. If you have contracts or technology attached to communications, counter-insurgency, ISR, and force protection, you're in good shape in the short and medium term. But many big strategic programs with roots in the post-Cold War era are going to be under pressure simply because our new president has a different set of values.

F-22 – an Air Force favorite not shared by the SECDEF – and DDG-1000 (despite its groundbreaking technologies) are probably too ambitious for now. F-35 is in good shape due to commitments to our allies, and well-established satellite/GPS communications gear will get the green light. Finally, I stand by my oft-repeated assertion that the Army's FCS will prove to be more of an appliqué-like feature enhancement on mostly existing platforms than an entire vehicle-building exercise.

Step back for a moment, and you'll see that we need to move materiel and fuel so cargo transport, tankers, and ships will get funding. Submarines, UAVs, and C4ISR provide good standoff capabilities, and existing pointy-nosed aircraft (USAF and USN) are probably sufficient for a while. Thankfully, the Marines, Special Forces, and Army finally get their due with better equipment, munitions, survivability, and – *thank heavens!* – long-needed diplomatic training to meet the necessities of modern urban warfare. Technology can help, big time.

Hot technologies

In fact, almost-certain changes in political direction will affect military doctrine and training, giving us a view of some hot technologies used by the military over the medium term. *In situ* embedded training will prepare war fighters for rapid redeployment to global hot spots, relying heavily on multimedia digital battlefield comms gear. High-performance pipes using whatever transport layer is available (copper, fiber, and RF) will need encryption, deep packet inspection, compression, and especially information assurance. This all points to VITA and PICMG technologies; SDR, cellular, UWB, and other civilian communications; as well as deploying COTS multimedia gear that has already debuted in your living room entertainment system.

Information assurance and security will require secure operating systems, mission-critical software applications and tools, and increasingly anti-spoof and -tamper techniques to prevent lost or stolen battlefield assets from becoming tools to our enemies. In the embedded space, innovation will be very difficult on the hardware side unless it's in the packaging or power management areas. Software (applications and IP) personalized in FPGAs and ASSPs is where designers need to put their efforts.

Advice to employers and workers

Finally, it's essential that companies realize that last year's company Strategic Plan is pure junk in today's economy. I'm a big planner and always advocate taking a strategic view, but Sun Tzu advocated changing strategy when the game completely changed. That's right now. So stay alert to the changing battle conditions, and you might possibly turn turmoil into the best of times for your company and yourself.

Chris A. Ciufo
Group Editorial Director
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