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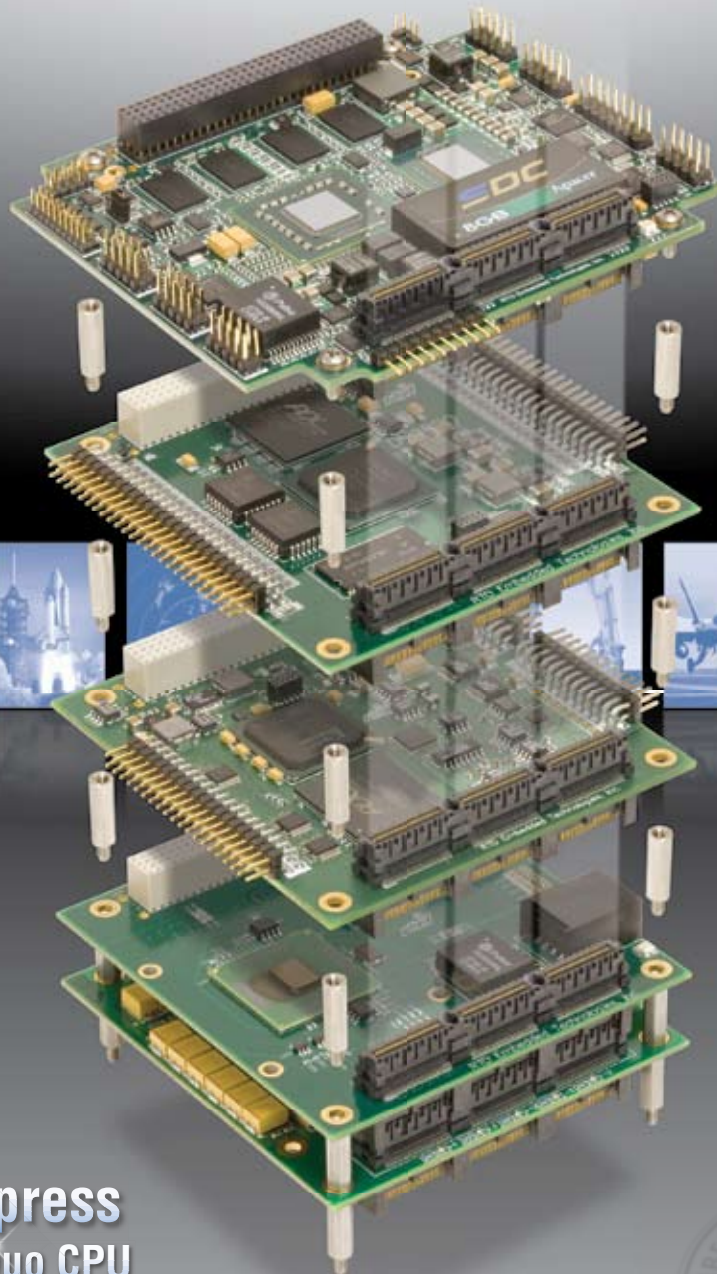
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June 2009 Volume 11 Number 6



The Journal of Military Electronics & Computing

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Coming in July...

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Commissioned last fall, the Navy's first littoral combat ship USS Freedom (LCS 1) is shown here crossing Lake Michigan last summer during builder's trials. Among the I/O technologies aboard the LCS-1 are several box-level mobile Ethernet-based router systems. The LCS operates manned and unmanned vehicles for conducting mine warfare, anti-submarine warfare and surface warfare. The units are installed in each LCS Unmanned Surface Vehicle (USV) to carry out those warfare missions.



Courtesy: DoD photo by Lockheed Martin

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

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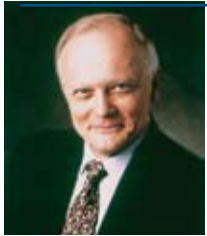
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# Publisher's Notebook



## Ashton Carter: Saint, Martyr or Sacrificial Lamb?

Is anyone out there keeping track on how many times I've written optimistically in this column either about changes in Acquisition Reform or a new Undersecretary of Defense for Acquisition, Technology and Logistics (USD-AT&L)? Well, here we go again, and this time both seem to be in transition simultaneously. And again, as before, the opportunity for these to actually make a difference is real—but actual success may require praying for a miracle.

Ashton Carter was sworn in as the new USD (AT&L) on April 27, replacing John Young, who held that position since November of 2007. Carter's confirmation hit a speed bump when Senators Jeff Sessions and Richard Shelby were showing their displeasure in the Pentagon's reopening of the bid for the Air Force tanker that was to be built in Mobile, Alabama by Northrop Grumman and EADS. After receiving assurances from SECDEF Gates and Carter that the re-bid process would be an open competition and fair, the Senators dropped their opposition to Carter's appointment.

Carter stated that his first priority is "to assess whether programs that have already experienced cost growth are still out of control and whether they can still be afforded." Last year the Government Accountability Office found that 95 of the Defense Department's major weapon procurement programs were \$295 billion over their original budgets—even after reducing performance requirements and quantities. The next item on Carter's hit list is logistics. That's despite the fact that in a recent meeting with Congress on the budget, Chairman of the Joint Chiefs of Staff, Admiral Mike Mullen, stated that he was not aware of any logistics problems in Afghanistan. But at least one Congressman felt that may not be the case. Carter putting logistics high on his priority list, and his assertion that it's often overlooked, must be seen as favorable in the eyes of Congress. With two wars and a major shift in combat operation, logistics is too crucial to be ignored.

Meanwhile, President Obama saying "I think everybody in this town knows that the politics of changing procurement is tough," is an understatement. Taking on defense contractors, their lobbyists and parochial interests of Congress is a political nightmare for any Don Quixote. You add changing acquisition reform to the shifts Gates is proposing in programs, and there's probably not a lot of happiness in board rooms of the Pentagon's top six suppliers: BAE Systems, Boeing, General Dynamics, Lockheed Martin, Northrop Grumman and Raytheon.

The House and the Senate Armed Services committees seemed to have come to an agreement on Acquisition Reform legislation, modifying the old Nunn-McCurdy statute that really

lacked teeth. Both chambers still need to vote on this piece of legislation before it goes to the President. After observing years of go-arounds on acquisition reform, it's difficult to get overly excited about this effort. This legislation establishes a few new offices and directors (with new titles) within the DoD that are only slightly different from existing ones.

The legislation sets new thresholds and reporting requirements for programs to judge their progress, costs and effectiveness. It then provides the all-powerful "can be ignored if the DoD (now Ashton Carter) thinks that ignoring them is the right thing to do" provision. The one interesting element is that this piece of legislation requires input from combatant commanders when making decisions on weapon requirements.

Like the Phoenix rising from the ashes of Future Combat Systems, a new program called Army Brigade Combat Team Modernization (ABCTM) is born. Boy, I liked FCS better than this new acronym. The break up of FCS now shifts all the non-ground vehicle items like Networking and UAVs to existing elements of the Army. The bottom line is yes, the Army needs ground vehicles different than what were in the FCS plan—but the basic infrastructure regarding command and control and communication between all the elements of a modern Army still needs one common overseer. Without that it's like someone saying "I'll just buy all these different computer boards from different suppliers and stick them in this backplane and they'll all work together." That's virtually impossible—even if they're all designed to the same spec.

So Ashton Carter has a very full plate to say the least: evaluating and reporting on all the key programs in the DoD proposed budget, Acquisition Reform and the Army's proposal for the revamping of the Phoenix arising from FCS. One good thing for our market segment is that Carter was co-director with Dr. William Perry on the Preventative Defense Project. The then SECDEF William Perry was the architect of the 1994 Department of Defense Memorandum entitled "Acquisition Reform: A Mandate for Change" that brought COTS military products out of the closet and into prominence. I'm sure Dr. Perry will have provided Carter with his views on the current problems, and that bodes well for our industry. And if Carter survives all this, he should apply for sainthood.

**Pete Yeatman, Publisher**  
*COTS Journal*



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# The Inside Track

## Harris Awarded Contract for Aircraft Fibre Channel Net Switches

Harris was awarded an \$9.8 million follow-on contract to provide 209 Fibre Channel Network Switches for the U.S. Navy's F/A-18 E/F Super Hornet (Figure 1) and for other military aircraft. The new award brings the total value of the switch development and production contracts for Harris to more than \$55 million since 2000.

The Fibre Channel Network Switch is a component of the on-board Advanced Mission Computer and Display subsystem. Under the new award, Harris will supply 188 switches for U.S. Navy Lot 33 F/A-18E/F, EA-18G and E-2D aircraft; for F/A-18F and EA-18G supplemental aircraft; and also for retrofitting of Lots 26-28 F/A-18E/F aircraft. The contract also will provide 21 switches for the Australian F/A-18F aircraft under the Foreign Military Sales program. The switches will be produced at the company's headquar-



**Figure 1**

The F/A-18 E/F Super Hornet uses Fibre Channel as its core networking infrastructure. A Fibre Channel switch provides the protocols required for node-to-node communications and true line-speed synchronous switching.

ters in Melbourne, Florida, with an expected completion date of December 2010. The Harris Fibre Channel Network Switch creates the core networking infrastructure for the next-generation avionics networks currently in production. It provides all of the Fibre Channel protocols required for node-to-node communications and true

line-speed synchronous switching, and a scalable architecture that supports current and future mission-critical flight environments.

Harris  
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## Intel to Acquire Wind River Systems

Intel entered into a definitive agreement to acquire Wind River Systems. The deal calls for Intel to acquire all outstanding Wind River common stock for \$11.50 per share in cash, or approximately \$884 million in the aggregate. Wind River, a major vendor of embedded operating systems, is expected to become part of Intel's strategy to grow its processor and software presence

outside the traditional PC and server market segments into embedded systems and mobile handheld devices. Wind River will become a wholly owned subsidiary of Intel and continue with its current business model of supplying leading-edge products and services to its customers worldwide.

The acquisition is expected to deliver to Intel robust software capabilities in embedded systems and mobile devices, both important growth areas

for the company. It's unclear whether the acquisition will have any effect on military users of Wind River's VxWorks operating system. Intel appears to be most interested in consumer areas where Wind River can play—such as smart phones, mobile Internet devices, other consumer electronics (CE) devices, in-car “info-tainment” systems and so on.

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## LynxOS-178 Tapped for Avidyne's Integrated Flight Deck System

Avidyne, a provider of integrated flight-deck systems for general aviation aircraft, has selected LynxOS-178 from Lynux-Works as the embedded real-time operating system (RTOS) for its next-generation Entegra Release 9 Integrated Flight Deck (Figure 2). LynxOS-178 is a commercially available operating system that enables manufacturers of DO-178B systems to get to market faster and with lower overall costs and risks associated with certifying FAA safety-critical flight systems. LynxOS-178 is a known certifiable RTOS package that allows avionics customers to achieve the highest degree of assurance, and DO-178B certification to meet unique FAA requirements.



**Figure 2**

Entegra Release 9 features large-format, ultra-reliable LED-backlit displays. Each Integrated Flight Display (IFD) is fully capable of performing the functions of the other, so no unfamiliar or limited reversionary modes are required.

Avidyne's Entegra Release 9 flight-deck systems include dual, triple, or quad Integrated Flight Displays (IFD) for general aviation and light business aircraft. The fully integrated design of Entegra Release 9 makes it ideal for high-performance singles, piston twins, turboprops and light jets. ARINC 653



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partitioning allowed Avidyne to integrate DO-178 Level B applications functionally next to Level D applications within the same machine, POSIX API, a software tool chain based on industry standards, and an artifact package that includes an RSC (Reusable Software Component).

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### Lockheed Martin Selects GNAT Pro for C-130J Software

Lockheed Martin Aeronautics, Marietta, Georgia, will be using AdaCore's GNAT Pro to develop the Flight Management System Interface Manager and Radio Control software on the C-130J Super Hercules aircraft. The specific product is GNAT Pro High-Integrity Edition for a PowerPC target running VxWorks 653, the time- and memory-partitioned real-time operating system from Wind River Systems.

The Lockheed Martin C-130J Super Hercules (Figure 3) is an advanced tactical airlifter, designed for mission flexibility, combat delivery, air-to-air refueling, special operations, disaster relief and humanitarian missions.



**Figure 3**  
GNAT Pro software is being used for the Block 7.0 upgrade of the Lockheed Martin C-130J the C-130J Super Hercules aircraft.

## Military Market Watch

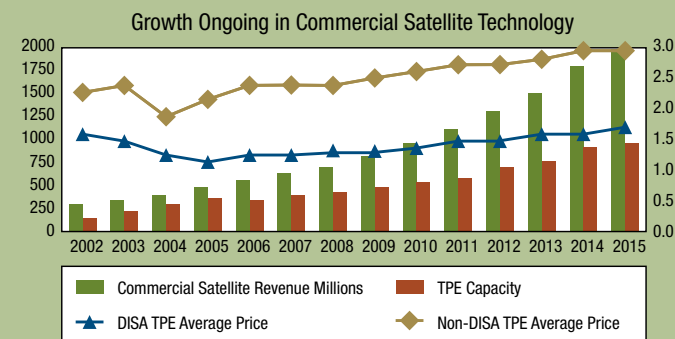
### Military Leverages Commercial SatCom Technology

The U.S. government depends on commercial satellite communications (COMSATCOM) to provide about 75% of their bandwidth requirements. From 2002 to the present, COMSATCOM spending grew at an average annual rate of 14.7%. More than \$700.0 million was spent on Transponder Equivalents (TPEs) in 2008, and spending is projected to be \$1.6 billion by 2015, despite the planned deployment of additional government-owned spacecraft. Military net-centric operational doctrine combined with the widespread use of unmanned vehicles that provide streaming video to warfighters, have been major drivers of bandwidth demand.

Commercial technology continues to be successfully applied to government and military applications by equipment manu-

facturers, COMSATCOM system integrators and communications architecture engineers. Fixed Satellite, Mobile Satellite, Broadcast Services and Systems Integration firms use a variety of COTS hardware and software technologies in both wideband and narrowband categories such as buses, routers, modems, terminals, spread spectrum, packet storage, software defined radio, cellular phone technology, DVBS-2, CompactPCI form factor boards and low visibility antennas.

Leveraging mature commercial technologies and bandwidth-efficient transmission methods saves the government research money, engineering efforts and time. In addition, widespread ground vehicle SATCOM-on-the-Move (SOTM) technologies using small terminals/antennas that can work in a wide range of



**Figure 4**  
From 2002 to the present, COMSATCOM spending grew at an average annual rate of 14.7 percent.

terrain and weather conditions are anticipated to grow rapidly in the next few years for use by military, law enforcement and disaster response teams. The government's intent is to continue to leverage commercial technology advancements as much as possible to ensure ease of use, standards-based interoperability and quick fielding of more capable COMSATCOM

systems. For more information please contact Brad Curran of Frost & Sullivan at: Brad.Curran@frost.com

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### Base10 Selects RTI's Middleware for Unmanned Ground Vehicle

Real-Time Innovations announced that Base Ten Systems

Electronics GmbH (Base10) has selected RTI Data Distribution Service for their unmanned ground-based vehicle (UGV) project. Base10 has over 30 years of experience in the use and adaptation of commercial electronics and microprocessor technology for military applications. Base10 is currently in the development phase of the RoboScout (Figure 5) project, a system demonstrator comprising two ground vehicles and a mobile command post, scheduled for delivery to the German Armed Forces next year. RoboScout is built around a modular design to support multi-role operation, from SIGINT and reconnaissance through convoy and transport systems. It also has the ability to support both terrestrial and satellite data links, as well as acting as a communications relay station for other vehicles. For such a mobile system,



**Figure 5**  
RoboScout is a system demonstrator comprising two ground vehicles and a mobile command post, and is scheduled for delivery to the German Armed Forces next year.

comprising multiple autonomous components, reliable real-time communications is a major concern. Base10 found that RTI's real-time middleware, the RTI Data Distribution Service, addressed a number of key technical and systems integration

issues in the development of this ground-breaking UGV project.

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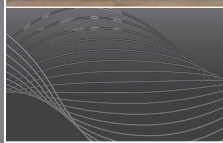
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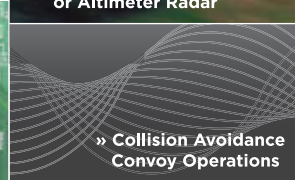
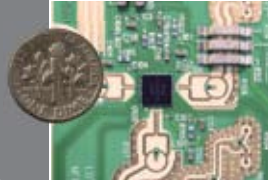
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# Special Feature

1553 and  
Beyond



# Military I/O Solutions Look Beyond 1553

As MIL-STD-1553's niche gets tighter, military systems developers are considering a variety of higher-bandwidth alternatives such as Ethernet, Fibre Channel and FPDP.

Jeff Child  
Editor-in-Chief

**T**ried and true I/O schemes, such as MIL-STD-1553 and ARINC 429, remain popular for pure control applications. But they're bandwidth-limited by today's standards. A slew of multipurpose communications protocols provide options to suit emerging needs. The struggle continues between legacy military I/O schemes like 1553 and new approaches like using Ethernet as a fabric I/O interconnect. Together, 1 Gbit and 10 Gbit Ethernet, Extended 1553 and Fibre Channel are all vying for attention.

While still an avionics bus at heart, the MIL-STD-1553 bus continues to play a role in a wide variety of systems such as tanks, ships, missiles and satellites. Several vendors continue to support 1553 with board-level or even box-level solutions that provide 1553, often included with other functions. Among those vendors are AIM-USA, Aitech Defense Systems, Alpha Technology, Ballard Technology, Curtiss-Wright, Data Device Corp., Excalibur Systems, GE Fanuc and Kontron America.

Because 1553's legacy and installed base is so strong, there's been no one technology to emerge as a straight replacement for it. What's happened instead is Ether-



**Figure 1**

The Sensor Management Unit subsystem aboard the Global Hawk UAV supports Gbit Ethernet and High-Speed Fibre Channel links while interfacing with legacy interfaces such as 1553, RS-422, ECL and Fast Ethernet.

net has now become both a technology to connect to specific high-bandwidth subsystems but also serving as a back-end fabric that aggregates new faster I/O technologies alongside slower legacy buses like 1553. The overall result has driven demand for more complete system or

box-level I/O solutions—many of which incorporate their own processing.

## IP-Based Networks on UAVs

The move toward network-centric architectures has made its mark on UAV platforms as they embrace newer fabric

## Special Feature

interfaces such as Gbit Ethernet, PCI Express, Serial RapidIO, and with discussion about migrating over to 10 GigE in the future. Many of the newer payload sensors are designed with high-speed ports to quickly transfer high-density data that is captured during mission in real time. What's happened is that they still support slower legacy interfaces such as 1553 on the protocol level to protect software application development investment.

In this time of transition away from legacy interfaces, UAV system integrators have taken a “best of both worlds” approach by, for example, supporting the simulation of 1553 over Gbit Ethernet and other high-speed interfaces. This encapsulation approach enables the system to utilize the entire 1553 structure and retain the software hooks that have already been built, tested and qualified for in-flight applications.



Figure 2

The RM983RC VME Ethernet Switch is a 6U VME form factor card that provides support for 12 or 24 Gbit Ethernet ports. Software provided with it lets users manage configuration of the RM983RC from a serial console or via the network.



Figure 3

The AB2000 embeds a user-programmable PowerPC processor that runs the software application and controls the various standard—serial, Ethernet, USB and discrete—and avionics databus—MIL-STD-1553, ARINC 429/708/717—interfaces. A separate computer runs the application and controls the AB2000 over Ethernet.

To be prepared for future requirements related to network-centric architectures, next-generation UAV subsystems are being built today that incorporate the hardware piping that will use IP packet data in the upcoming future. This means laying down high-speed “cables” while retaining support for application code that was written in legacy protocols. As an example, Curtiss-Wright’s SMU (Sensor Management Unit) subsystem deployed aboard the Global Hawk UAV (Figure 1), provides a fully modern platform with the capability to support Gbit Ethernet and

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High-Speed Fibre Channel links while interfacing with legacy interfaces such as 1553, RS-422, ECL and Fast Ethernet. In this way, the SMU works essentially as an interface fusion box, routing various interfaces and fusing them together.

### Ethernet for High Bandwidth Needs

Looking for a faster solution than 1553, aircraft system integrators are on the hunt for an easy way to implement Gbit Ethernet to handle high-bandwidth elements such as multifunction displays, moving maps and multiple full rate video feeds. With just that in mind, the Aeronix GES provides twelve Gbit Ethernet ports in a rugged package designed specifically to address this problem. At less than three pounds and with dimensions of 8.25 x 5.1 x 1.38 inches, the GES is very compact. With an average power consumption of 16W with all 12 ports active, the GES is very low power, which allows for ambient air cooling.

The GES meets MIL-STD-704A power specifications and shock/vibration qualification to aircraft gun fire levels. The small footprint of the GES is not at the cost of functionality. At the heart of the GES is a fully manageable switch fabric that includes support for VLANs, QoS, Link Aggregation, IPv6 and Ingress/Egress monitoring. The GES contains an in-band ARM9 management processor, which will allow custom management functions as required by the integrator. A serial port is also available in the form of an Ethernet to serial bridge, which allows control of legacy equipment from anywhere in the network.

### Ethernet on Armored Vehicles

Rugged Ethernet Switch products are available in many form factors, including VME, VXS and VPX. Switched Ethernet technology is finding its way into numerous programs. An example along those lines, Switched Ethernet is being used as an interconnect for the upgraded electronics on BAE Systems' Bradley Fighting Vehicle Program. The Ethernet Switch Unit (ESU) in the A3 Bradley Combat Systems vehicle functions as a router and a switch, making local forwarding decisions to devices operated in the vehicle's LAN. The A3 upgrade version of the Bradley features

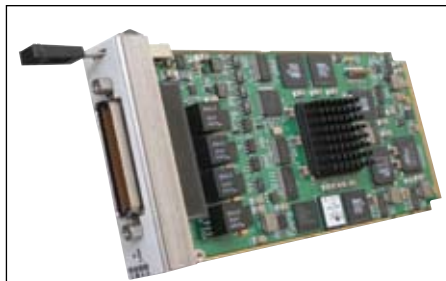


Figure 4

This multi-I/O AMC card offers up to four dual redundant MIL-STD-1553 channels operating in BC, RT, MT, or RT/MT modes, eight ARINC 429 receive channels, four ARINC 429 transmit channels, six user programmable Digital Discrete I/Os, two RS-232 Serial I/O channels, two RS-422/485 Serial I/O channels and an IRIG-B time synchronization input.

an advanced digital architecture that integrates communications equipment, digital sensors, battle management systems, embedded diagnostic and training systems.

Among GE Fanuc's Ethernet offerings is the RM983RC VME Ethernet Switch (Figure 2), a 6U VME form factor RM983RC switch that provides support for 12 or 24 Gigabit Ethernet ports. It ships with GE Fanuc's OpenWare Lite switch management environment, providing customers with the flexibility to manage configuration of the RM983RC from a serial console or via the network.

Capable of Layer 2 switching at wire speed, the RM983RC's 12 or 24 ports are routed to front panel I/O and can be 10/100/1000BaseT, 1000BaseSX or 1000BaseLX. Mixing and matching of fiber and copper media in groups of four is supported. Scanbe front panel and urethane or acrylic conformal coatings are optional. The front panel I/O routing of the RM983RC extends the capability of the NETernity 6U VME product family by offering designers a choice of I/O routing; the recently announced NETernity RM982RC features rear I/O.

The trend toward complete box-level systems has broadened to include some offerings that target specific needs like avionics. Along those lines, Ballard Technology

offers its Avionics BusBox 2000 (AB2000) systems (Figure 3)—a family of over 30 small, lightweight, conduction-cooled, embedded computers for rugged environments. These systems have many built-in standard peripherals and interfaces for various avionics databuses, as well as PMC expansion capability. Typical applications for the AB2000 include data and protocol conversion, databus and network bridging, data servers, data recorders, communications, power controllers, federated controllers and multiple net-centric applications. The AB2000 is suited for helicopter, fixed wing and ground mobile platforms.

At the heart of the AB2000 is a user-programmable PowerPC processor that runs the software application and controls the various standard—serial, Ethernet, USB and discrete—and avionics databus—MIL-STD-1553, ARINC 429/708/717—interfaces. The high level of functionality implemented in the hardware interface circuitry ensures full use of the PowerPC processor for the software application. At power-on the embedded application boots from the flash memory and runs without host intervention. The tethered case is where a separate computer runs the application and controls the AB2000 over Ethernet.

### 1553 on Many Form Factors

Products with 1553 interfaces exist in myriad board form factors including VME, CompactPCI, PMC, PrPMC, AMC, PC/104 and others. Within that universe, a trend has been gathering momentum whereby one or more 1553 channels are becoming part of multi-function board-level solutions. The latest generation of multi-function mezzanine products enables military system designers to blend a variety of I/O functions onto a single PMC or similar form factor. Multi-function solutions available are combining 1553 with everything from ARINC-429 to RS-232/422/485 and even IRIG-106 Recording.

A case in point is Data Device Corp.'s introduction of a new Multi-I/O 1553/429 AMC card that provides up to four dual redundant MIL-STD-1553 channels operating in BC, RT, MT, or RT/MT modes, eight ARINC 429 receive channels, four



ARINC 429 transmit channels, six user programmable Digital Discrete I/Os, two RS-232 Serial I/O channels, two RS-422/485 Serial I/O channels and an IRIG-B time synchronization input.

The BU-65590A AMC (Figure 4) card provides a unique solution by combining multiple protocols on one card, saving valuable space, power and weight in a MicroTCA or ATCA system. These features make it ideal for use in navy applications, flight data recorders, ground vehicles, and other embedded systems that require an AMC card. The card has a PCI-E back-end interface and provides front panel I/O using a rugged micro-miniature D connector. An intelligent hardware off-load engine provides extremely low host CPU utilization while storing 1553 Monitor data in a convenient IRIG-106 Chapter 10 format. ■■

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# Special Feature

1553 and Beyond

## High-Speed 1760 and FC-AE-1553 Pave Upgrade Path for 1553

As heavy data bandwidth needs emerge, 1553 alternatives such as High-Speed 1760 and FC-AE-1553 offer an upgrade suited to this net-centric, smart weapon era.

Mike Glass, Principal Marketing Engineer  
Data Device Corp.

**N**etwork interfaces for future “smart” weapons will need to support applications such as transfers of terrain maps, target templates, program files and digitized video for lock-on before launch. These applications will require the use of a high-speed data interface. For over 20 years, MIL-STD-1760, Aircraft/Store Electrical Interconnection System, has defined the interface between aircraft stores management computers, carriage stores (racks and launchers) and mission stores (bombs and missiles). This standard defines the connector, signal set definitions, topologies, types of interfaces, signal path requirements and power; along with special requirements for MIL-STD-1553 bus interfaces. This includes a command set with detailed message formats, along with a defined protocol for mass data transfer.

In 2008, the SAE AS-1A2 task group released AS5653, the High-Speed Network for MIL-STD-1760, aka High-Speed 1760. This standard defines a gigabit-speed communication option for MIL-



Figure 1

Fibre Channel is deployed on a number of platforms and programs, including the AESA Radar system aboard this US Navy F/A-18F Super Hornet aircraft.

STD-1760. AS5653 specifies a network based on Fibre Channel, operating at 1.0625 Gbits/s over a pair of 75 ohm coaxial cables. The choice of 75 ohm coaxial cable was based on environmental ruggedness—compared to fiber optics—and the availability of positions for coax cable inserts in the MIL-STD-1760 connector.

### Fibre Channel-Based 1760

The base standard for High-Speed 1760 is Fibre Channel. Fibre Channel is a high-performance networking standard that's deployed on a number of military/aerospace platforms and programs, including F/A-18E/F, F-16, F-35, B-2, E-2D, the MMH helicopter and AESA Radar



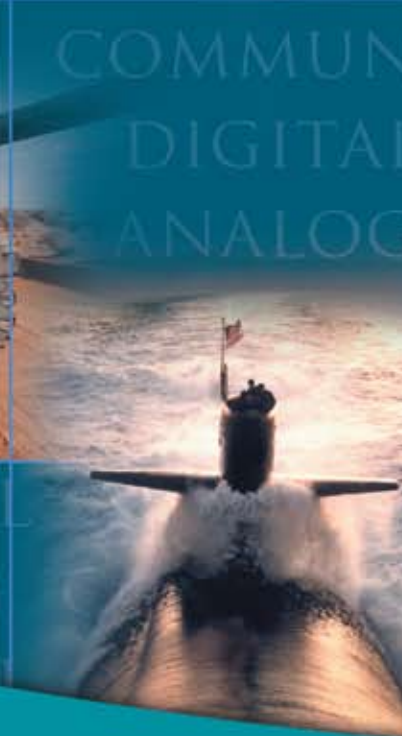
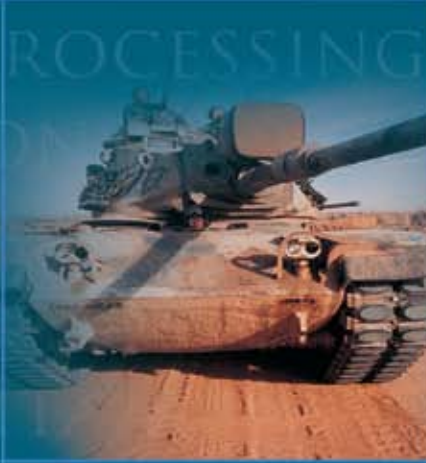
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## Special Feature

(Figure 1). Applications include mission computers, processor and DSP clusters; data storage; video processing and displays; sensors such as radar, FLIR, video and IFF; and serial backplanes.

While Fibre Channel can also operate over point-to-point and loop topologies, AS5653 specifies the use of a switched fabric. The fabric topology provides advantages in terms of the number of nodes supported and aggregate data through-

put. Fibre Channel provides a highly robust low-level protocol providing strong throughput and latency performance, along with provisions for flow control, segmentation and reassembly, error checking and broadcast. Fibre Channel's credit-based flow control ensures that data transfers between endpoints and switches don't result in overflow conditions, while segmentation and reassembly enable reliable in-order delivery for large

data transfers such as program files and video.

Fibre Channel data is transmitted as frames, in which a 24-byte Fibre Channel frame header is followed by up to 2112 bytes of payload data. Fibre Channel Sequences consist of series of one or more frames transmitted by the same sender to one or more receiving nodes. Fibre Channel Exchanges consist of series of Sequences transmitted by either the same end node and/or alternating between a pair of end nodes. Upper layer protocol (ULP) mappings define the series of Se-

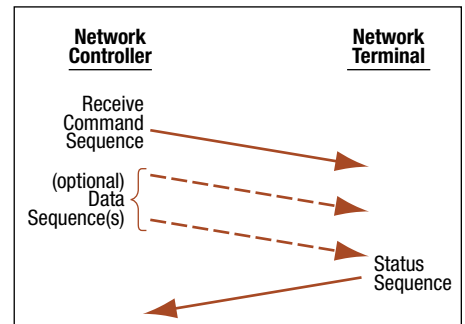


Figure 2

Shown here, an FC-AE-1553 NC-to-NT transfer Exchange, which is directly akin to a MIL-STD-1553 BC-to-RT transfer message.

quences that constitute individual Exchanges. Some ULPs used in avionics include ASM (Anonymous Subscriber Messaging), TCP/IP and SCSI. AS5653 specifies the use of two upper layer protocols: FC-AE-1553 and FC-AV (Fibre Channel audio-video).

### 1553-Compatible Approach

The FC-AE-1553 Fibre Channel upper layer protocol is based primarily on the familiar word structures, command/response protocol, and message formats of MIL-STD-1553. In addition, FC-AE-1553 defines a number of extensions and additional capabilities. FC-AE-1553 supports all familiar MIL-STD-1553 constructs, including command and status, subaddresses, mode codes, RT-to-RT transfers, broadcast and extensive error checking.

Since a portion of the FC-AE-1553 protocol maps directly to MIL-STD-1553



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## Special Feature

messages, FC-AE-1553 enables the reuse of software written for MIL-STD-1553 and MIL-STD-1760 applications. As a result, this allows software written for stores management systems, launchers and weapons that involves the use of MIL-STD-1760 messages to be ported for use over AS5653 networks. In addition to providing an accelerated means

FC-AE-1553 defines two types of nodes, NCs (Network Controllers) and NTs (Network Terminals). An FC-AE-1553 NC performs the function of network master, akin to a MIL-STD-1553 bus controller (BC), while an NT performs the function of network slave, akin to a MIL-STD-1553 remote terminal (RT). Since FC-AE-1553 can operate over a fabric network rather than a multi-drop bus like MIL-STD-1553, it's possible to have multiple active NCs operating over the same network simultaneously.

For example, this could enable one weapon attached to an AS5653 network to transmit a video stream to a stores management computer, while the computer in a launcher transmits commands to other attached weapons. Alternatively, FC-AE-1553 networks can operate with a single network controller. In addition, individual nodes may operate as NCs and NTs simultaneously.

The FC-AE-1553 address field is expanded from MIL-STD-1553's 5 bits to Fibre Channel's 24-bit address space. Similarly, the 1553 subaddress field is expanded from 5 to 32 bits, while the 1553 5-bit word count field is expanded to a 32-bit byte count field. FC-AE-1553 defines all of the standard MIL-STD-1553B Status bits (such as Message Error and Service request) and mode codes, such as Transmit status, Transmit last command, Synchronize and so on.

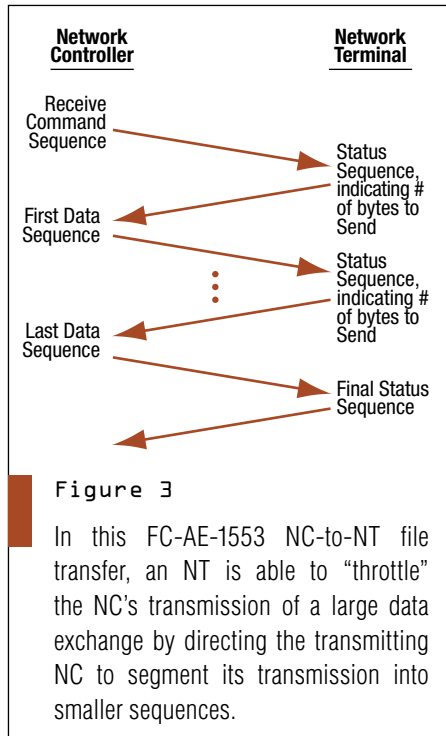


Figure 3

In this FC-AE-1553 NC-to-NT file transfer, an NT is able to "throttle" the NC's transmission of a large data exchange by directing the transmitting NC to segment its transmission into smaller sequences.

for conveying MIL-STD-1553 messages, FC-AE-1553 includes extensions for supporting file transfers of up to 232 ≈ 4.3 Gbytes.

### Emerging Universal Armaments Interface

Future messaging software for weapons will be based on UAI (Universal Armaments Interface), an emerging high-level interface that's an extension of the MIL-STD-1760's message set. The intent for UAI is to enable software reuse of common software for weapons' OFPs (operational flight programs), with the goal of reducing the validation and integration times for new weapons. In addition to weapons, future applications for UAI may also extend to training pods and sensors.

### Multiple Exchange Formats

Within SAE AS5653, FC-AE-1553 supports three different types of operations: (1) periodic (deterministic) or asynchronous "MIL-STD-1553-like" command and control messages; (2) file transfers; and (3) transfers of large data structures such as images.

FC-AE-1553's command and control Exchange formats directly mirror MIL-STD-1553 message formats. As a result, these include NC-to-NT, NT-to-NC and NT-to-NT transfers; mode codes; plus broadcast support. Figure 2 illustrates an FC-AE-1553 NC-to-NT transfer Exchange, which is directly akin to a MIL-STD-1553 BC-to-RT transfer message.

The NC initiates an NC-to-NT Exchange by transmitting a receive

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Command Sequence. This Sequence, which consists of one or more Fibre Channel Frames, includes a 24-byte FC-AE-1553 Command Header in its first frame, and may contain the first portion of payload data bytes for the Exchange. For example, for High-Speed 1760, Subaddresses '00 00 01'h through '00 00 00 1E'h are used for command and control Exchanges to mimic MIL-STD-1553B messages.

As a result, the data payloads for these Exchanges will be limited to a maximum size of 64 bytes.

As a means of minimizing overhead, SAE AS5653 requires that Exchanges (such as command and control Exchanges) with payloads of less than or equal to 2048 bytes be transmitted as single-frame Sequences. As shown in Figure 1, Exchanges with larger payload sizes, such as images, may be sent either as a single Sequence, or

as a Command Sequence followed by one or more Data Sequences.

### Two File Transfer Methods

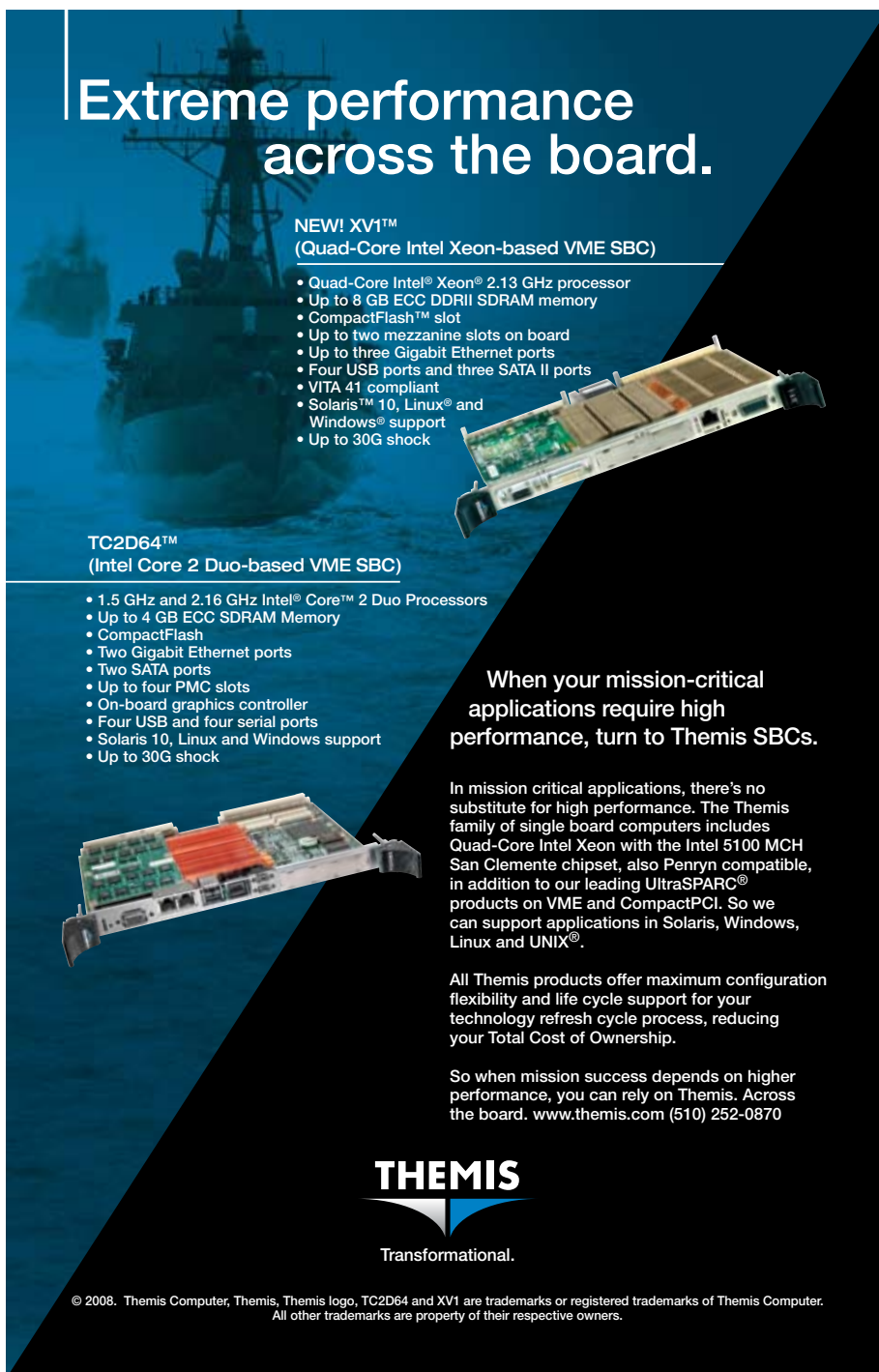
AS5653 provides two different methods for performing file transfers. The first way uses the MIL-STD-1760 Mass Data Transfer (MDT) protocol. This protocol can operate over FC-AE-1553, using NC-to-NT or NT-to-NC data transfers. While this method allows reuse of legacy MDT software written for MIL-STD-1553/1760, it is burdened with a high level of overhead, since individual MDT Exchanges are limited to 30 words (60 bytes).

Within AS5653, the second and far more efficient option for transferring files is by means of FC-AE-1553 file transfer Exchanges. These support file transfers from NCs to NTs, NTs to NCs and between NTs. FC-AE-1553's 32-bit byte count field enables file transfer Exchanges of up to 4.3 Gbytes. For a "write" (NC-to-NT transfer) type of file transfer operation (Figure 3), an NT is able to "throttle" the NC's transmission of a large data Exchange by directing the transmitting NC to segment its transmission into smaller sequences. For example, this mechanism may allow an NT to force an NC to segment a 1 Gbyte file into one hundred 10 Mbyte segments.

For a file transfer Exchange, the NC's Command Sequence will indicate the overall byte count for the Exchange (1 Gbyte). Following reception of this command, the NT will include an indication of the maximum size segment that it can receive in its initial Status Sequence response (100 Mbytes). After the NC transmits its first Data Sequence, this process repeats until all data has been transmitted. The "throttling" mechanism provides the receiving NT with sufficient time to transfer received data from high-speed memory buffers to lower speed memory, such as flash.

### Other Modes and Provisions

FC-AE-1553 defines all MIL-STD-1553 mode codes, along with a few additional ones. FC-AE-1553 also calls for rigorous error checking, including correct delimiters and encoding, Fibre Channel and FC-AE-1553 header fields, Exchange



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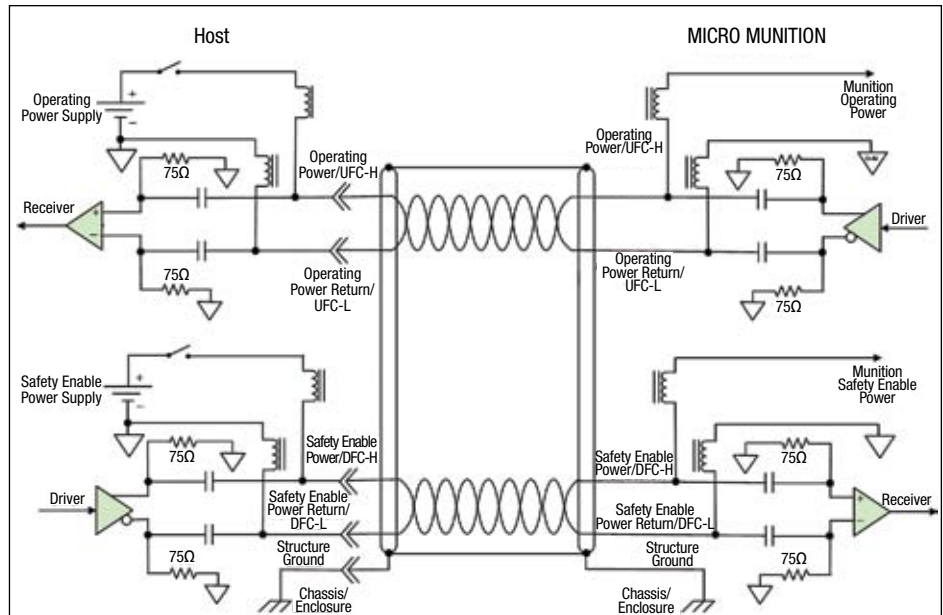


Figure 4

The Interface for Micro Munitions standard is intended for use on small weapons (under 50 pounds) and for UAVs, and specifies the provision of 28V or 56V power over Fibre Channel, which enables the use of a small, 7-pin connector.

byte count and frame CRCs. In addition to the features required by AS5653, FC-AE-1553 also includes provisions for multicast transfers. There are also options for either acknowledged or unacknowledged transfers, including for broadcast and multicast. Similar to MIL-STD-553, AS5653 uses only acknowledged non-broadcast transfers and unacknowledged broadcast transfers. FC-AE-1553 also boasts DMA capability, which uses the FC-AE-1553 Subaddress field to enable direct access to remote nodes' memory address spaces. There are also methods available for bridging to 1 Mbit/s MIL-STD-1553 buses.

The FC-AV upper layer protocol, which is included in AS5653, supports containerization of multiple video and audio streams, and provides standardized methods for identifying pixel characteristics, lines, frames, frame rates and color information. For weapons, target applications for FC-AV include the transmission of video, FLIR, radar and image sensor data from weapons to an aircraft. As FC-AV provides a great deal of flexibility in terms of the video formats it can handle, it is able to support a wide range of sensors and displays.

#### Fast Fabric Initialization

Another protocol incorporated into High-Speed 1760 is FFI, or Fast Fabric Initialization. FFI provides modifications to the standard Fibre Channel protocol for assigning switch addresses over a multi-switch fabric. For a weapons network, this could entail multiple switches, on the aircraft, and/or installed in launchers, racks, or weapons. The benefits of FFI for a weapons network include deterministic switch addressing, along with reduced time for initialization and re-initialization following power outages.

The protocols defined by the High-Speed Network for MIL-STD-1760 have been incorporated into three weapons interface standards. For MIL-STD-1760E, MIL-STD-1553 is a required interface, with the Class I option also providing SAE AS5653. For SAE AS5725, MMSI (Miniature Munitions Store Interface) Rev. D, EBR-1553 is a required interface, with the Class I option also providing AS5653. AS5653 is the only interface defined for SAE draft standard AS5726, the Interface for Micro Munitions, or IMM. This standard is expected to be published in 2009. IMM, which is intended for use

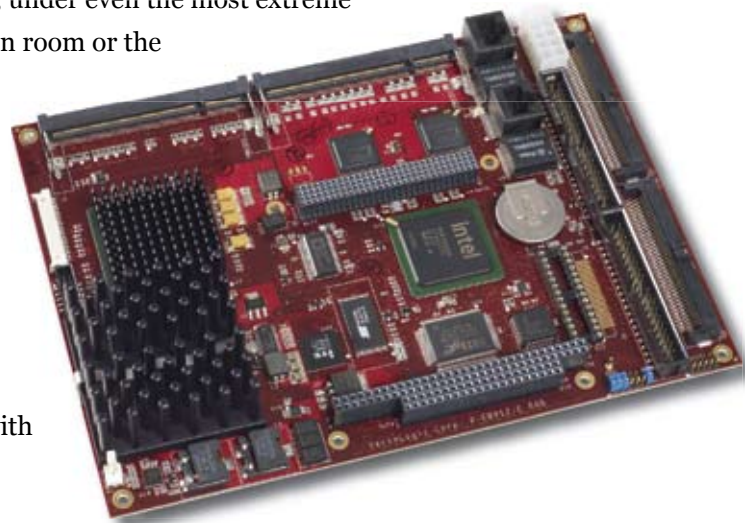
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on small weapons (under 50 pounds) and for UAVs, specifies the provision of 28V or 56V power over Fibre Channel (Figure 4), which enables the use of a small, 7-pin connector.

### Fibre Channel Physical Layer

The Fibre Channel physical layer for MIL-STD-1760E is defined by SAE AS5653. This specifies the use of 75 coax cable, and a transmitter voltage range of 2.0 to 3.0 volts peak-to-peak through the “High Bandwidth” HB2 and HB4 locations in the MIL-STD-1760E connector. This voltage range is higher than the standard Fibre Channel range of 1.1 to 2.0V. This was necessary to achieve the SAE working group’s benchmark for operation over 100 feet of coax cable with 5 disconnects, with cable that’s sufficiently small in diameter to fit in the MIL-STD-1760 connector’s size 12 inserts.

The MMSI and IMM standards were not burdened with the need to accommodate legacy coax connector positions. As a result, the physical layer for these two standards calls for 150 ohm differential signaling, and the standard Fibre Channel transmitter voltage range of 1.1 to 2.0V peak-to-peak.

Figure 4 illustrates power over Fibre Channel, as defined by the IMM draft standard. This interface also includes a pair of discrete signals not shown in

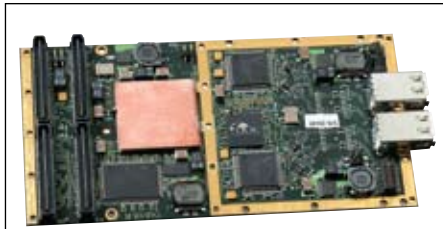


Figure 5

This FibreACCESS NAC card provides multiple upper layer protocols, including TCP/IP, SCSI Initiator, SCSI and Raw Mode, with software drivers for VxWorks and Linux. DDC can modify FibreACCESS to provide support of AS5653 and FC-AE-1553.

Figure 4. These are Mated Status, to indicate a physical connection; and Safety Enable Discrete, a safety interlock signal. As shown, the Micro Munition operating power is transferred over the same two wires as the UFC (Up Fibre Channel, weapon to host) differential pair, while the Micro Munition safety enable power is transferred over the same two wires as the DFC (Down Fibre Channel, host to weapon) differential pair. The IMM standard defines the detailed requirements for isolating between the Fibre Channel signals and power.

DDC’s FibreACCESS NAC (network access controller) card shown in Figure 5

is an example of a COTS Fibre Channel interface card. The FibreACCESS cards are ruggedized, dual-channel PMC cards designed for embedded applications, and operate at 1 or 2 Gbit/s over copper or optical media. They include 64-Bit, 66 MHz PCI or 66/100 MHz PCI-X Initiator/Target interfaces, operate on all Fibre Channel topologies, and provide near “line rate” throughput with capability for end-to-end latency on the order of 10  $\mu$ S. ■■

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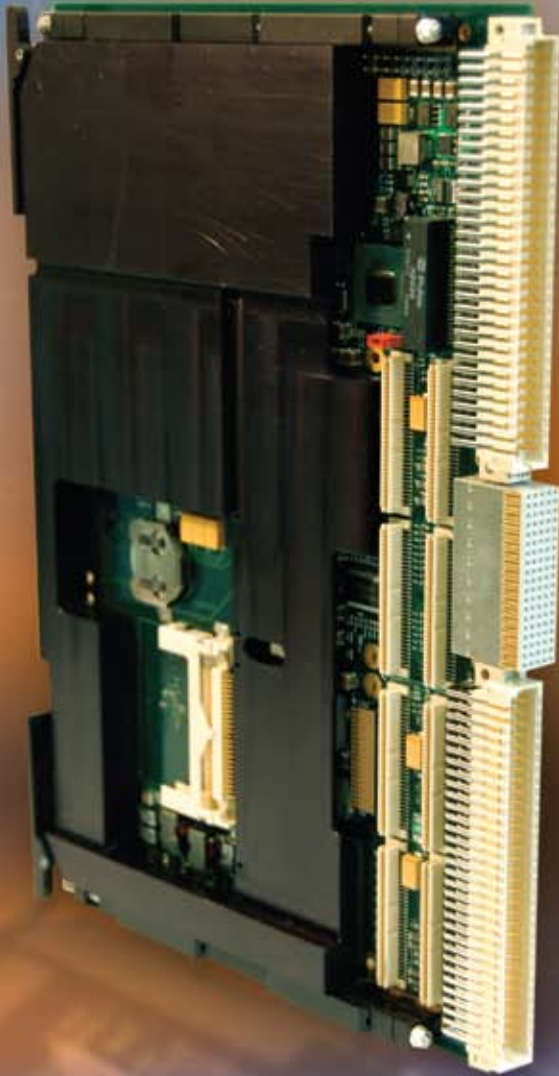
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## Space-Qualified Boards and ICs Satisfy Rad Hard Needs

The current crop of space-qualified boards and chips is leveraging higher FPGA gate counts and radiation hardness, edging out the need for custom board designs and ASIC-based solutions.

Jeff Child  
Editor-in-Chief

Electronic systems designed for space face unique requirements over and above those of any typical military application. Satellites designed for space missions, for example, have to endure harsh environmental conditions over the mission's lifetime, which can be decades. Space-based semiconductors and board-level systems must be capable of withstanding everything from intense radiation due to high-energy atoms to bombardments from neutrons and other particles. Right-sizing the appropriate level of radiation hardening is somewhat of an art. Trying to provide the most cutting-edge computing technology while still meeting the unique requirements of space is no easy balancing act. (See sidebar "Can Commercial Components Be Used Successfully in Space Systems?")

A satellite's system architecture is typically partitioned as two distinct systems: the "bus" and the payload. And while reliability is critical in the payload, its failure isn't likely to jeopardize the entire mission. It's in the bus, however, where reliability problems can lead to catastrophic failure.



Figure 1

Tactical Satellite-3 launched on May 19 weighs less than 400 kg (880 lbs) and employs a first-generation modular bus providing the adaptability for a range of future small satellite missions.

### Reliability and Flexibility

An example of an open standard form factor used in a satellite bus system is the 3U CompactPCI (cPCI) conduction-cooled bus avionics card set for the ATK

Space Systems' Responsive Space Modular Bus (RSMB) used on the Tactical Satellite-3 (Figure 1), which was successfully launched last month. Weighing less than 400 kilograms (880 pounds), the TacSat-3



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## Tech Recon

will demonstrate a first-generation modular bus providing the adaptability for a range of future small satellite missions.

At the core of the avionics solution for RSMB was Aitech's S950 SBC. Specifically designed for mission-critical space environments, the 3U CompactPCI radiation-tolerant S950 (Figure 2) functions using as little as 13.5W in full operation, less than 8W in nap mode and less than 10W with limited performance for less intense processing requirements, all based on a core processor speed of 733 MHz.

The S950 offers extreme protection against single event upsets (SEUs). The board incorporates the low-power PowerPCT 750FX Processor with a maximum power dissipation of less than 8W, 128 Mbytes of SDRAM arranged in a bit-wise triple voting architecture and 1 Mbyte of dual-redundant boot flash to store the onboard Boot firmware. The 32 Kbyte L1 cache includes a parity check for both tags and data, while the 512 Kbyte L2 cache provides a parity check on tags and ECC protection on data. A rad-tolerant antifuse FPGA maintains the memory controller to ensure data integrity for secure system reliability in harsh space environments. Also implemented on the FPGA is additional ECC protection for the board's 64 Mbytes of user flash memory.

Aitech also supplied non-volatile flash mass memory and customized digital I/O cards providing various serial and spacecraft bus interfaces. The Aitech solution also incorporated communications PMC for the remaining serial interfaces required to communicate with the onboard sensors and payloads.

### Modular Approach

ATK's RSMB is the core platform of the TacSat-3 space vehicle, and by using modular form factors like Compact PCI, it was versatile enough to support AFRL's three mission payloads. TacSat-3 is the first small satellite to participate in a formal payload selection process, and consists of three distinct payloads.

The first and the mission's primary experiment, the Advanced Responsive Tactically Effective Military Imaging Spectrometer hyperspectral imager (ARTEMIS HIS), will rapidly supply target

detection and identification data as well as information related to battlefield preparation and combat damage assessment. Second, the Office of Naval Research's Satellite Communications Package (SCP) trial will collect data from sea-based buoys and transmit information back to a ground station for expeditious communication to the war fighter. Lastly, the AFRL-designed Space Avionics Experiment (SAE) payload will validate plug-and-play avionics capabilities using reprogrammable components to integrate the experiment and the spacecraft structure.

### Flash-Based FPGAs for Space

Many radiation-tolerant, space-flight FPGAs make use of antifuse programming technology, including Actel's family of space-based offerings. Last fall, the company rolled out the first flash-based rad-tolerant family called RT ProASIC3. The devices use flash cells to store configuration information. A positive or negative charge stored on floating-gate transistors is used to hold pass transistors in either the "on" or "off" states, thereby opening or closing connections between routing tracks and logic resources. This use of flash-based interconnects presents some unique opportunities and advantages to designers of space-flight electronic hardware.

The reprogrammability of the RT ProASIC3 devices simplifies prototyping and eases hardware timing validation while offering critical immunity to radiation-induced configuration upsets. The new radiation-tolerant, flash-based 600,000-gate RT3PE600L and three million-gate RT3PE3000L support power supplies ranging from 1.2 to 1.5V, which allows designers to choose the optimum balance between power consumption and performance. Because high power consumption requires larger, heavier power supply components, minimizing power consumption in space-flight systems is critical. Managing heat dissipation also requires bulky and heavy mechanical infrastructure in the spacecraft. As a result, designers are motivated to carefully monitor these factors as increased size and weight contribute to higher launch costs.



## Can Commercial Components Be Used Successfully in Space Systems?

Omar Faricy, Director, Programs and Business Development  
Aitech Space Systems

It is natural for satellite equipment designers and users to aim for the same throughput and functionality that they find on their desktops, in their laboratories and in their complex ground systems. And, because space-qualified components do not always provide those levels of functionality, it is becoming more common that designers use commercial components to satisfy these design goals.

Experience has shown that starting with QML (Qualified Manufacturers List) components often yields the highest reliability. Yet, tight program schedules, increasing design complexity, and the need for improved performance and cost pressures, have been driving the trend toward the use of non-QML, commercial parts.

For those systems where the use of commercial components are deemed an acceptable alternative, the selection process starts with commercial components that satisfy a minimal level of quality, then parts are 100% screened. In fact, some parts are inherently radiation resistant; these parts include:

- Silicon on Insulator (SOI)
- Diodes (other than Zener)
- GaAs (Gallium Arsenide) technologies
- Bipolar devices with low dose rate characterization
- Crystal oscillators
- Most passive devices

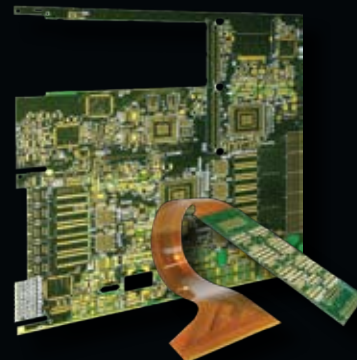
Verified by thorough and 100% testing, modern SOI microprocessors have an inherent transistor construction—eliminating the parasitic SCR—that resists total dose radiation effects and single event upsets

found throughout space applications. This inherent survivability is equally applicable to the L1 instruction and data caches as well as L2 cache on the die, thus extending this radiation-tolerant robustness during full cache utilization. Error correction mechanisms are also built in to the cache arrays to minimize data corruption from single event upsets. Components of this technology type included in a space design are then typically de-rated and screened to provide added risk reduction by tightening design margins through additional up-screening, as well as lot and 100% unit qualification testing, as needed.

An added benefit of commercial micro-processors is that they allow the use of the latest software tools and real-time operating systems that are commercially available, saving development time while enabling design reuse. Design reuse in turn also lowers development time and costs. Taking this concept to a higher level of organization, space systems engineers and mission managers are moving to space-qualified, off-the-shelf boards and subsystems. Single board computers (SBCs), flash-based mass memory and peripheral I/O cards designed and built for space applications allow design teams to complete complex, capable designs in a much shorter timeframe and with minimal expenditures. Manufacturers with this proven space experience provide a portfolio of space-qualified processors, peripheral cards and enclosures to give designers the freedom to implement flexible, modern architectures and the throughput to complete high-performance, highly complex systems.

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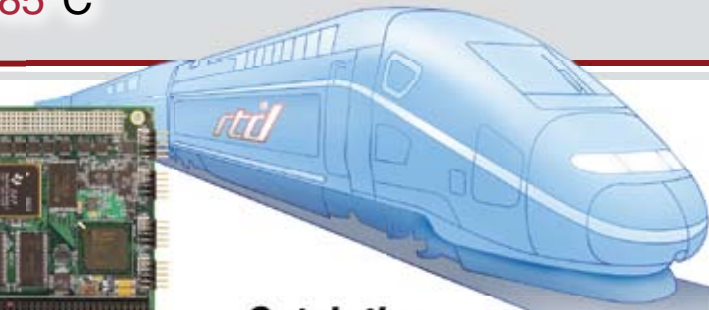
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<b>Analog Input</b>	Single-Ended Inputs Differential Inputs Max Throughput (KHz) Resolution (bits) Input Ranges/Gains Autonomous Calibration Data Marker Inputs		16 8 1250 12 3/7 ✓	16 8 1250 12 3/7 ✓	16 8 500 12 3/4	16 8 100 16 1/4	16 8 1250 12 3/6	16 8 500 16 3/3	16 8 500 16 3/3						
<b>Conversions</b>	Channel-Gain Table Scan/Burst/Multi-Burst A/D FIFO Buffer Sample Counter SyncBus		1K ✓ 8K ✓	1K ✓ 8K ✓	1K ✓ 8K ✓	1K ✓ 8K ✓	1K ✓ 8K ✓	1K ✓ 8K ✓							
<b>Digital I/O</b>	Total Digital I/O Bit Programmable I/O Advanced Interrupts Input FIFO Buffer Versatile Memory Buffer Opto-Isolated Inputs Opto-Isolated Outputs User Timer/Counters External Trigger Incr. Encoders/PWMs		16 8 2 8K	16 8 2 8K	16 8 2 8K	16 8 2 8K	16 8 2 8K	16 8 2 8K	48 24 2	18/9 6/0	64	48 48 2	48 48 2	48 48 2	48 ✓† ✓†
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## DSP FPGAs for Space

In parallel with the RT ProASIC3 rollout, Actel announced the addition of DSP capabilities in its line of radiation-tolerant FPGAs. Called the RTAX-DSP, these devices combine the radiation-tolerant RTAX-S FPGA fabric with a high-speed multiply-accumulate (MAC) capability on a single chip. An attractive alternative to costly and complex SRAM-based, DSP-enabled FPGAs or radiation-hardened ASICs, the RTAX-DSP devices are protected against single-event upsets (SEUs) and offer total signal processing capability in excess of 15 billion multiplications per second.

There are two RTAX-DSP devices—the four-million-gate RTAX4000D and the two-million-gate RTAX2000D. The larger of the two devices features 120 DSP mathblocks, each capable of performing 18-bit x 18-bit multiplications in excess of 125 MHz over the entire military-temperature range (-55° to 125°C). The two-million-gate RTAX2000D features 64 DSP mathblocks, giving a total signal processing capability

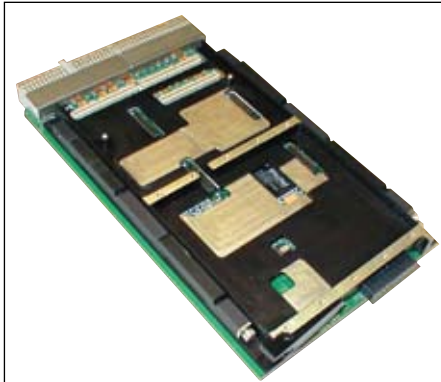


Figure 2

At the core of the avionics solution for RSMB was Aitech's SBC. Specifically designed for space environments, the 3U CompactPCI radiation-tolerant S950 functions using as little as 13.5W in full operation, less than 8W in nap mode. The S950 offers extreme protection against single event upsets (SEUs). The board sports the PowerPCT 750FX Processor.

in excess of eight billion multiplications per second. These signal processing rates make RTAX-DSP suitable for implementing DSP functions such as FIR and IIR filtering, FFT, IFT and DCT transforms in applications such as radio communication in spacecraft command and data handling systems and communications payloads, imaging and radar systems.

Unique to the RTAX-DSP devices, mathblocks feature built-in mitigation against single-event upsets and single-event transients, which could otherwise occur due to heavy ion radiation in space. Further, the RTAX-DSP devices are immune to radiation-induced configuration upsets, unlike SRAM-based FPGAs, which require costly and complex user-instantiated triple-chip redundancy.

## Software Defined Radio in Space

Beyond the typical satellite areas of space-based electronics, a new area that is expected to get more interesting is digital radio in space. In March, NASA awarded Harris a contract to advance a common,

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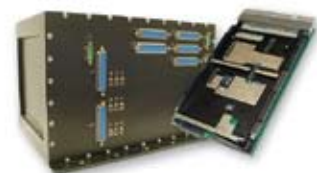
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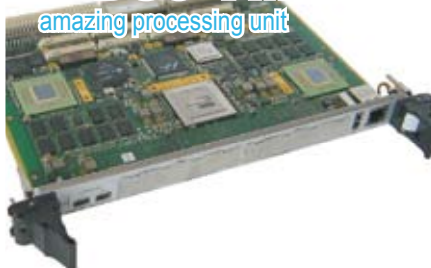
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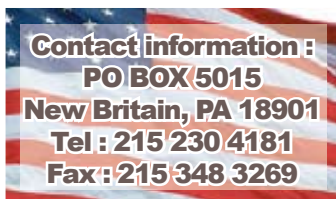
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Figure 3

The Communication Navigation and Networking reConfigurable Testbed (CoNNeCT), which will be installed on board the International Space Station (ISS), will demonstrate standards-compliant software defined radios (SDR) that will provide an on-orbit, adaptable radio facility to conduct a suite of experiments.

software defined radio architecture for future space missions. This 14-month, multimillion-dollar contract calls for Harris to develop Ka-band-capable radios as part of the Communication Navigation and Networking reConfigurable Testbed (CoNNeCT), which will be installed on board the International Space Station (ISS) (Figure 3). CoNNeCT is currently scheduled to be launched to the Space Station via a Japanese H-II launch vehicle in 2011.

The overall goal of the CoNNeCT program is to demonstrate Space Telecommunications Radio System-compliant software defined radios (SDR) that will provide an on-orbit, adaptable radio facility to conduct a suite of experiments. The experiments will advance communications technologies, reduce risk, and demonstrate future mission capabilities such as those planned for NASA's Constellation Program. Harris also produced the Internal Audio System and the Internal Video Distribution Subsystem that help make up the fiber-optic communications network on board the Space Station. The systems are provid-

ing sophisticated, digital voice and video communications for astronauts and scientists who live and work on board the station. ■■

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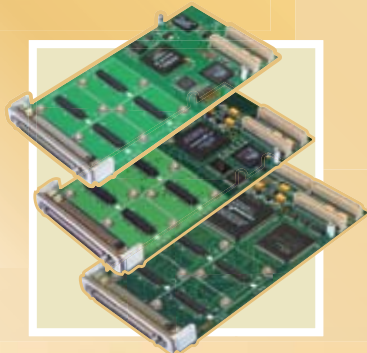
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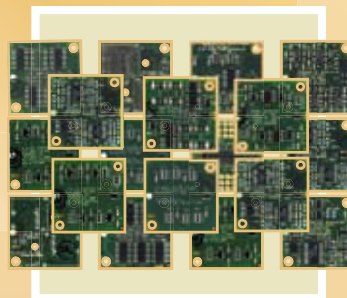
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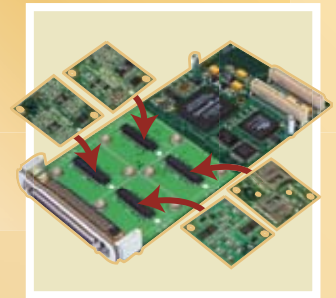
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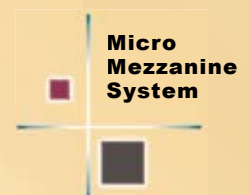
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# System Development

Shock and Vibration Testing

## Shock and Vibe Testing Remains Critical for Military Systems

As electronic systems get more complex and integrated, testing for shock and vibration is more vital than ever for successful military embedded computing applications.

---

Ivan Straznicky, Senior Staff Mechanical Engineer  
Curtiss-Wright Controls Embedded Computing

---

**D**esigning for shock and vibration is as critical as any other design parameter to ensure performance. It is even more important for military applications because of high shock and vibration levels. Failures due to broken components, leads or solder connections are equally fatal to a military system as poor electronic design.

Shock and vibration environments, such as those found on military vehicles, can be highly damaging to electronics, particularly for circuit cards that have not been appropriately designed, analyzed and tested (Figure 1). These environments vary widely depending on the vehicle, location of the electronics, and mission profile. In general, aircraft have much higher vibration levels than ground vehicles and watercraft, however, aircraft shock requirements are less severe.

Vibration is of particular concern because it causes high cycle fatigue. Failures such as broken leads, cracked solder balls and fractured printed circuit board (PCB) interconnects can easily occur on and around IC packages due to high cycle fatigue. In addition, fretting wear leading to corrosion can occur on connector contacts when circuit cards are exposed to higher vibration levels and durations. Successful fielding of a circuit card for military vehicle environments demands

an intimate understanding of the assembly, its components, and how it behaves dynamically during shock and vibration.

### Mechanical Shock

Mechanically induced shock results in very short duration responses that are of a similar magnitude as the input shock. This makes designing for standard functional shock requirements (such as MIL-STD-810F, Method 516.5, Procedure I) relatively straightforward because fatigue considerations play a significantly lesser role than in vibration. As long as the shock pulse does not produce stresses beyond materials' yield strengths (or lower for margin), and structures can absorb the limited number of pulses, the circuit card assembly should continue to operate. If the shock levels are beyond these limits, for example ballistic shock or pyroshock, isolators can be used on chassis to reduce the levels seen by the circuit cards inside.

Unlike shock, vibration is typically applied over longer durations of one hour or more. This results in high cycle counts, for example, a sine dwell at 200 Hz for one hour equates to 720,000 cycles. These high cycle counts can readily produce fatigue failures, particularly at higher acceleration levels. Fatigue stresses are caused by deflections of the circuit card resulting from its natural mode shapes under the applied vibration and given boundary conditions (Figure 2). The highest displacements, strains and stresses will typi-

cally occur at the first, or fundamental, frequency, although the more complex shapes of higher natural frequencies can also cause problems due to local curvatures and/or by superposition onto the first mode shape—during random vibration for example.

The two types of vibration typically used for testing circuit cards are sine and random. Sine vibration is often applied as a sweep between two frequencies to characterize the structural dynamics of the circuit card—in other words, determine its natural frequencies and response accelerations. Occasionally it's also superimposed over random vibration to simulate driving frequencies of higher-level structures—helicopter rotor blades for instance.

### Random Vibration

Random vibration is extensively used to test circuit cards for various reasons (e.g., qualification, endurance, ESS) because it can represent many real-world environments. Random vibration is expressed as a power or acceleration spectral density (PSD or ASD, in units of  $g^2/Hz$ ) over a frequency range, typically around 20 to 2,000 Hz. PSD plots are often generated for specific locations on specific platforms based on accelerometer data under various scenarios. These plots are used as the input to a vibration test fixture that holds the circuit card in a representative manner.

Because random vibration applies accelerations at all frequencies in a range si-



multaneously, all the circuit card's resonant frequencies in that range are excited concurrently. This makes analysis of the card's response, for determination of displacements, strains and stresses, much more difficult than sine vibration. It is not, however, impossible, and analysis tools do exist that can predict random vibration responses and associated fatigue problems, although they require a high level of understanding.

A circuit card's response to a random vibration PSD profile will be dominated by its first mode shape, with decreasing effects from higher frequency mode shapes. Response accelerometer data can be used to determine displacements, which will have probability distributions due to the random nature of the vibration. Stress and fatigue damage distributions can then be determined based on an understanding of electronic component geometries and applicable material fatigue properties. This approach is useful when prototypes are not available, and for comparative and sensitivity analyses. Test results can then be compared to analytical results for a more complete product understanding.

Random vibration testing should be performed on every circuit card that is expected to survive in a vibration environment. At the product development stage, this can entail prototype, qualification and HALT (Highly Accelerated Life Testing) testing. For production circuit cards, vibration ESS is a valuable screening method for manufacturing and component defects, although care must be exercised to limit the impact to the card's vibration life.

Failures that can occur during vibration testing include broken leads, cracked solder balls and fractured PCB interconnects (Figure 3). Many such failures will initially show up as intermittent functional faults, which disappear if vibration is stopped. This highlights the necessity of full coverage of circuit card functional operation while vibration is being applied. "Before and after" functional testing will not catch a large number of vibration-related failures.

### Fretting Corrosion Failures

A failure mechanism somewhat unique to vibration is fretting corrosion of electronic connector contacts. This occurs when the circuit card displacements under



Figures 1a and 1b

Shock and vibration environments vary widely depending on the vehicle, location of the electronics, and mission profile. In general, aircraft—like the F-35 (top)—have much higher vibration levels than ground vehicles—like this Stryker Mobile Gun System (bottom)—but aircraft shock requirements are less severe.

vibration cause relative micromotion—tens to hundreds of microns—between the contacts of a mated connector pair. Figure 4 shows this for the first mode shape of a circuit card. Relative micromotion can also occur due to backplane resonances, however, the accelerations required for this to happen must be beyond the extraction

forces of the mated connector sets between the backplane and its daughtercards.

Connector design plays a major role in whether or not fretting corrosion failures occur for given circuit card boundary conditions and random vibration levels/durations. Connector contacts that have more than one point of contact are superior

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because of reduced probability of concurrent high resistances. Other favorable connector attributes are geometries that limit relative motion and that maintain consistent normal forces. Thicker noble metal overplates are also desirable—50 micro-inches gold versus 30 or less for example.

Other significant factors that affect fretting wear and corrosion include:

**Boundary conditions:** Conduction-cooled cards with tightened retainers at card edges have significantly less deflection under vibration than air-cooled cards in guide rails.

**Circuit card stiffness:** Stiffer cards have less deflection under vibration, although if there is still enough to overcome static friction between connector contacts, fretting wear will occur.

**Circuit card mass:** Lower mass reduces displacements under vibration.

**Damping:** Can be used to absorb dynamic loads along the vibration input path.

Analysis to prevent fretting corrosion is difficult because of the small displacements, static vs. dynamic friction, and other variables associated with the

connector (e.g., normal force, contact area, plating thicknesses and surface hardness). For this reason, well planned and executed testing is required to understand when, where and under what conditions fretting corrosion occurs.

**Vibration Testing Example**

Testing of the VPX (VITA 46) high-speed connector shows that it is possible to meet relatively high levels of random vibration over relatively long durations with COTS connectors. The connector chosen

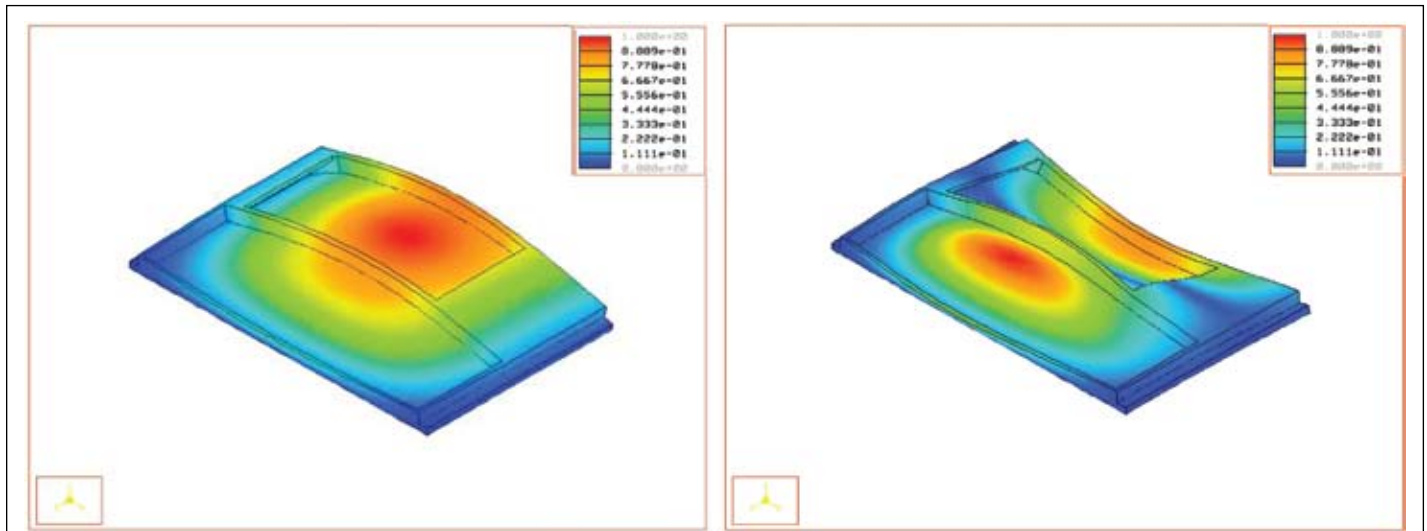


Figure 2

Fatigue stresses are caused by deflections of the circuit card resulting from its natural mode shapes under the applied vibration and given boundary conditions. Shown here are the first two mode shapes of a conduction-cooled card mounted in a chassis.


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for the VITA 46 (VPX) and VITA 48 (VPX-REDI) standards needed to be qualified to random vibration levels and durations typical of military COTS board suppliers' specifications. Higher vibration levels were applied to a second card/connector assembly in a HALT test, which was intended to explore the limits of the connector on a specific test vehicle (0.8-inch pitch, 6U conduction card). Both tests were successful—the qualification test passed all performance

verification criteria and the HALT test discovered the limit of the connector on the 6U test card. It is expected that improvements such as increased stiffness—from card covers and/or use of thicker cards on 1-inch pitch for example—would increase the limit at which the connector experiences fretting corrosion.

In conclusion, shock and vibration are two of the most common environments to which electronics are exposed.



Figure 3

Failures such as broken leads, cracked solder balls and fractures in PCB interconnects can all occur during vibration testing. Shown here is a microvia fracture caused by vibration.

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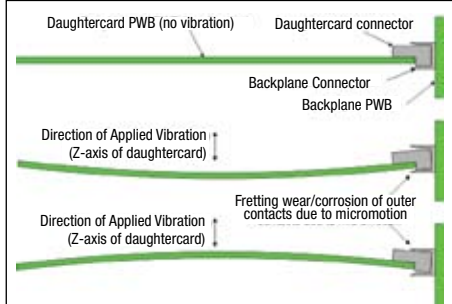
The advertisement features a laptop displaying a complex software interface with various charts, graphs, and data tables. The text is overlaid on the image in large, bold, red and white fonts.

Figure 4

Fretting corrosion of connector contacts occurs when the circuit card displacements under vibration cause relative micromotion.

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Military electronics are particularly susceptible to failure from vibration because of the high acceleration levels involved and the long lives required. An intimate understanding of a circuit card's dynamic behavior under these environments can uncover potential problem areas during the design phase. Carefully planned and executed testing must then be performed to ensure that other failures do not occur and that applied solutions work as intended. Otherwise, failures can and will occur in the field. ■■

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# System Development

Shock and Vibration Testing

## Comparing NAVMAT Versus 6DOF for HALT/HASS Testing

6DOF and NAVMAT offer significantly different ways to do HALT/HASS testing. These differences have vital consequences on the design and manufacturing of military electronic systems.

George Henderson, founder, President and CEO  
GHI Systems  
William Burgess, Reliability Engineer  
Leach International

**M**ilitary system developers have warmed to the strategy of using advanced environment screening methods like highly accelerated life testing (HALT) and highly accelerated stress screening (HASS). Testing systems to withstand preproduction thermal ramping and random vibration stimulation is collectively called HALT. An ability to withstand post-production highly accelerated stress screening (HASS) is likewise critical.

There are two principal technology standards available for the performance of HALT and HASS vibration screening: 6DOF and NAVMAT. There are significant differences in the basic characteristics between these two approaches. These differences can, and do, affect the accumulation of damaging fatigue and hence the ability to precipitate design and fabrication defects of the products.

### 6DOF Spectrums

The 6DOF machine's excitation is considered to be quasi-random, but the spectrum shape is not controllable, as there is no means of control feedback. The repetitive impacting of several pneumatic hammers beating against a metal plate produces

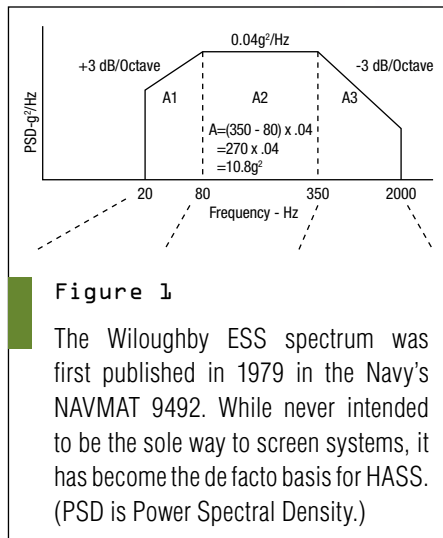


Figure 1

The Willoughby ESS spectrum was first published in 1979 in the Navy's NAVMAT 9492. While never intended to be the sole way to screen systems, it has become the de facto basis for HASS. (PSD is Power Spectral Density.)

the spectral excitation. These shock impacts result in waveshapes that define the power spectral density. The PSDs result from hammer impacts superimposed on the resident bending modes of the table structure.

In general, the frequencies of hammer impacts are set by their mechanical design, which results in stationary repetition frequencies between 20 Hz and 50 Hz, depending on their mass, internal shock programmers, air pressure, valves, etc. The interaction of several hammers and the table structural response results in nearly random spectrum amplitudes across a frequency span of tens of Hz to several thousands of

Hz. The lowest useable spectral line is that of the primary hammer harmonic. These hammer harmonics are present across the entire table spectrum of the machine.

### Electrodynamic Excitation NAVMAT Spectrum

In 1979, Willoughby of Grumman Aircraft, while developing test spectra for Navy hardware, proposed the vibration spectrum seen in Figure 1. The purpose of the spectrum was to define an optimum loading for equipment subjected to accelerated stress testing HASS. While never intended to become a test standard, it did just that as NAVMAT P9492.

In order to create vibration response induced fatigue damage, it is required that acceleration loading applied to the defective component bracket the first order bending mode frequency and be of sufficient amplitude to cause high self-resonance. The resulting strain of the component bending produces accumulation of fatigue according to Miners Rule. The intensity of this fatigue accumulation is directly related to the velocity component of motion and its amplitude. These are described by a velocity spectrum equation proposed by Piersol and Henderson that includes the vibrator damping, duration of excitation, and the fatigue S/N beta ratio.

# COTS JOURNAL

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## SPECIAL JULY ISSUE

### ALERT: CRITICAL CHANGES TO MILITARY VEHICLES MANDATED

Changes by the DoD and U.S. Army to vehicle requirements will necessitate re-thinking previously planned electronics. Existing programs like Future Combat Systems were launched before technologies like VPX emerged and before the trend toward integrated rugged box-level systems hit its stride.

Will the "short delay", mentioned by Secretary Gates, allow for changes in suppliers? Changes in technology? Who are the suppliers targeting the changes in the vetronics market? As an engineer re-designing vehicles how do I best proceed?

The latest requirements will be featured in the **July issue of COTS Journal**. Discover how these changes may be influenced by technology and the latest available products.

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### COTS Journal July Special Feature:

#### Military Vehicle Electronics: Power and Size Tradeoffs

Onboard communications and control electronics (vetronics) are expected to multiply in sophistication for both next-generation and Current Force fighting vehicles. These factors are putting

pressure on system designers to find ways to meet the complicated cooling, shock and vibration problems that emerge when more computing gear is packed into those vehicles. Included will be an update on the Army's Future Combat Systems program, Current Force upgrades and the latest DoD mission requirement changes.



Robert Gates, Secretary of Defense

"...there is no question in my mind that the Army needs a vehicle modernization program. I will make the money available for it." Robert Gates, Secretary of Defense, "we can have a short delay, while we look at the requirements again."

"... as they began working on the infantry fighting vehicle and looking at the lessons learned, in Iraq and Afghanistan, they began adding armor to the infantry fighting vehicle," said Gates "And all of a sudden, it was looking like 38 tons on a 30-ton chassis. That seems to me to be a problem."

## Products for HALT/HASS

Products that are subject to self-resonance fatigue accumulation are those that are solidly anchored but with some mass component free to vibrate. This vibration

will be at its natural resonance frequency and is governed by its damping (Q of response). The magnitude of potential damage is related to the duration of loading exposure and the particular materials S/N beta ratio. A classic

example of such a component would be the quartz crystal cans described in a previous paper, or can be seen in Figure 2.

In the past, it was assumed that the span of self-resonance frequencies of electronic components ranged from 20 Hz at the low end to 2000 Hz at the high end. This range was sufficiently bracketed by the NAVMAT profile. The problem is it was based on larger through-hole mounted components of earlier design. The migration to smaller surface mount components has forced a rethinking of this frequency range. In unpublished work by Allen Piersol, he comments that results from pyroshock testing within JPL, NASA and commercial satellite-producing companies have resulted in the upper range of interest becoming 7 KHz or higher. While good components may have a wide margin of design integrity (normal end of life), components with defects such as wire nicks, partial stress cracks, etc., will precipitate rapidly due to requiring fewer stress loadings to fail.

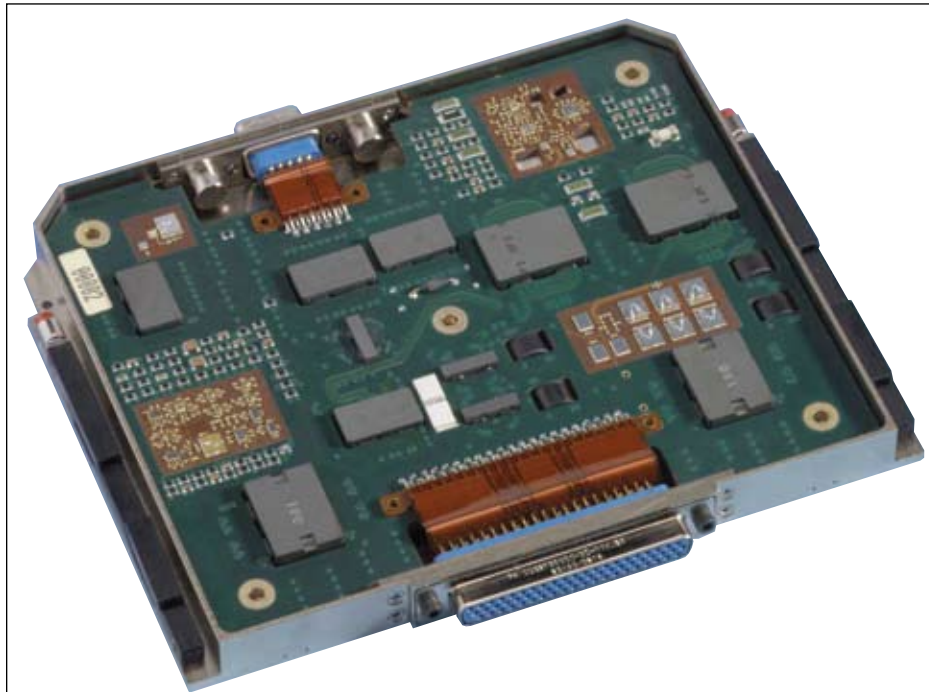


Figure 2

Typical miniaturized electronics module produced for military product. (Photo courtesy of Aeroflex)

## Which Is Most Effective?

Figure 3 shows overlaid PSDs from both the electrodynamic NAVMAT type shaker and the uncontrolled 6DOF quasi-random impact hammer excited table. Below the cursor frequency of approximately 500 Hz, the NAVMAT shaker provides more fatiguing excitation than the quasi-random 6DOF machine. However, above this frequency, the 6DOF machine predominates. This would mean that products with self-resonance defect frequencies above 500 Hz would not be as well excited by the NAVMAT shaker as they would by the 6DOF shaker. This is very obvious above 3 KHz where the NAVMAT shaker has no loading ability whatsoever. The gRMS values for the two shakers are listed on the data table

The triaxial excitation ability of the 6DOF machine must also be taken into account. Since reasonably equivalent simultaneous excitations are available at least in the three principal orthogonal axes, and accounting for the extended high-frequency capability of this type of machine, a reduction in screen time is possible over the single direction motion of the electrodynamic shaker.

## Fatiguing Comparison

By application of the Damage Potential Spectrum, it is possible to visualize the

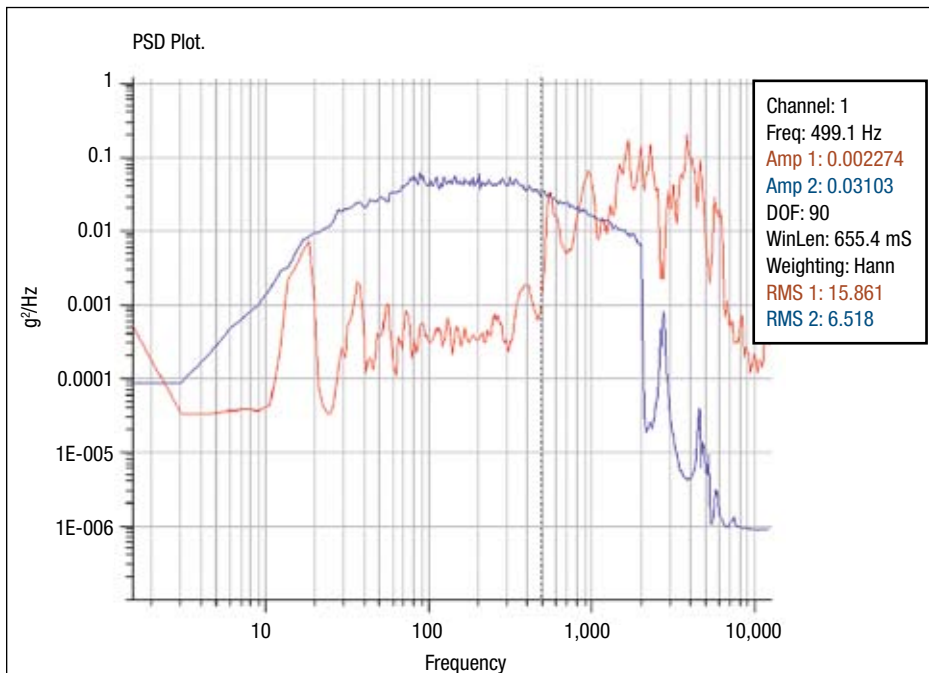


Figure 3

Overlaid PSD plots of excitations from NAVMAT (Blue) and 6DOF (Red) shaker excitations. Vertical scale is amplitude  $g^2/Hz$ ; horizontal is frequency, Hz.



difference in fatigue accumulation that would take place over an excitation period of an hour. This plot is shown in Figure 4. The results show a large amount of damage potential associated with the low-frequency displacement motion of the NAVMAT shaker. On average it is about four to five orders of magnitude greater than that of the 6DOF machine at frequencies between 20 Hz and 500 Hz. However, above 500 Hz, the ratio of potential damage per hour of exposure is perhaps two or more orders of magnitude greater in favor of the 6DOF machine. In addition, there's essentially no fatiguing ability associated with the ED NAVMAT shaker above 2 KHz.

With the reduction in mass of electronic components made possible by miniaturization for surface mounting, resonant frequencies shift to higher bandwidth. At these higher frequencies, the 6DOF type machine provides much higher fatiguing potential. Over the complete product bandwidth, the 6DOF machine provides approximately 1.5 times the fatiguing ability despite the four to five orders of magnitude advantage the ED NAVMAT machine enjoys across the low-frequency end of the spectrum.

**The Correct Choice**

Military system developers must go with the approach dictated by the definition of what is to be screened. Heavy components that require displacement for excitation will naturally be screened by the NAVMAT type system. Components that have high resonant frequencies and are therefore compatible with response producing excitation, are candidates for the 6DOF machine. Where this division between choices must be made, it must be made in terms of the available spectral power at the resonant frequency of the particular component. ■■

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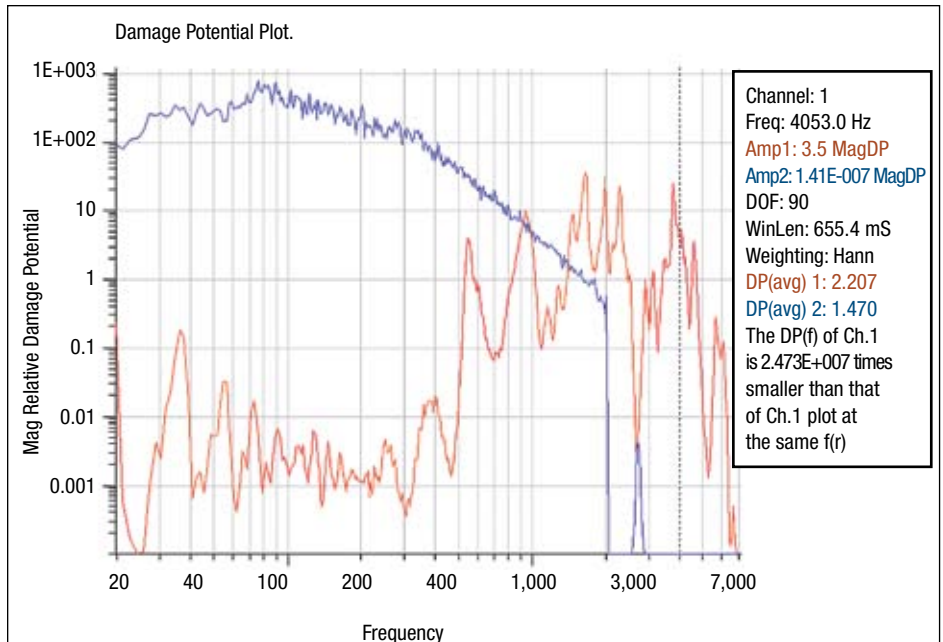


Figure 4

Overlaid Damage Potential Spectrum plots of excitations from NAVMAT (Blue) and 6DOF (Red) shaker excitations. Vertical scale is amplitude relative damage potential; horizontal is frequency (Hz). The plots have been zoomed to focus on the typical self-resonance bandwidth of small surface mount components.

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# Technology Focus

FPGA Processing Boards

## FPGA Boards Deliver DSP Muscle and I/O Flexibility

FPGA-based boards are ramping up their processing strength and I/O functionality. Radar and other signal processing-based military applications are reaping the rewards.

Jeff Child  
Editor-in-Chief

As FPGAs evolve to ever greater sophistication, complete systems can now be integrated into one or more FPGAs. Board-level product developers continue to ride that wave in two ways. On the one hand they're using FPGAs to create powerful compute engines that perform signal processing computation on the FPGAs themselves. At the other extreme, FPGAs are enabling a new class of I/O board solution that enables users to customize their I/O as well as do I/O-specific processing functions.

Waveform-intensive applications like sonar, radar and SIGINT rank among the applications that have been most transformed by FPGA advances. Faster FPGA-based DSP capabilities coupled with a broader range of IP cores and development tools for FPGAs are joining forces to form new system architectures. Using those building blocks, board-level subsystems must quickly acquire and process massive amounts of data in real time.

System developers can now build radar receiver systems with a higher instantaneous bandwidth thanks to the converters, and can handle the corresponding increase in compute power required to process the received data streams using FPGAs. The ASIC-based radar design approaches of the past can achieve the performance needed, but that path lacks the flexibility inherent in designs based on FPGA technology.

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

Driven by the fact that FPGAs are now a key part of the embedded computing landscape, a VITA form factor spec has formed around them. Called VITA 57, the FPGA Mezzanine Card (FMC)



Figure 1

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

specification defines an I/O mezzanine module designed to work intimately with an FPGA. FMC modules enable I/O devices that reside on an industry standard (VITA 57) mezzanine card to be attached to and directly controlled by FPGAs that reside on a host board. About half the size of a PMC mezzanine module, FMCs provide a small footprint, reduced I/O bottlenecks, increased flexibility, and reduced cost through the elimination of redundant interfaces. To maximize data throughput and minimize latency, the FMC connector provides numerous I/O pins that support high-speed signals for moving data between the FMC and the FPGA. The FMC specification was developed to enable FMCs to be supported on a wide range of existing form factors, including but not limited to VME, CompactPCI, VXS, VPX, VPX-REDI, CompactPCI Express, AdvancedTCA and AMC. ■■

# FPGA Processing Boards Gallery

## Featuring the latest in FPGA Processing Boards technology



### S4-AMC

- ▶ Altera® Stratix® IV GX FPGA
- ▶ BittWare's ATLANTiS™ FrameWork supporting 15 SerDes ports and four LVDS I/O ports
- ▶ BittWare's FiNe™ Host/Control Bridge providing Gigabit Ethernet on port 0
- ▶ VITA 57 FMC Site
- ▶ Up to: 2 GBytes DDR3 SDRAM, 18 MBytes QDRII+ SRAM, 64 MBytes of Flash



### BittWare

**Phone:** (603) 226-0404  
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**E-mail:** info@bittware.com  
**Web:** www.bittware.com



### GX-AMC

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- ▶ BittWare's FiNe™ Host/Control Bridge providing Gigabit Ethernet on port 0
- ▶ Up to: 1 GByte DDR2 SDRAM, 18 MBytes QDR2 SRAM, and 64 MBytes of Flash



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### SF/GX-AMC

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- ▶ BittWare's ATLANTiS FrameWork supporting 15 SerDes ports (four to the SFP/SFP+ connector) and eight LVDS I/O ports
- ▶ BittWare's FiNe™ Host/Control Bridge providing Gigabit Ethernet on port 0
- ▶ Up to: 1 GByte DDR2 SDRAM, 18 MBytes QDR2 SRAM, and 64 MBytes of Flash



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- ▶ Four Analog Devices ADSP-TS201S TigerSHARC DSPs
- ▶ PrPMC+ Interface compatible with standard PMC modules
- ▶ XMC site with 8 SerDes channels (4 to each Stratix II FPGA)
- ▶ Up to 5 GBytes DDR2 SDRAM and 128 MBytes Flash memory



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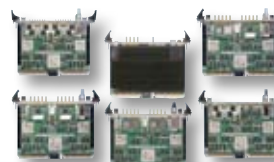
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**Web:** www.tekmicro.com

# Technology Focus:

## FPGA Processing Boards Roundup

### PMC Uses Virtex 5 FPGA for Speedy I/O Processing

At one time FPGAs served merely as glue logic interfaces. Now they function as complete processing engines. Acromag's PMC-VFX modules feature a Xilinx Virtex-5 FPGA with a hard core PowerPC block that is reconfigurable for high-performance I/O processing and user-developed computing applications. Now users can offload CPU-intensive operations such as video/3D data processing or floating-point math for superior system performance. For fast data transfer in and out of the FPGA, the PMC-VFX provides large banks of DDR2 DRAM and dual-port SRAM for high-speed DMA transfer to the PCI bus. The PMC base



card provides 64 I/O channels or 32 LVDS lines accessible via P4 rear connectors. Inserting optional front-connecting AXM I/O extension modules augments I/O processing capabilities with an efficient interface for 16-bit 105 MHz A/D conversion, CMOS digital I/O, RS-485 differential signals, or extra LVDS I/O lines. Typical uses include processing of video, 3D data, radar/sonar, software-defined radio, electronic warfare, floating-point math and fuzzy logic algorithms.

A high-throughput PCI-X interface ensures plenty of bandwidth to rapidly move data. An assortment of plug-in I/O extension modules offers great flexibility to interface various analog and digital I/O signal types. By streamlining the design and limiting the features to core functions needed for fast and easy implementation, Acromag makes FPGA-based computing accessible to many more applications. Boards start at \$4,950 with extended temperature (-40° to 85°C) and conduction-cooled models available.

Acromag  
Wixom, MI.  
(248) 295-0310.  
[[www.acromag.com](http://www.acromag.com)].

### FPGAs Enable 24 Serial sFPDP Channels

Using FPGAs in conjunction with the Serial sFPDP (sFPDP) interconnect makes for a powerful combination. Such a solution has enormous benefits for radar, sonar, SIGINT, ELINT, digital signal processing, FFTs, communications, software radio, encryption, image processing, prototyping, text processing and other processing-intensive applications. Serving exactly



that arena, Annapolis Micro Systems offers its FPGA-based WILDSTAR family that provides 24 sFPDP channels per VME slot. The Annapolis sFPDP Cards (UNI3 or UNI6) come with an easy-to-use Serial sFPDP interface supporting up to 12 lanes of 2.5 Gbit Full Duplex data. Three frame types are supported: Normal Data Fiber Frame, Sync without Data Fiber Frame and Sync with Data Fiber Frame in Point-to-Point Mode. The card has three individually configurable, industry-standard 4X connectors, providing 4 lanes per connector, with dedicated signal conditioners to ensure clean communication. It supports up to 7.5 Gbytes/s full duplex per I/O card and a wide variety of readily available copper and fiber cables.

Up to two serial I/O cards and two LVDS I/O cards can reside on each WILDSTAR 4 or WILDSTAR 5 VME/VXS main board, with half that number for the PCIX or PCIe. The sFPDP card (UNI6) also supports Rocket I/O protocol at up to 75 Gbit full duplex per I/O card, three ports of 10G full duplex InfiniBand per I/O card or 10G full duplex Ethernet per I/O Card. No other FPGA board vendor can match the volume of data we can send straight into the heart of the processing elements and then straight back out again. WILDSTAR 4 for PCI boards starts at about \$13,500 and UNI6 I/O Mezzanines start at about \$4,500.

Annapolis Micro Systems Inc  
Annapolis, MD.  
(410) 841-2514.  
[[www.annapmicro.com](http://www.annapmicro.com)].

### Advanced MC Card Sports Altera Stratix IV GX FPGA

The AMC mezzanine form factor is destined to have a bright future in military applications, particularly when used as slot card modules in a MicroTCA system. BittWare's S4-AMC (S4AM) uses the Altera Stratix IV GX FPGA to blend performance and flexibility. The S4AM can be populated with multiple densities of the Stratix IV GX FPGA, from 230K to 530K logic elements (LEs). At the heart of the S4AM is the state-of-the-art Altera Stratix IV GX FPGA which provides up to 530K equivalent LEs, 20 Mbits of RAM and 1,024 embedded multipliers in addition to up to 27 full-duplex, multi-gigabit transceivers. Twenty-four of those transceivers are capable of supporting PCI Express Rev 2.0 and Serial RapidIO Rev 2.0.

The S4AM connects the Stratix IV GX transceivers to three ports (1, 2 and 3) in the



AMC commons options region, and 16 ports (4 to 15, 17 to 20) in the AMC fat pipes region. These 19 ports provide a network data and control switch fabric interface on the AMC connector. Additionally, four of the Stratix IV GX transceivers are made available on the AMC front panel via an Infiniband-type connector. All AMC clocks are also connected to the Stratix IV GX FPGA to facilitate system synchronization. Supporting processing and I/O expansion, the S4AM provides a Front-panel Module (FM), which is connected to the Stratix IV GX FPGA via eight SerDes and 68 pairs of LVDS I/O. This VITA57-like proprietary module site can be populated with FMs provided by BittWare or with modules developed by third parties or customers. The board is priced at \$5,000.

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



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## FPGA Card and SBC Form 3U VPX Solution

FPGA processing solutions work best in conjunction with an efficient general-purpose SBC. With that in mind, Curtiss-Wright Controls Embedded Computing has announced a multi-card 3U VPX solution for rugged deployed embedded FPGA processing applications. With the interoperability of its 3U VPX FPE320 FPGA processor card, 3U VPX VPX3-450 FPGA processor and 3U VPX VPX3-127 SBC running Wind River's VxWorks, Curtiss-Wright Controls



delivers an unmatched level of flexibility for addressing high-performance 3U VPX systems applications. Using this solution, system integrators can now utilize the largest Xilinx Virtex-5 FPGAs currently available in a small form factor embedded system powered with a high-performance Power Architecture general-purpose processor. The FPE320 supports Virtex-5 LXT, SXT, or FXT devices. With its onboard FMC expansion site the FPE320 supports optimized FPGA I/O. The VPX3-450 FPGA processor combines the computing power of a Xilinx Virtex-5 FPGA with the high-performance floating-point capabilities of the Freescale 8640D dual-core Power Architecture processor.

The VPX3-127 features a Freescale MPD8640D processor and can be expanded via its onboard PMC/XMC expansion site. The VPX3-127 uses PCI Express to connect to the FPE320 and/or to the VPX cards. All three boards are available in a combined development chassis that includes FPE320 and/or VPX3-450 cards and a VPX3-127 card. The FPE320, VPX3-450 and VPX3-127 are available in both commercial and rugged versions. Pricing for the FPE320 starts at \$19,950. Pricing for the VPX3-450 starts at \$12,500. Pricing for the VPX3-127 starts at \$6,744.

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

## ADC PMC Module Boasts FPGA Engine

As signal processing becomes increasingly mission-critical, it is becoming vital to process as much raw incoming data as possible at the front end, close to the receiving antenna, freeing the back-end processor to perform high-speed interpretation of the data. GE Fanuc's ICS-1556B does just that with its four 14-bit ADCs sampling synchronously at frequencies up to 400 MHz, and a fast (64-bit/133 MHz) PCI-X interface. The powerful signal processing capability provided by the FPGA allows the user to perform standard functions such as



wideband DDC (digital down conversion), FFT (Fast Fourier Transform) and time stamping—or to implement any required functionality. A Hardware Development Kit (HDK) provides support for users who wish to implement their own signal processing algorithms in the FPGA. Alternatively, GE Fanuc's FPGA applications programming team can develop FPGA cores specific to customer needs.

The board is designed for demanding communication applications such as software defined radio, signals intelligence (SIGINT), digital receivers and tactical communications where the requirement is to convert analog data into digital information in as close to real time as possible. The ICS-1556B features a very high sampling rate (400 MHz) and very high resolution (14-bit): its combination of high sample rate and high resolution is unsurpassed in the industry. The ICS-1556B can be used with any type of carrier card that accepts a PMC module, including VME, VPX, PCI and CompactPCI.

GE Fanuc Intelligent Platforms  
Charlottesville, VA.  
(800) 368-2738.  
[www.gefanucembedded.com].

## FPGA Enables Flexible 3U cPCI Solution

For military systems in particular there's always a formidable challenge when it comes to balancing I/O functionality with high integration. Addressing that issue, MEN Micro introduced a new I/O concept on 3U CompactPCI. The interfaces of the F215 can be configured as desired—allowing the user nearly unlimited application possibilities for this card.



The physical layer can be realized individually for each channel by means of SA-Adapters. SA-Adapters are small universal boards that provide the line drivers for I/O functions. This concept allows the ability to add additional I/O interfaces to the F215, which enhances flexibility when combining all kinds of interfaces and with regard to different isolation requirements.

Two SA-Adapters can be mounted directly on the F215, and are connected using a 9-pin D-Sub connector each. If you want to use further adapters, up to a maximum of six, you need more front-panel space. These adapters are connected to the carrier via ribbon cable. The F215 comes in a standard configuration with five predefined functions on an 8 HP front panel: two CAN interfaces, two UARTs and one 8-channel binary I/O interface. All of the board's I/O functions are realized by means of an FPGA, making it a very flexible, inexpensive solution for serial I/O. The F215 was designed for use in rugged environments. All of its components are specified for an operating temperature of -40° to +85°C. In addition, they are soldered on to meet the high demands of shock and vibration.

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

### XMC Digital Receivers Employ FPGA Technology

FPGAs are providing a vital function in today's signal processing-based military systems. FPGA processing lets systems convert incoming analog signals quickly into a digital format, and do critical preprocessing of the data before sending it along. Feeding such needs, Mercury Computer Systems provides a series of high-performance, Virtex-5-based digital receivers. The Echotek Series DCM-V5-XMC



digital receiver features the latest in A/D and D/A technology, allowing for high-speed/high-resolution data conversion while still preserving the quality of the original signal. It implements either a Virtex-5 SX95T or LX155T FPGA, which can be programmed by the end user for customer-specific application features.

Each Virtex-5 FPGA is accompanied by both DDR-II-SDRAM and QDR-II-SRAM memory chips; the memory is available for buffering input data streams and for supporting computationally intense applications. This set of flexible resources delivers unique capabilities, such as multi-board coherency, making the new product especially well suited for beamforming and direction-finding, as required by many radar, signals intelligence, electronics intelligence and communications applications.

Mercury Computer Systems  
Chelmsford, MA.  
(978) 256-0052.  
[www.mc.com].

### FPGA Computing Platform Leverages PCI Express

PCI Express was a latecomer to the switched fabric wars, but its adoption into the embedded arena now ranks as wider than all its rivals. Riding that wave, the BenONE PCIe from Nallatech includes PCI Express capability and incorporates Xilinx Virtex-5 technology to provide users with a low-cost FPGA carrier card featuring an onboard Xilinx Virtex-5 FPGA, high-bandwidth 8-lane PCI Express host interface. The onboard DIME-II expansion module slot supports a wide range of high-performance analog and digital I/O interfaces, memory types and Xilinx User FPGAs.

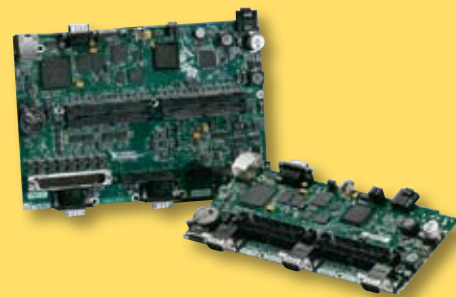


The BenONE PCIe allows developers to take advantage of the PCI Express bus standard providing higher performance, increased flexibility and scalability as well as providing a seamless migration path for next-generation FPGA systems. With the FPGA industry's first built-in PCI Express Endpoint, Virtex-5 FPGAs give designers an off-the-shelf solution that saves time, reduces power consumption and frees up valuable FPGA fabric resources. The host interface is a x8 PCI Express connector for a theoretical maximum performance of 2 Gbytes/s full duplex. Software support includes the Nallatech FUSE API for Windows and Linux. FUSE also includes an application and development API for C/C++.

Nallatech  
Eldersburg, MD.  
(410) 552-3352.  
[www.nallatech.com].

### FPGA Cards Provide Reconfigurable I/O

One way that today's military system designers are exploiting FPGAs is by using them to create reconfigurable I/O systems for data acquisition. Serving exactly such needs, National Instruments offers a family of single-board reconfigurable I/O devices that offer engineers and scientists a low-cost, integrated hardware option for deploying embedded



control and data acquisition applications. The eight new sbRIO-96xx devices combine an embedded real-time processor, reconfigurable FPGA and analog and digital I/O on a single printed circuit board (PCB), making them ideal for applications that require flexibility, high performance and reliability in a small form factor. Engineers and scientists can use the NI LabVIEW graphical system design platform to customize NI Single-Board RIO hardware as well as develop all aspects of their embedded systems for increased productivity and shorter time-to-market.

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

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



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## FPGA Processing Boards Roundup

### Dual FPGA PMC Targets SDR and Radar

Wideband data converters and multichannel synchronization are high priorities in military radios and new wideband radar applications. Feeding those needs, the Model 7156 Dual Channel Transceiver is Pentek's latest PMC module, comprising two 400 MHz A/D converters with 14-bit resolution and two 800 MHz D/A converters with 16-bit resolution. Both data converters on the 7156 use new Texas Instrument monolithic devices, the ADS5474 and the DAC5688, respectively.



This PMC features a built-in clock synthesizer that accepts an external 5 or 10 MHz reference and synthesizes two phase-locked, low-jitter clocks delivered separately to the A/D and D/A converters. A front panel digital connector synchronizes multiple 7156s to support beamforming, diversity combining and phased array applications. The TI DAC5688 provides an interpolation filter and a digital upconverter to translate a complex baseband digital signal to an IF frequency up to 300 MHz and then deliver it through the D/A converter as an analog IF output. The dual FPGA architecture of the 7156 offers tremendous processing power with the flexibility to handle custom DSP algorithms in the signal processing FPGA and custom I/O functions in the interface FPGA. The price for the Model 7156 with the Windows operating system begins at \$11,500.

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

### VXS Card Offers 1.3 TeraMAC/s Signal Processing

Multichannel applications such as beamforming, Radar, SIGINT, COMINT and wireless communications have a seemingly endless appetite for high-speed data conversion. With that in mind, TEK Microsystems has released its QuiXilica Atlas-V5 VXS product. The new Atlas-V5 provides eight channels of 12-bit 1 Gsps (Gigasamples per second) analog inputs streaming up to 12 Gbytes/s into three Xilinx Virtex 5 FPGAs in a single 6U VME/VXS slot. The Atlas-V5 is the first product to support 1 Gsps ADC devices with 12 bits of resolution.

Atlas-V5 uses eight 12-bit ADC digitizer channels each performing at up to 1.0 Gsps combined with three Xilinx Virtex-5 FPGAs. Each channel has an input bandwidth of 1.5 GHz, supporting operation up to the third Nyquist band, and uses a single ADC without interleaving. The front-end FPGAs, typically SX95T devices, each accept four channels of input data for initial processing. The outputs of the front-end FPGAs are then combined in the back-end FPGA for additional processing and output via the VXS backplane or front panel QSFP fiber optic links at aggregate rates up to 3.75 Gbytes/s. Like all of the QuiXilica-V5 products, the Atlas-V5 is available for a wide range of operating environments, including rugged air- and conduction-cooled for deployed applications.

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



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*Editor's Note: This product was mistakenly left out of the Technology Focus: Multicore Boards Roundup on p.52. of our April issue. We apologize for the oversight.*

## Quad-Core Intel Xeon-Based VME SBC

The multicore trend has swept through the military embedded computing industry, and military system developers are embracing it with open arms. Along just such lines, Themis Computer's XV1 is a VME SBC designed to meet the needs of customers who require quad-core performance for their demanding applications. The Quad-Core Intel Xeon Processor on the board using Intel's new 45nm process brings workstation and server performance to the VME market.

Themis' XV1 is based on the low-power, Quad-Core Xeon L5408 processor clocked at 2.13 GHz, and Intel's 5100 chipset used in high-performance Xeon servers. The 5100 chipset memory controller supports ECC to maintain the highest system integrity, and provides the bandwidth necessary to support high-performance I/O. XV1 memory is expandable to 8 Gbytes of DDRII memory. The XV1 base configuration includes two Gbytes of DDR II memory, three Gbit Ethernet ports, two SATA II ports, four USB 2.0 ports and two XMC/PMC slots. An onboard ATI ES1000 video controller is provided with either front or rear panel VGA access.

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

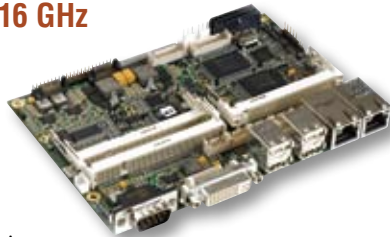


## 3.5-Inch SBC Sports 2.16 GHz Core 2 Duo CPU

Busless, stand-alone SBCs are capturing a growing niche in the defense realm. Avoiding the size, weight and power overhead of a slot-card backplane approach can be very beneficial. With that in mind, Advanced Digital Logic (ADL) announced the release of its ADL945HD 3.5-inch form factor computer board. The ADL945HD is based on the Intel Celeron M / Core Duo / Core 2 Duo and the Intel 945GM chipset processors, with clock speeds up to 2.16GHz. The Intel Generation 3.5 graphics engine is integrated into the chipset, along with the Intel Graphics Media Accelerator 950 (Intel GMA 950), and can drive either a CRT and/or LVDS LCD.

The memory is added by way of a SODIMM200 socket and can accept up to four Gigabytes of DDR2 DRAM. The ADL945HD power management incorporates ACPI/APM functions. The standard ADL945HD also incorporates EIDE, SATA, 4x Onboard External USB 2.0, 4x Internal USB 2.0, 2xRS-232 COM ports, PS/2 Keyboard and Mouse, parallel printer, AC97 Sound, separate 10/100Mbit and Gbit Ethernet LAN, and more.

Advanced Digital-Logic, San Diego, CA.  
(858) 490-0597. [[www.adl-usa.com](http://www.adl-usa.com)].



## FPGA Family Marries Low Power with Security

Advanced security features such as anti-tamper capability and design separation have been seen on larger FPGAs. Power-sensitive applications like military radios have been hungry for those security features too, but must shun larger FPGAs because they draw too much wattage. Offering the best of both worlds, Altera has announced a new low-power FPGA family with security features. The new Altera Cyclone III LS FPGAs offer the highest logic, memory and DSP density per board area. These devices are the lowest power FPGAs at less than 0.25W of static power for 200K logic elements (LEs).

The security features of the Cyclone III LS FPGA include a comprehensive information-assurance design suite that offers anti-tamper, design-security and design-separation capabilities. To protect highly sensitive information, the Cyclone III LS FPGAs' anti-tamper features include JTAG port protection, tamper monitoring and cyclical redundancy check (CRC). Offering another layer of protection, these devices feature a proven industry-standard AES 256-bit encryption key for design security. Where size, weight and power (SWaP) requirements are crucial, the design-separation Cyclone III LS FPGAs allow a single-chip solution for next-generation military applications such as software-defined radio (SDR), crypto-subsystems and crypto modernization equipment where long battery life, density at the lowest power, and small board space are required.

Altera, San Jose, CA. (408) 544-7000. [[www.altera.com](http://www.altera.com)].

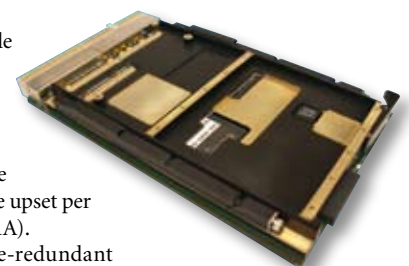


## Rad-Hard 3U cPCI Board Does 1 GHz Under 10W

Rugged military requirements are one thing, but outfitting an embedded computer to work in space takes a whole different level of ruggedness. Aitech Defense Systems meets those needs in the S950-02, an enhanced, 1 GHz version of its space-flown S950 3U CompactPCI (cPCI) radiation-tolerant SBC. Using the high-performance PowerPC 750GX running at 1 GHz, coupled with silicon on insulator (SOI) PowerPC technology, the new conduction-cooled S950-02 combines a significantly low overall board power consumption of less than 10W with configurable processor speeds and better radiation tolerance to provide an effective unshielded total ionization dose (TID) greater than 15 krad (Si). The highly reliable SBC provides a low single event upset (SEU) rate of less than one upset per 900 days of operation in LEO with considerations for the worst case solar flare and the South Atlantic Anomaly (SAA).

To protect onboard memory resources from radiation effects, the S950-02 incorporates 128 Mbytes of triple-redundant SDRAM with three bits per cell. On the rad-tolerant FPGA, a voting mechanism performed only on the read cycle allows for data correction before sending to the CPU or PowerPC bus. One Mbyte of dual-redundant boot flash stores the onboard Boot firmware and ensures full data integrity in the event of corruption during the boot-up sequence.

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





## Virtex-5Q FPGA Version Targets Defense Systems

Xilinx has introduced the Virtex-5Q family of FPGAs for the Aerospace and Defense (A&D) industry. Virtex-5Q FPGAs provide the silicon foundation for a host of applications, including Xilinx's single-chip cryptography (SCC) targeted design platform aimed at accelerating development of next-generation secure communications systems. The new Virtex-5Q family delivers the highest performance, largest capacity FPGAs with ruggedized packaging and advanced cryptographic capabilities, and is the industry's most comprehensive portfolio of defense-grade devices that are also available in bare die form for customized form factors.

The inherent re-programmability and SCC technology advances of Virtex-5Q FPGAs overcome the limitations of traditional ASIC and ASSP approaches, making them ideal for secure communications applications, as well as for electronic warfare, aircraft and transport vehicles; C4ISR systems (Command, Control, Communications, Computer, Intelligence, Surveillance and Reconnaissance); radar; and missiles and munitions.

Xilinx, San Jose, CA. (408) 559-7778. [[www.xilinx.com](http://www.xilinx.com)].

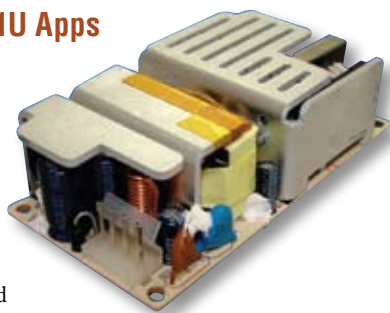


## 65W Open-Frame Power Supply Aims at 1U Apps

The 1U server form factor is creeping into a number of defense applications such as SATCOM on-the-move. Phihong has developed two single-output, 65W, open-frame power supplies designed to fit 1U applications. Available in 12, 24, and 48V output models, the power supplies, designated the PSA065 and PSA065M series, comply with the CE low-voltage directive and feature a low-profile 2 x 4-inch footprint.

Both the PSA065 and PSA065M power supply series operate at more than 80 percent efficiency at maximum load and are extremely reliable, featuring a minimum of 250,000 hours MTBF in standard operating conditions. The power supplies can tolerate temperatures ranging from 0° to +50°C and humidity ranging from 5 to 95%. The series also feature over-voltage and over-current protection with auto-restart. The PSA065M also features a maximum leakage current of 100 uA. Both series measure 4 inches in length by 2 inches in width by 1.11 inches in height and weigh 6.35 ounces. The suggested unit price for the PSA065 is \$22.08 in single piece quantities, and the suggested unit price for the PSA065M is \$23.98 in single piece quantities.

Phihong USA, Fremont, CA. (510) 445-0100. [[www.phihong.com](http://www.phihong.com)].

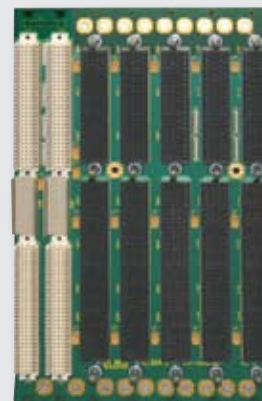


## 288-Port Physical Layer Switch Adds T1/E1/J1 Support

High-density electronic switches can function as essentially an electronic patch panel that provides military network designers with greater flexibility and power. It significantly reduces setup time compared to older, manual patch panel solutions. Curtiss-Wright Controls Embedded Computing has announced the availability of a new T1/E1/J1 telecommunication port card, further expanding the capabilities of their 144-port and 288-port GLX4000 series physical layer switch. The GLX 4000, a "4th Generation" Layer 1 switch, offers flexible, expandable crossbar switch performance for industrial, defense and aerospace applications. The GLX4000 is a non-blocking, multi-protocol physical layer switch that enables any serial digital signal input, up to 10 Gbits/s, to connect to any single output.

The new Port Card for the GLX4000 physical layer switch series supports T1/E1/J1 international telecommunication line interfaces. Each T1/E1/J1 Port Card supports 24 bi-directional RJ48C ports, individually configured for T1, E1, or J1 data rates. The T1/E1/J1 Port Card runs at data rates of 1.544 Mbits/s (T1/J1) and 2.048 Mbits/s (E1). The GLX4000 is a non-blocking, Layer 1 switch that enables any of a wide variety of input signals to be connected to any of its 144 or 288 output ports.

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



## VPX Mesh Hybrid Backplane Boasts Seven Slots

The military world won't switch over to VPX overnight. There's a lot of legacy VME that needs to be accommodated. Hybrid backplanes are a good way to interface VPX with legacy VME slots. Elma Bustronic now offers a VPX Hybrid Backplane with 5 mesh slots and 2 legacy VME64x slots. The VPX architecture per the VITA 46 specification allows for optional use of the VMEbus. Many applications will reuse existing VME64 extensions (VME64x) cards. This allows legacy cards to be used in conjunction with the performance of VPX's high-speed differential signals. Bustronic's new hybrid solution provides two of these slots in addition to 5 VPX slots in a 6U high backplane.

The 5+2 Slot VPX Hybrid backplane features a 16-layer controlled impedance stripline design. The backplane provides RTM support. Bustronic offers other VPX configurations in a 3U 6-slot, 6U 5-slot, 6U 17-slot Hybrid and has developed a wealth of custom configurations. Pricing for the 5+2 slot VPX Hybrid backplane is under \$2,500 depending on volume and configuration requirements.

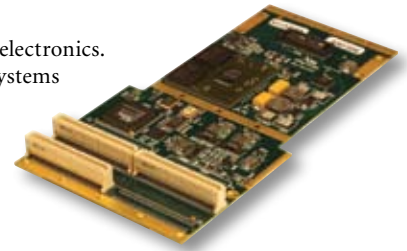
Elma Electronic, Fremont, CA.  
(510) 490-7388. [[www.elma.com](http://www.elma.com)].

## Rugged Graphics PMC/XMC Supports Dual Displays

The same silicon designed for advanced gaming systems is enabling today's generation of military graphics electronics. Gone are the days when a graphics controller required an entire system of its own. Today power graphics subsystems can easily fit in a rugged mezzanine solution. Case in point, Extreme Engineering Solutions's XPort4100 is a conduction- or air-cooled XMC/PMC solution featuring AMD Radeon E2400 graphics processor supporting two independent displays.

XPort4100 includes 128 Mbytes of GDDR3 SDRAM, support for dual independent displays and UXGA 1600 x 1200 DVI resolution. The card provides a PCI Express interface. Operating system support includes Linux LSP and Windows drivers. XPort4100 is shipping today. Pricing starts at \$2,995.

Extreme Engineering Solutions, Middleton, WI. (608) 833-1155. [www.xes-inc.com].



## PC/104-Plus Card Does Multi-Channel Video

Military information requirements are getting even more sophisticated. Instead of static maps and text, the new trend is high graphical blends of video, audio and graphics. Enabling the video portion of the equation, Advanced Micro Peripherals' new VAC2000 PC/104-Plus multi-channel video annotation and overlay controller board features two real-time analog NTSC/PAL input channels. VAC2000 offers industry leading flexibility in mixing these with one another or with computer generated graphics and text for TV and VGA output.

The VAC2000 accepts either two S-Video inputs, or up to four composite video inputs from video cameras, DVRs, TV broadcasts or other NTSC/PAL sources. Each video input can be alpha blended with another video channel or with graphics using one of 256 translucency levels from opaque to transparent. The VAC2000's output can simultaneously drive a composite or S-Video TV video monitor (RS170), analog VGA screen and a DVI (PanelLink) flat panel display. A preview output can also monitor the input video channels. Applications include merging of daylight and infra-red video images for military environments, text annotation of video for traffic monitoring, superimposition of crosshair graphics onto battle zone target area video, visible watermarking, command and control consoles, vehicle telematics, medical instrumentation and security installations.

Advanced Micro Peripherals, Witchford, Cambridgeshire, UK. +44 1353 659 500. [www.ampltd.com].



## Portable System Does Wideband Signal Recording and Generation

The emergence of highly portable, sophisticated test instruments has changed the way military system developers can do field work. Along those lines, Signatec released the SIG-PRG series, its portable high-speed data acquisition and waveform generation systems that combine the features of oscilloscopes, spectrum analyzers and signal generators with high-speed RAID storage to create advanced turnkey wideband signal test systems.

With two analog signal recording channels at up to 160 MHz sampling rate, two analog I&Q waveform generation channels at up to 1 GHz sampling rate, 16-bit resolution for both the A/D and D/A channels and an analog capture bandwidth from 100 KHz to 600 MHz, the SIG-PRG system enables users to record and play back continuous analog signals with no break in the signal record at its peak 400 Mbyte/s data rate. By embedding compatible high dynamic range signal capture and signal generation channels within a portable, lightweight chassis with terabytes of data storage, customizable real-time data processing and easy-to-use turnkey system software, the system offers engineers a powerful new tool for high frequency wideband signal applications that require significant data storage capabilities.

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



## PC/104-Plus Board Sports Three GbE Controllers

Ethernet has found its way onto nearly every embedded computing form factor on the market, and PC/104 is no exception. MPL introduces a rugged Gigabit Ethernet Family called TRIGET, which is specially designed for rugged applications. Extended temperature versions for -40° to +75°C are available as well. The TRIGET Family consists of highly integrated, flexible and robust PC/104-Plus-compliant Ethernet modules. With a single PC/104-Plus module, a system can be expanded with up to three Gbit Ethernet interfaces. By using a PCI-to-PCI Bridge on the module, the TRIGET requires only one slot on a PC/104-Plus stack. Therefore, the stack still can be expanded with up to three additional PC/104-Plus cards.

The card features up to three Gigabit LAN controllers using only one PC/104-Plus slot. The card has status LEDs on board, RJ45 or 2 mm lockable headers and an adapter kit for remote connectors. To match different system requirements, two interface options and two mechanical versions are offered. Choose between RJ45 or 2 mm lockable headers as well as different mechanical sizes. If a fiber optic interface is needed, just combine the TRIGET with a TX2FX media converter.

MPL AG, Dättwil, Switzerland. +41 56 483 34 34. [www.mpl.ch].





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## 8-Channel Resistance and RTD Simulator Rides VME

It may be getting old in the tooth, but VME continues to enjoy a huge installed base in the military market. And new products keep rolling out to serve the multitude of tech refresh programs out there. Highland Technology's V420 is a VME solution that simulates resistors, RTDs, thermistors, strain gages and load cells, and remains accurate for DC, AC, or pulsed excitation. Users directly program resistances or simulated RTD temperatures. Unlike competitive products that switch strings of resistors with mechanical relays, the V420 is quiet and reliable, and resistance changes are fast and monotonic with no contact bounce or transient switching errors.

The V420 simulates eight 2- or 4-wire resistive sensors. Channels are individually programmable in four ranges, from 5 ohms to 65.5K ohms and operate from microvolts to 24V/50mA. Channels are fully isolated with up to 750V common-mode range with overvoltage protection up to 50V. The module provides channel calibration check capability and optional built-in self-test.

Highland Technology, San Francisco, CA.

(415) 551-1700. [[www.highlandtechnology.com](http://www.highlandtechnology.com)].



## PCI-104 Card Is Relay, Isolated Digital Input Solution

The venerable ISA-bus hasn't completely gone away, but the PC/104 crowd has a version of its form factor family that puts ISA out of the way, and focuses on PCI. The Industrial Automation Group of Advantech's latest PCI-104 offering is the PCM-3761I, a form C type eight-channel relay and eight-channel isolated digital input PCI-104 card machine and production automation. The PCM-3761I's relay allows operators to retain output values even in the event of an unexpected system reboot. The input channels support 2,500 VDC and a wide input range of 5 to 30V, allowing it to be resistant from surge or noise interference.

Moreover, the PCM-3761I provides a newer variation on the PC/104 standard, PCI-104, which is designed for embedded computing environments. PCI-104 is replacing the ISA bus, which is being phased out of the industry due to speed and compatibility issues with newer processors. PCI-104 is stackable and fast, providing reliable anti-vibration functionality.

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



## PICMG 3.1 Board Serves Up 2.4 GHz Quad-Core Opteron

For a lot of military applications, the priority is to have the fastest computing engine possible. Along those lines, Win Enterprises offers a PICMG 1.3 form factor motherboard that supports the low-power 45nm Quad-Core AMD Opteron (Shanghai) processor. This energy-efficient version of the Shanghai processor (2379HE) runs at 2.4 GHz and requires 55 watts per quad-core processor. The MB-60580 can support one or two of the high-performance, low-power processors.

The 45nm Quad-Core AMD Opteron processor draws up to 35 percent less power at idle compared to the previous generation of Opteron processors while delivering up to 35 percent more performance. The MB-60580 is used in both fixed-station and mobile platforms that support field applications. Additional features of MB-60580 include the PICMG 1.3 form factor measuring 13.330 x 4.976 inches (33.86 cm x 12.64 cm), an NVIDIA nForce Professional 2200 chipset and two memory slots with up to 8 Gbytes and optional 4 slots with up to 16 Gbytes. The MB-60580 supports Windows XP, Windows XP 64-Bit Edition, 2000 Server and the following additional operating systems: BSD and Redhat Linux. Pricing for the MB-60580 begins at \$834 in OEM quantities.

WIN Enterprises, North Andover, MA.  
 (978) 688-2000. [[www.win-ent.com](http://www.win-ent.com)].

## MIL-STD-1553 and CANBus Together on VME, cPCI and PCI

The magic of semiconductor integration has enabled a new generation of I/O boards that feature more than one function on the same card. Exemplifying this trend, North Atlantic Industries (NAI) has announced the availability of MIL-STD-1553 and CANBus functions for its wide range of VME, cPCI and PCI multi-function boards. Known as N7, N8 (MIL-STD-1553) and P6 (CANBus) modules, they join the already extensive list of standard function modules that are available from NAI.

The N7 and N8 modules provide two dual-redundant MIL-STD-1553B Notice two interface channels. Each channel can be configured to act as a Bus Controller (BC), Remote Terminal (RT) or Monitor (MT). Features include 128 Kbyte (64K words) onboard memory per channel, register compatibility with the Summit family of devices from Aeroflex, support for automatic message return and Automatic Health Monitoring (BIT). The P6 module provides four independent, isolated channels of Control Area Network (CAN) serial data bus links, conforming to the ISO 11898 International Standard. Both CAN A and B are supported. The boards have operating temperature ranges of -40° to +85°C and 0° to +70°C. Pricing for 100 pieces of the 64C2 VME Board with the MIL-STD-1553 function starts at \$3,300.

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





### ATCA Quad-Core Node Blade Features Xeon 5500s

ATCA is finding its niche in defense applications. If for no other reason, ATCA is the only advanced form factor in a larger than 6U size. A new AdvancedTCA 10 Gigabit node blade from Kontron is designed with the highly anticipated Intel Xeon 5500 Platform based on the latest 45nm quad-core processors. The Intel Xeon processor 5500 series, based on the latest Intel microarchitecture, includes an Integrated Memory Controller with DDR3 support and Intel QuickPath Technology, Intel Turbo Boost, Technology and Intel Hyper-Threading Technology.

Compliant to PICMG 3.1 Option 9, Option 2, the Kontron AT8050 features 10 + 10 Gigabit Ethernet on the Fabric Interface, plus two 10/100/1000 Mbit/s Ethernet on the Base Interface and two 10/100/1000 Mbit/s Ethernet via the Front Panel or RTM. Expansion features include one AdvancedMC mid-size slot supporting PCI Express x4, and SATA / SAS interfaces. The associated Intel 5520 chipset, which supports up to 36 lanes of PCI Express 2.0 and directly assignable I/O for virtualization (VT-d), offers significant new enhancements to accelerate I/O traffic and lower CPU utilization in both native and virtualized environments.

Kontron, Poway, CA. (888)-294-4558. [[www.kontron.com](http://www.kontron.com)].

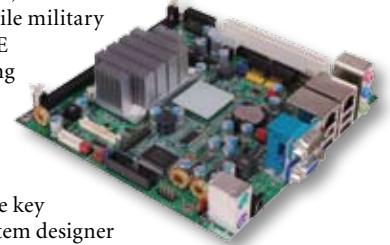


### Pair of Atom-Based Boards Target Low-Power Apps

Size, Weight and Power (SWaP) has become the new mantra for a variety of mobile military systems. Serving those needs, GE Fanuc offers two boards featuring the Intel Atom processor that provide PC functionality in a broad range of applications where low power consumption and minimal heat dissipation are key requirements, but where the system designer cannot compromise on I/O capability. The bCOM2-L8000 and mITX-945S-ED from GE Fanuc Intelligent Platforms are both based on the 1.6 GHz version of the Atom.

The bCOM2-L8000's I/O capability includes one Gigabit Ethernet port, two Serial ATA interfaces, support for up to two IDE devices and eight USB 2.0 ports, while expansion can be achieved via three PCI Express lanes, with support for up to four devices via the PCI bus—making it a highly flexible choice. The mITX-945S-ED is equally well provided with I/O functionality, and includes two Gbit Ethernet ports, PCI Express and PCI expansion slots, a COM port, two Serial ATA ports, support for up to two IDE devices and four (optionally expandable to eight) USB 2.0 ports.

GE Fanuc Intelligent Platforms, Charlottesville, VA. (800) 368-2738. [[www.gefanucembedded.com](http://www.gefanucembedded.com)].



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## 2.0 GHz Xeon CPUs Ride 6U CompactPCI

The demand for compute-density hasn't slowed at all in the military realm. The need to pack faster, multicore processing in the same space is as strong as ever. One of the first product families to feature the quad core



2.13 GHz Intel Xeon processor L5518 or the dual core 2.0 GHz Intel Xeon processor L5508, is a new family of 6U CompactPCI boards, the PP66x/07, from Concurrent Technologies. Based on 45nm process technology and the new Intel microarchitecture, formerly codenamed "Nehalem," both processors are from the Intel embedded roadmap, which offers at least seven-year availability. With up to 64 Gbytes of DDR3-1066 ECC SDRAM, two 10 Gigabit Ethernet ports, and several SAS and SATA300 disk interfaces, the PP 66x/071 boards are particularly suitable for CPU-intensive processing applications within the defense market sector.

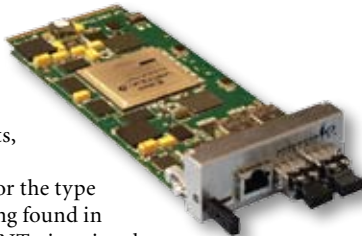
For high-performance I/O, control and data processing flexibility, the PP 66x/071 supports, via the front panel, a PMC/XMC site as well as optional I/O interconnections via two 10 Gbit Ethernet ports (copper or optical). The rear connectors provide an interface to an optional onboard 8-port hardware RAID Controller supporting SAS and SATA300 drives.

Concurrent Technologies, Woburn, MA.

(781) 933-5900. [www.gocct.com].

## Ethernet AMC Delivers 10 Gbit Packet Inspection

The military has warmed to Ethernet in a big way. The V3021 from AdvancedIO Systems is a dual-channel 10GbE Advanced Mezzanine Card (AMC) that includes two front-panel SFP+ ports, a Xilinx Virtex-5 FPGA and SRAM memory. The V3021 is optimized for the type of real-time data flow and processing found in applications such as COMINT, ELINT, situational awareness systems, security, and network monitoring and optimization.



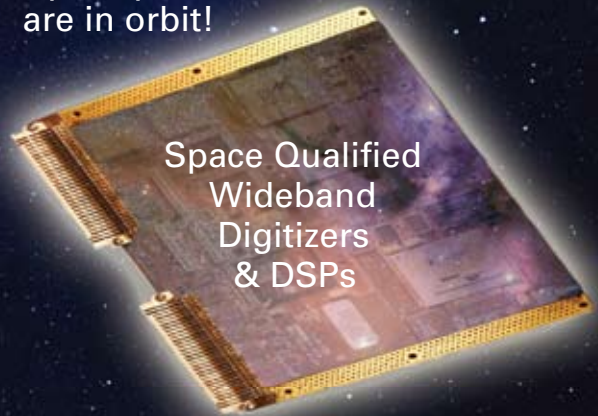
Designed for real-time embedded applications running in MicroTCA and AdvancedTCA platforms, the V3021 facilitates 10 Gbit line-rate packet inspection and manipulation via its high-performance architecture. Its software reconfigurability enables a common hardware platform to be used for multiple missions and applications. The card's FPGA-based processing engine allows gate-level control to meet the highest requirements for determinism in both packet and signal processing algorithms. Key features of the V3021 include two 10-Gbit Ethernet SFP+ optical ports, the Xilinx Virtex-5 XC5VLX110T FPGA (up to LX330T / FX200T optional) and PCI Express x4 or x8 fat pipes. Optional application acceleration IP and user programmability software kits are also available.

AdvancedIO Systems, Vancouver, Canada.

(604) 331-1600. [www.advancedio.com].

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## Command Consoles Offer Choice of Configurations

Rugged command and communication consoles that may be used in military applications are available from Optima. Based on standard modules, the rugged console range can easily be modified to suit most applications and ensures optimum access to critical information in command and control systems. The user-friendly design of Optima's consoles accommodates typical floor layout requirements: straight, L, or U-shaped styles. Optional ergonomically designed laminate writing desks provide a comfortable work surface and maximum leg area. With removable sides, rear and top panels, the installation and accessibility of the equipment is fast and easy.

Optima can ruggedize the consoles in various ways. This includes thicker gauge aluminum frames, extra mounting and supports, cross bracing for enclosures, spot welding, T-frame supports, and more. Optima offers a range of Mil-Spec, Harsh Environment and Seismic cabinets enclosures and racks that are geared for rugged applications. The company also offers ruggedized versions of its products for Mobile environments. This design background gives Optima one of the most experienced teams for rugged enclosure and command center/console designs.

Optima, Tucker, GA. (770) 496-4000. [[www.optimaeps.com](http://www.optimaeps.com)].



## 1U MicroTCA Box Provides Powerful 1U Solution

The MicroTCA has a lot going for it that military system developers are attracted to. It's particularly suited to IP-based communication. Serving those needs, a new member of the IPnexus family from Performance Technologies provides a wide range of flexible options to meet design criteria for telecom and networking, as well as aerospace and defense communication systems. Fully integrated and operational right out of the box, the AMP5071 enables embedded engineers to begin their new product development faster, without all the time spent integrating disparate technologies from multiple vendors into a working prototype. The fully integrated system is ideal for applications such as radar gateways, military VoIP/SIP servers and network equipment.

The AMP5071 comes integrated with a choice of processing Advanced Mezzanine Cards (AMCs). Developers can select an Intel Core 2 Duo processor, or a Freescale MPC8641D dual-core 1 GHz PowerPC processor. Additional AMC modules for I/O, storage and compute functions can be configured and integrated into the system in order to meet a wide range of IP-based communications design criteria. The unit also includes a NexusWare Portal for remote monitoring and management. OEM quantity pricing for the AMP5071 Application-Ready System, configured with a processor AMC, storage and NexusWare, starts at \$4,595.

Performance Technologies, Rochester, NY.  
 (585) 585-256-0200. [[www.pt.com](http://www.pt.com)].



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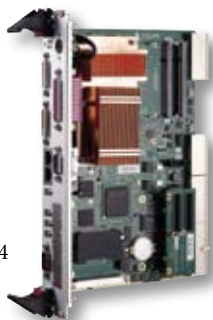
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## Core2 Duo cPCI Blades Support Dual Displays

The military's shift toward net-centric operations is driving demand for more display nodes linked to that network. Serving that need, the 3U cPCI-3965 and 6U cPCI-6965 series from Adlink Technology CompactPCI boards are based on the Santa Rosa platform and feature the Mobile Intel GME965 Express chipset (code name Crestline), low-power Intel Core2 Duo up to 2.2 GHz and up to 4 Gbytes of dual channel capable DDR2 RAM. Both of these blades support integrated graphics with a 3D graphics engine and dual independent VGA/DVI ports offering a 1.5 times graphics performance gain over the previous 945GME chipset.

The cPCI-3965 and cPCI-6965 also provide up to QXGA (2048x1536) resolution and 3 Gbit/s Serial ATA (SATA) bandwidth. They enable greater graphics performance with the integrated Mobile Intel Graphics Media Accelerator X3 100 and its 32-bit 3D graphics engine with Microsoft DirectX 9 and SGI OpenGL 1.5 support, and provide dual independent displays through VGA and DVI ports on the cPCI-3965, and two DVI ports on the front panel of the cPCI-6965. With regard to storage and expansion, the cPCI-3965 and cPCI-6965 both have a reserved space for a 2.5-inch SATA hard drive mounted onboard and additional SATA signal connectors for external drives. The cPCI-6965 and cPCI-3965 are priced at \$1,699 and \$1,499, respectively.

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



## USB Module Offers 96 or 48 Digital I/O Lines

USB was slow at first to catch on as an embedded I/O technology, and slower still to be embraced in military systems. With that in mind, the USB-DIO-96 from Acces I/O Products is a USB device designed for compact control and monitoring applications that features 96 or 48 industrial strength TTL digital I/Os. It can link digital I/O to any PC or embedded system with a USB port. It is a true USB 2.0 device and is fully compatible with both USB 1.1 and USB 2.0 ports. The unit is hot-pluggable, which allows quick connect or disconnect whenever additional I/O is needed on a USB port.

The boards use two or four industry standard 50-pin IDC-type shrouded headers with 24 lines per connector. Utility 5 VDC is available on pin 49 of each connector with grounds on all even numbered pins to reduce crosstalk and maintain industry compatibility. The unit's size and pre-drilled mounting holes match the PC/104 form factor (without the bus connections). This ensures easy installation using standard standoffs inside most enclosures or systems. The USB-DIO-96 can be integrated into any PCI-104 or PC/104 stack by connecting it to a simple USB port usually included on board with embedded CPU form factors such as EBX, EPIC and PC/104.

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



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## Coming Next Month

**Special Feature: Military Vehicle Electronics: Power and Size Trade-offs** — Changes by the DoD and U.S. Army to vehicle requirements will necessitate re-thinking previously planned electronics. Last month the DoD announced that the vehicle portion of the Army's Future Combat Systems would be killed and moved into a successor program dubbed Army Brigade Combat Team Modernization (ABCTM). Onboard communications and control electronics are still expected to multiply in sophistication for both next-generation and Current Force fighting vehicles. Articles in this section explore the latest requirements and how these changes may be influenced by technology and the latest products available.

**Tech Recon: Impact of RoHS: Can We Survive it?** — The commercial electronics industry embraced the European Union's RoHS initiative and never had to look back. But for the defense industry it's not so simple. The military market may be exempt from the restriction of hazardous substances (RoHS) initiative, but that doesn't mean makers of board-level products, for example, are off the hook. Most embedded computer companies craft board designs targeted for both military and non-military markets. Even companies purely in the military market can't escape RoHS's effects because for some categories of components, lead-free versions are the only game in town. This section examines the test and analysis issues that complicate military system design in this era of RoHS.

**System Development: Java and Ada Tackle Real-Time and Safety-Critical Challenges** — The military has good reasons for wanting to migrate toward Java. Using Java means leveraging the software industry's best tools and programming talent. Efforts are moving forward to solidify specs for real-time and safety-critical Java. Meanwhile, the Ada language offers unique features and an installed base that remains formidable. This section offers articles that track the latest on Java products and specification efforts, along with some comparisons between Java and the robust Ada 2005 language.

**Tech Focus: VXS and VPX SBCs** — VME has earned an enduring role as the most popular embedded computer form factor for defense applications. Next-generation, fabric-based flavors of VME are coming together in the form of specs such as VXS (VITA 41) and VPX (VITA 46). This section updates readers on the progress of those implementations, and displays a sampling of the current crop of VME, VXS and VPX single board computer (SBC) products.





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# Editorial

Jeff Child, Editor-in-Chief

It's nice to see signs now that our economic troubles may not be as catastrophic as once feared. And, for its part, the defense electronics business—especially compared to the rest of the economy—has been humming along nicely. Of course, as a reader of *COTS Journal*, you already work in the defense industry—or a technology area that does business in the defense market—so you already know that. Likewise, our magazine (knock on wood) seems to have fared much, much better on average than the rest of the trade publishing industry.

## High Barrier of Entry

I recall during the last recession (2001/2002) how many technology suppliers looked to the military market as a possible “safe haven”—a place to shift into in order to compensate for the drying up of the non-military business they'd focused on before. During that era, I remember that trend most vividly amongst embedded computer vendors and power suppliers that had been focused on the telecom market. Many such suppliers made an attempt to shift into the defense market, but very few were able to mount the high barrier of entry into this market. Beyond any particular expertise in developing products appropriate for military systems, there's just a simple matter of establishing trust and relationships with military customers. That trust is much more hard won than outsiders understand. As a result, many have failed to make the transition.

Fast forward to the current recession and I'm seeing that same trend again of non-military-focused suppliers hungry to enter into the lucrative, stable defense arena. This time around the barriers are even higher thanks to the increased concerns about security, tighter enforcement of International Traffic in Arms Regulations (ITAR), anti-tamper regulations, the complications of RoHS and so on.

In some ways, there's a benefit to entering the defense market now. I recently spoke to the folks at Columbia Tech, a small U.S.-based turnkey contract manufacturer, about their recent efforts to achieve ITAR registration with the goal of growing its presence in the military market. According to Richard Schulman, VP of Quality and ITAR Technology Control Officer for Columbia Tech, it took the company several months to get themselves educated and prepared for ITAR approval. But once achieved, their military customers told them that Columbia Tech exhibited a greater level of awareness of ITAR than many other long-time establish military electronics suppliers. The chance to “come at the issue fresh” is not such a bad thing these days.

Meanwhile, companies with a long history of playing in the defense market appear to be enhancing their focus on security. It seems like this past month in particular, has seen a flurry of security-related initiatives and product offerings from the military em-

bedded market. For example, Curtiss-Wright Controls Embedded Computing launched a new initiative dubbed “Trusted COTS,” an effort aimed at responding to the DoD's mandate that all critical military technologies and data be protected. The specific mandate in question is the DoD's directive DoDD 5200.39, Research and Technology Protection Procedures. Re-issued last summer, the directive declares that all military systems must provide protection of Critical Program Information (CPI). Under its Trusted COTS initiative, Curtiss-Wright Controls is developing standards, methodologies, tools and knowledge that will define improved engineering product design and development processes. This will involve seeking out partners with whom the company can work with to customize and integrate security-focused solutions into deployable products.

In response to that same directive, DoDD 5200.39, processor and tool vendor CPU Tech earlier this year rolled out its Acalis CPU872 secure processor. The CPU872 is, according to CPU Tech, the first processor with anti-tamper capability in accordance with 5200.39, which defines anti-tamper as “Systems engineering activities intended to deter and/or delay exploitation of critical technologies in a U.S. defense system in order to impede countermeasure development, unintended technology transfer, or alteration of a system.”

Advanced security features—such as anti-tamper capability and design separation—have been available before on large FPGAs, like the Xilinx Virtex. Xilinx, for its part, recently announced a defense grade version of the Virtex FPGA family that marries ruggedized packaging and advanced cryptographic capabilities. Meanwhile, Altera has instead chosen its lower power Cyclone line of FPGAs for its first offering of sophisticated anti-tamper and security features. The security features of this new family of Cyclone FPGAs enable it to serve as a single-chip solution for next-generation military applications such as software defined radio, crypto-subsystems and crypto modernization equipment.

As I talk to various board, IC and software vendors about their latest security-targeted offerings, I get a clear message that the whole area of security is, in some ways, in its infancy. In other words, even the most knowledgeable of today's developers of military, embedded computer-based systems are not, on average, experts on all the nuances, methods and regulations having to do with anti-tamper capabilities, security and trusted component sources. That's why it's imperative that the education process along those lines gets kicked into higher gear. Security may on one hand be all about restricting information, but now more than ever, the development of secure, trusted systems and tools available to make them should be moved into the foreground of today's military electronics engineering knowledge. The barriers of entry may be high, but the defense industry needs all the expertise and experts it can get its hands on. ■■



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