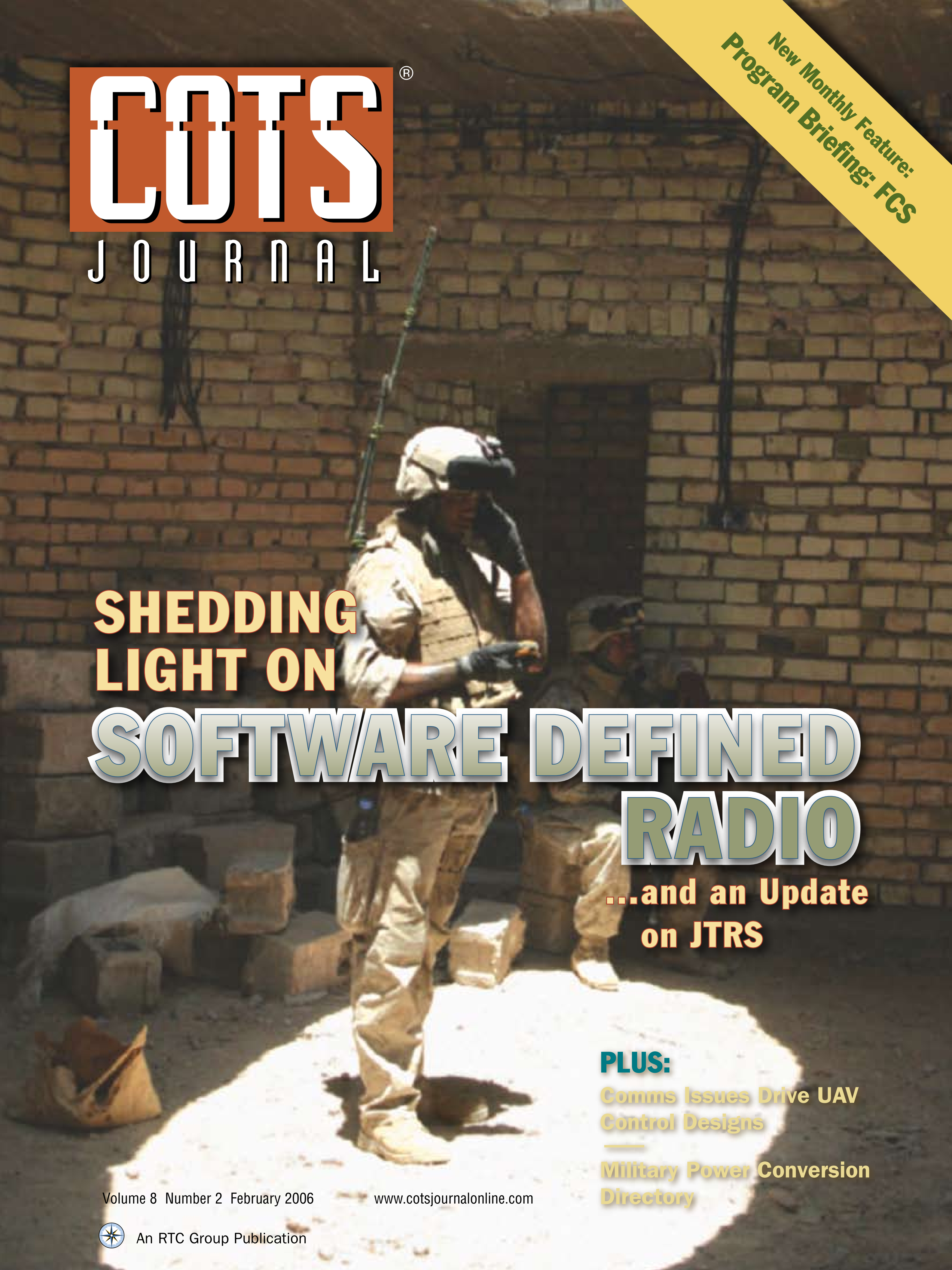

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Volume 8 Number 2 February 2006 www.cotsjournalonline.com

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COM 5	RS–232/422/485	NA	NA
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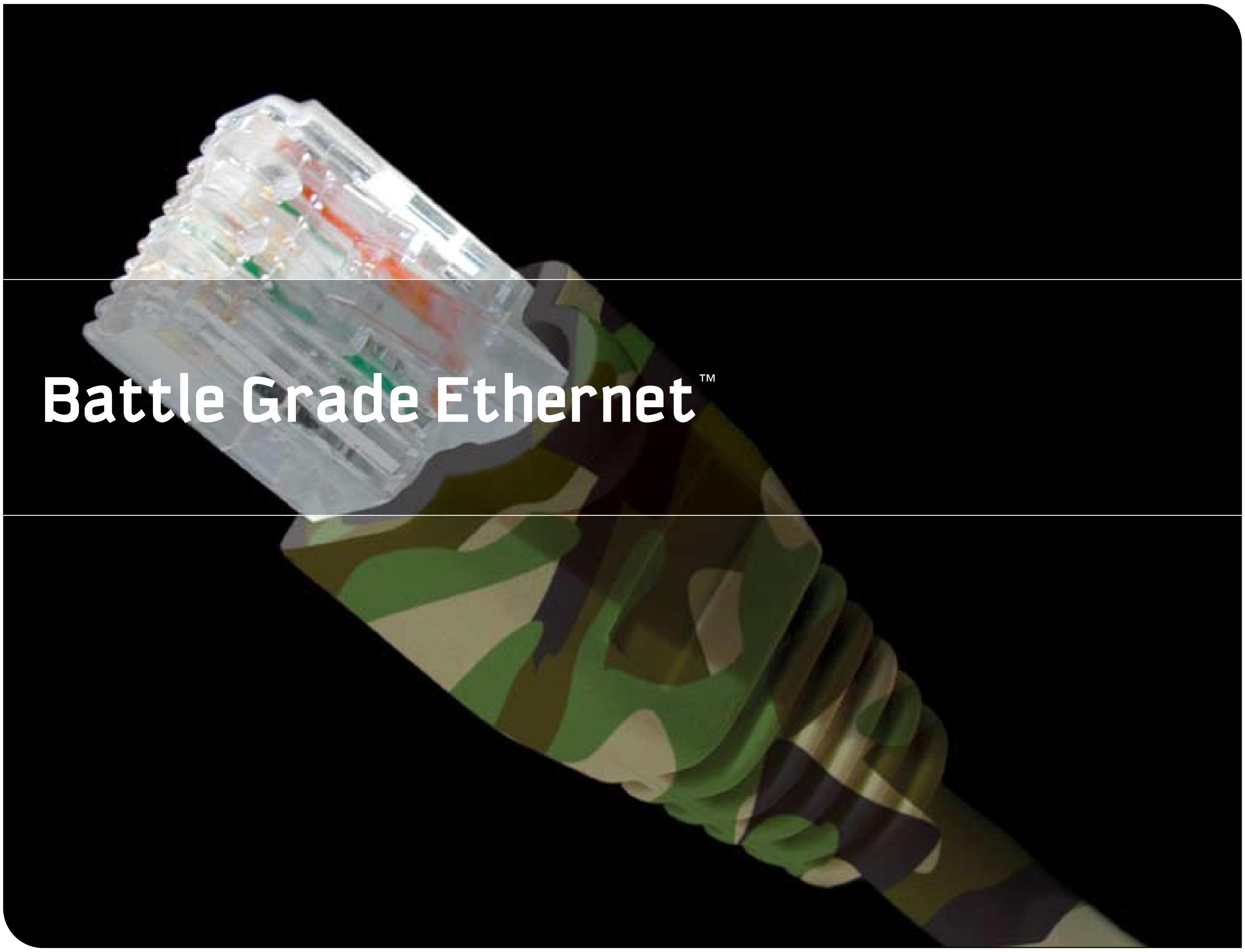

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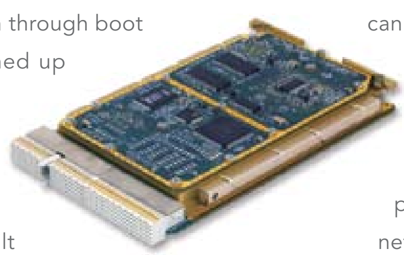

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COTS JOURNAL

Features

February 2006 Volume 8 Number 2

Main Feature

Software Defined Radio

Tech Recon

UAV Control Systems

Special Section

Military Power Conversion Directory

Our 2nd annual Military Power Conversion Products Directory provides an "apples-to-apples" sampling of today's current crop of power products including DC/DC converters, power supply module "bricks" and slot-card power supplies. Check on www.cotsjournalonline.com to see the on-line version of this directory featuring contact info, URL links and downloadable datasheets for the companies listed in this directory.

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

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Departments

Coming in March...
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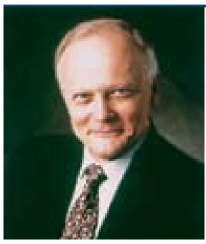
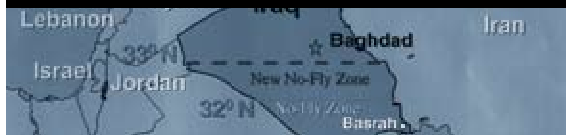
Conventional military radios—like the one used by this Marine as he radios in his current position during counter-insurgency operations with Iraqi Security Forces—will be a thing of the past once the JTRS program is complete. Based on software programmable radio technology, the DoD's multi-services Joint Tactical Radio System (JTRS) calls for seamless real-time communications with and across the U.S. military services, and with coalition forces.

Courtesy: (DoD photo by Lance Cpl. Matthew Hutchison, U.S. Marine Corps).





Google, Moore's Law and Me

I need a college course on how to more effectively use Google—or something better than Google. I know what I want when I Google, and don't get me wrong. For me it's the best search engine ever, but I waste so much time getting what I want. If you put in exactly the right words, quotes, plus signs, minus signs, you may get what you want rather quickly. That's the problem for me. I put in the words and signs that I think will get me there and nine times out of ten I either get too much or not anything I'm looking for. If I don't get close to what I'm looking for I start pulling things out of my request, until I get too much. The next step is reading the headings in the results and guessing which one might get me where I want to be. After visiting several sites and being totally frustrated I go back to square one. Eventually I get what I want and many times I come across things that are not related but extremely interesting and get sidetracked.

After getting what I want I look back and think, if I had known to type in this and that I could have found this in a minute rather than an hour. One problem is expectation. Fifteen years ago getting what I want could have taken days and irritated my staff by forcing them to do it when they could have been productive. In contrast, now I have a very fast computer and Internet access. So now that the technology is here, I need to face the reality that I'm the problem. What I need now is technology to work around—or work with—my personal characteristics. If I want to look at all "military electronic magazines," it would be nice to not have to type "minus" to eliminate libraries, magazine sales and so on. I also don't want to wade through 55,000,000 hits. Again, this is my personal problem. So, tell me Microsoft, when are you going to help the non-programmer challenged individuals like me?

Search engines are just one small facet of the war that goes on between the Internet data provider and the data user. Prior to the Web, buyers (potential buyers) needed to contact sellers and expose their identity. That enabled sellers to identify the buyer and "sell" them. The Internet enables buyers to remain anonymous, preventing sellers from the ability to "sell" the buyer. Sellers then started building layers of "selling" into their Web sites, frustrating, but not altering the buyer's anonymity. In the last few years all sorts of traps have been put in place by organizations to get your e-mail address—freebees requiring your e-mail address, e-mail-only as preferred communication, e-mail portals providing multiple and quicker data access, cookies and so on. As a result, little by little sellers are getting back the ability to know who the buyer is and "sell" them.

The most recent craze with the Internet is what I call information "dumping." This is where you elect to get some specific type of update from a company or information provider via e-mail. But enveloped around the information you are interested in is all the things they are trying to expose you to. In my profession, newsletters, alerts, updates, whatever they are called, can be very useful, and I'm sure that they are useful to people in various positions.

All that said, I'm starting to feel a little like I do when I Google. I get every electronic version of industry information going. And now each information dump is filled with more and more material that I don't want. In the past when my "confuser" and Internet access were slower, I would just unsubscribe from the biggest offenders because I couldn't handle it. Now that I have a faster "confuser" and Internet service I thought I would be better off. I'm not sure I am. Now there's even more information dumps and they keep getting larger. That takes more of my time to sort through them looking for that germ of what I want to know.

Unfortunately Moore's Law doesn't extend to my personal ability to sort the information that's available or dumped on me. I doubt I'm alone with this problem, so the question is: "Is this form of selling effective or counterproductive?" Those annoying little cards that fall out of magazines are very effective, but there are only one or two in each magazine. How effective would they be if there were several hundred? I liked the time when I'd go to lunch with a salesperson rather than getting information dumped. Back then maybe I didn't have the ability to know about every alternative product in the universe, but on the other hand, my problems always seemed to get solved effectively. ▮▮

Pete Yeatman, Publisher
COTS Journal

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The Inside Track

Northrop Grumman Selects VMETRO System for ALMDS Program

Northrop Grumman, Integrated Systems Division, in Melbourne, FL has contracted VMETRO for the Central Electronics Chassis (CEC) system of the Airborne Laser Mine Detection System (ALMDS) program. The CEC uses VMETRO's Phoenix family of VXS (VITA-41) system solutions for real-time multiprocessing with high-speed serial communications. The system processes image sensor data in a liquid-cooled system incorporating several Phoenix VPF1 quad processor payload cards and VMETRO's recently announced CSW1 zero latency switch card. Delivery of systems will begin during the first half of 2006. The order for initial deliveries is valued at approximately $600,000, with follow-on orders for additional systems and options expected over the next six years leading to potential business in excess of $15,000,000 over the life of the program.

ALMDS is deployed on helicopters to allow the U.S. Navy to detect sea mines at or near the water's surface. Using an airborne light detection and ranging blue-green laser, the ALMDS system covers a large area of the ocean detecting, localizing and classifying mines. This system allows the military to expedite mine hunting and reconnaissance. More than fifty helicopter platforms, including the MH-60S Seahawk (Figure 1), are expected to be outfitted with the ALMDS technology.

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

Figure 1
More than fifty helicopter platforms are expected to be outfitted with the Airborne Laser Mine Detection System (ALMDS) technology, including the MH-60S Seahawk shown here. ALMDS uses an airborne light detection and ranging blue-green laser to allow the Navy to detect sea mines at or near the water's surface. (U.S. Navy photo.)

Boeing Taps Concurrent's Linux for C-17 Program

Concurrent's RedHawk Linux operating system has been selected by Boeing for use in Symtx avionics test equipment used in support of the Boeing Integrated Defense Systems' Air Force C-17 modernization program. Concurrent's quad processor iHawk systems powered by the RedHawk Linux operating system will be used in hardware-in-the-loop (HIL) simulation testing of the C-17's avionics subsystems. RedHawk Linux reportedly met the high frame rates required in the HIL simulation without frame overruns.

HIL simulation is a critical product development process that provides for comprehensive testing of components in a virtual environment in which other subsystems are replaced by mathematical models. Components to be tested are inserted into a closed loop that is reproducible, systematic, fast and more reliable than actual bench testing.

The iHawk systems are powered by up to eight Intel Xeon or AMD Opteron processors and up to 64 Gbytes of memory in rackmount and tower enclosures. iHawks are true symmetric multiprocessors that run a single copy of RedHawk Linux. RedHawk Linux guarantees that a user application can respond to an external event in less than 30 microseconds on a dedicated processor.

Concurrent
Duluth, GA.
(678) 258-4000.
[www.ccur.com].

Saft Awarded Li-Ion Battery Order from Orbital Sciences for MEASAT-1R and THOR II-R GEO Satellites

Orbital Sciences Corporation (Dulles, VA) has placed an order for Saft Lithium-ion (Li-ion) batteries, continuing the ongoing partnership for two additional geosynchronous (GEO) communications satellites. The first spacecraft battery order is for the MEASAT-1R satellite that Orbital is building for MEASAT Satellite Systems of Malaysia. MEASAT-1R will generate approximately 3.6 kW of payload power at launch. The satellite will be launched into a Malaysian orbital slot at 91.5 degrees east longitude over Southeast Asia. The launch of the new spacecraft is scheduled for late 2007.

The second spacecraft battery order is for the THOR II-R satellite that Orbital is building for Telenor Satellite Broadcasting of Norway. The THOR II-R spacecraft will provide Ku-band fixed telecommunications and direct-to-home television broadcasting services from

Figure 2
Scheduled to launch in late 2007, the MEASAT-1R satellite will carry 12 Ku-band and 12 C-band transponders and will feature three antennas. MEASAT-1R will provide C-band communications services throughout Asia, the Middle East and Africa, and Ku-band direct-to-home television broadcasting to Malaysia and Indonesia.

Telenor's one-degree west longitude orbital location. The new satellite will have 24 transponders with three times more payload power (3.6 kW) compared to the current THOR II satellite. THOR II-R will weigh approximately 2,450 kg at launch and will improve Telenor's service coverage in the Nordic countries, Europe and the Middle East. Delivery of the satellite is scheduled for late 2007.

The rechargeable Li-ion batteries will deliver the satellite power during two eclipse seasons per year when the spacecraft is blocked from the sun. The battery's high specific energy of 120 Wh/kg make for approximately 30 to 50 percent weight savings on the battery, enabling the satellite manufacturer and user to dedicate more of the satellite's crucial mass to the payload, or revenue generating part of the spacecraft.

Saft
Bagnolet, France.
+33 (0)1 49 93 19 18.
[www.saftbatteries.com].

DoD Releases Its Fiscal 2007 Budget and QDR Report

Earlier this month, President George W. Bush sent to Congress his defense budget for fiscal 2007. The budget requests $439.3 billion in discretionary budget authority for the Department of Defense, a seven percent increase over enacted fiscal 2006 funding levels. The budget was accompanied by the Report of the Quadrennial Defense Review (QDR). This is the first time that the Report of Quadrennial Defense Review and the President's budget for the Department of Defense have been delivered to Congress together.

Among the highlights is a major increase in the size and capabilities of Special Operations Forces (SOF), including the establishment of a SOF Unmanned Aerial Vehicle Squadron. The budget provides $3.7 billion in funding in FY 2007 for the Army's Future Combat System program and $22.4 billion in FY 2007- 2011.

In the area of Joint air operations, the budget provides $10.4 billion in FY 2007 to fund acquisition of F-22 and F/A-18 E/F aircraft, as well as continued development and the first procurement of the Joint Strike Fighter (F-35). To improve Joint maritime capabilities, the budget invests $11.2 billion in FY 2007 in more capable and multi-mission ships. In FY 2007, the budget funds two DD(X) Destroyers, two Littoral Combat Ships (LCS), one Virginia class submarine, one LHA amphibious assault ship, and one T-AKE logistics ship.

The QDR, the first conducted during a time of war, reflects the process of change that has been ongoing in the Department of Defense since 2001, and sets the department's direction to the future, establishing strategic priorities and identifying key areas for needed investment. Based on the President's 2005 National Security Strategy, the QDR outlines the mix of forces and capabilities needed to fulfill the strategy's stated goals and objectives.

The fiscal 2007 budget is posted at www.dod.mil/comptroller/defbudget/fy2007/index.html. The Report of the Quadrennial Defense Review is posted at www.defenselink.mil/qdr.

Figure 3

The Adtron 16 Gbyte I25FB flash disk is being installed in the Local Control Panels (LOCOPs). The LOCOPs are designed to monitor and control the parameters required to start and operate the generator sets used on CG-47 Ticonderoga class cruisers, like the cruiser USS Philippine Sea (shown) and DDG-51 Arleigh Burke class destroyers.

Adtron Solid-State Disks Pass MIL-STD-167-1 and 901D Tests

Solid-state disk manufacturer Adtron announced that its I25FB IDE flash disk passed standard military tests conducted by National Technical Systems in Tempe, AZ. Going beyond the more typical MIL-STD-810F testing, MIL-S-901D tests demonstrate that the I25FB Flashpak flash disk is capable of withstanding shock loadings that may be incurred during wartime service due to the effects of weapon attacks. In separate MIL-STD-167-1 tests, the I25FB proved resilient to internally and externally imposed shipboard vibrations, subject to dry and damp heat conditions necessary to operate in a shipboard environment.

The Adtron 16 Gbyte I25FB flash disk with commercial temperature media is being installed in the Local Control Panels (LOCOPs) by Woodward Governor Company. The LOCOPs are designed to monitor and control the parameters required to start and operate the generator sets used on the CG-47 Ticonderoga class cruisers and DDG-51 Arleigh Burke class destroyers. With a capacity range from 1 to 56 Gbytes, the I25FB flash disk supports standard IDE UDMA transfer modes. Solid-state media options include either commercial (0° to 70°C) or industrial (-40° to 85°C) temperatures.

Adtron
Phoenix, AZ.
(602) 735-0300.
[www.adtron.com].

COTS Websites

http://leadfree.ipc.org

IPC's Lead-Free Portal Offers Useful RoHS Technical Info

As the July 1 deadline for RoHS compliance draws near, technical information on lead-free electronic system design has become a valuable commodity. The Restriction of Hazardous Substances (RoHS) directive restricts makers of electronic equipment from selling to the European Union market, any equipment that exceeds a specified maximum concentration per homogeneous substance of materials considered hazardous including lead and four other substances. And although the military is exempt, it's a matter of concern to makers of board-level products because most companies craft board designs targeted for both military and non-military markets.

While the Web is jam packed with Web sites talking about RoHS, IPC's Lead-Free portal presents some of the best technical resources on the subject. The compliance section of the site includes all the latest information including which products are covered, the definition of lead-free (.pdf) and testing. Also covered are links to RoHS resources including training, conferences and compliance tools. Meanwhile, the implementation section of the site draws upon IPC's strength as a technical, standards developing organization by offering information on solder selection, tin whiskers, laminate and other PCB material issues, and lead-free components. The site provides tools like a peer-to-peer lead-free listserve and links to relevant IPC standards. IPC is a U.S.-based trade association that brings together industry players in the electronic interconnect industry, including designers, board manufacturers, assembly companies, suppliers and original equipment manufacturers.

IPC, Bannockburn, IL. (847) 615-7100.
[www.ipc.org].

Platform Integration Challenges Loom Ahead for Army's FCS Program

Jeff Child,
Editor-in-Chief

For the Army's Future Combat Systems (FCS) program, 2006 will be a critical year—and embedded computing technologies will begin playing a significant role. With the System of Systems Functional Review completed successfully last August, the program is now in its Integration Phase 1. That will involve the platform and network teams initiating their sub-tier System Functional Reviews, followed by the first major field experiment this year, with the first "spin-out" of FCS technologies to the Current Force in 2008. Implementing those spin-outs will be tricky business, especially when it comes to merging the embedded computing systems with the existing legacy platforms.

Meanwhile, the prospect of cuts or outright termination continues to loom over the FCS program. As the 2007 budget request takes final shape over the coming months, costly programs like FCS, Joint Strike Fighter and DD(X)—or at least portions of them—are never far from the chopping block. A major restructuring of the program last year bumped the estimated cost significantly. The DoD's own assessment in a Selected Acquisition Report last fall, raised the estimated cost for the FCS Program by more than $62 billion, up from the $98 billion to over $161 billion. That $62 billion increase is comprised of $54 billion due to the program's restructure and $8 billion due to the extension of the program by four years.

The goal of the restructure was to split the System Development and Demonstration (SDD) phase into a series of integration phases (Figure 1). It's part of a "spiral acquisition" strategy, which calls for testing and fielding technology building blocks that comprise a major program, rather than implementing them all at once.

Platform Tradeoffs

As development work continues, FCS decision makers will be confronted with making tradeoffs between economics of standardizing on a single vendor's solution weighed against and the benefits of open platform architecture. At the heart of those tradeoffs is the question of whether to support a truly open architecture where different RTOS and processor architecture can play together, or to rely on a selected vendor's solution. Those tradeoffs raise a number of issues that will affect the integration.

FCS decision makers opted for a single-vendor approach for the embedded operating systems on FCS' Integrated Computer System (ICS). The ICS is the common computing environment for 17 of the 18 platforms in the FCS "system of systems." The computing environment connects a network of sensors, unmanned air platforms, and both manned and unmanned ground platforms. Responsible for the ICS development, the team of Rockwell Collins and General Dynamics chose LynuxWorks as the embedded operating system vendor—specifically LynuxWorks' LynxOS-178, the company's safety-critical, Linux-compatible, POSIX-compliant RTOS.

That decision to select a single OS vendor strays from the original concept envisioned in FCS for a completely open System-of-Systems Common Operating Environment (SOSCOE). The idea was that the SOSCOE would serve as a layer of abstraction, allowing different RTOSs and processor platforms. In other words, boards running VxWork, LynxOS or Linux on any processor architecture—Pentium or PowerPC and so on—could operate with the FCS network with the Common Operating Environment at a higher level tying those together.

Observers say that the decision to go with a single OS vendor was primarily an economic decision. For a truly open SOSCOE approach, there would have to be a layer of software to support SOSCOE for each of the various platform combinations —one for LynxOS on Pentium, one for VxWorks on PowerPC and so on. That would have entailed a lot of separate development activities that have to be implemented and supported.

Leaning Toward Intel?

Narrowing the options still further, word is that the FCS ICS will favor an Intel architecture. Part of that is driven by a software package called the Commercial Joint Mapping Toolkit (C/JMTK), which runs on an Intel platform. Apparently because of contractual and budget

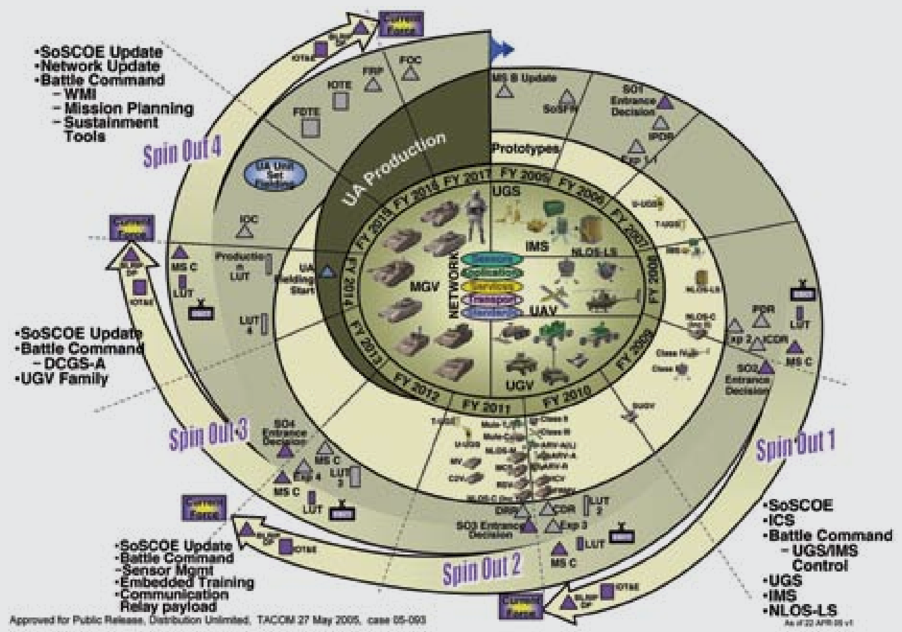

Figure 1

The Future Combat Systems program went through a major restructuring last year that split the System Development and Demonstration (SDD) phase into a series of integration phases. It's part of a "spiral acquisition" strategy, which calls for testing and fielding technology building blocks that comprise a major program, rather than implementing them all at once. Sub-tier System Functional Reviews are going on now, to be followed by the first major field experiment this year, with the first "spin-out" of FCS technologies to the Current Force in 2008.

reasons, that tool won't be ported to a PowerPC platform or even to an open SOSCOE platform.

C/JMTK replaces the JMTK, which is a collection of government-owned application program interfaces (APIs) that enable mission applications to interface with the COE Mapping, Charting, Geodesy and Imagery (MCG&I) functionality. In the 1999 Defense Authorization Bill, Congress directed that future versions of the JMTK be based on commercial technology. Those type of mapping and terrain functions are critical for the Battle Command (BC) mission applications specified, as in FCS, which include mission planning and preparation, situation understanding and mission execution applications.

The jury may still be out on whether Intel architectures will dominate in FCS. Part of the "spin-out" plan for the program calls for deploying the ICS on today's existing combat vehicles including Bradley fighting vehicles, Abrams main battle tanks, Strykers and Humvees. The VxWorks running on PowerPC VME64 dominates in those existing vetronics platforms, so having a separate Intel platform running another OS adds an unwelcome layer of complexity.

All-in-One Integration

Moreover, because there's so little space to spare inside any of today's armored fighter vehicles, it's critical that the embedded computing racks that house a vehicle's vetronics systems—motor control, fire control and so on—can be shared by the net-centric communications and graphics functions that are part of FCS. Smaller than Bradleys and Abrahms, each of the eight manned ground vehicles in the FCS program have even less space to spare, so integrating all the computing systems is even more vital there. To meet the size, weight, power and cooling requirements, the goal will be to integrate as much as possible.

Interconnect issues also come into play. The FCS ICS is based primarily on a Gbit Ethernet architecture. In contrast, Abrahms tanks use MIL-STD-1553. Going from 1553 to Gbit Ethernet is quite a leap in itself. A challenge ahead is determining if it's possible to run the vehicle electronics in an IP (Internet Protocol) network. Will some other interim interconnect—whether it's RapidIO or switched Ethernet—be necessary as the deterministic protocol required for the vehicle electronics? A decision hasn't yet emerged on what bus architecture the ICS will be implemented on, but VITA 46/48 is a likely candidate for marrying those requirements of high-bandwidth throughput and real-time determinism. The first products based on VITA 46 were announced at last month's Bus & Board, although evolution units of those products aren't expected to be available until Q4 of this year.

It's All About the Wireless Network

Of course, the FCS network is nothing without the wireless comms technology that ties it together. The network is comprised of several homogenous communication systems such as Joint Tactical Radio System (JTRS) Clusters 1 and 5 with Wideband Network Waveform (WNW) and Soldier Radio Waveform (SRW), Network Data Link and Warfighter Information Network–Tactical (WIN-T). In mid-December Boeing received the first delivery of Joint Tactical Radio System Cluster 1 (JTRS C1) radios produced for the FCS program.

The seven pre-engineering development model radios were shipped from team members BAE Systems and Rockwell Collins to the Boeing integration facility in Anaheim last week. The operating environment provides the radio support infrastructure for the operation of software communication architecture-compliant waveforms. The initial waveform set will include the single channel ground air radio system waveform and the Wideband Networking Waveform-increment 1 (WNW). Operational software and waveform upgrades will be provided with FCS radio deliveries scheduled to take place in August.

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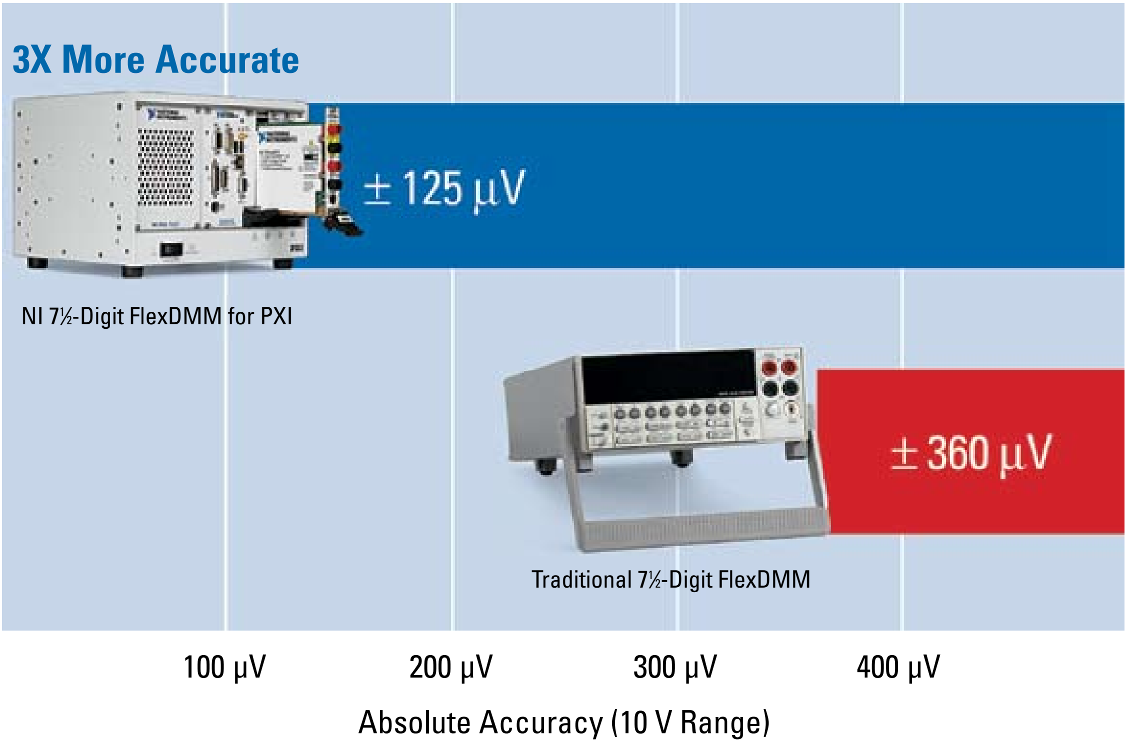

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SDR Soldiers On, But Where's JTRS?

Although in the last year there was a lot of commercial activity for Software Defined Radio, the current military status is not clear while the JTRS program is being reorganized.

David B. Cotton
Contributing Editor

Judging by the new product announcements, 2005 was a very active and productive year for Software Defined Radio (SDR). The theme of the SDR Forum's November conference—"Software Radio Technology Is Here and Now"—sums it up. With 375 participants from 16 countries and 175 organizations participating in tutorials, panel sessions, paper presentations and exhibits, the conference proved that SDR is here and ready for prime time.

Offsetting this enthusiasm are concerns for the premier military SDR program—the DoD's multi-services Joint Tactical Radio System (JTRS). Faced with product delays and cost overruns, during 2005 JTRS went into reorganization mode, and almost a year later we're still waiting to hear the results. (For more details, see sidebar "JTRS—What's Next?")

Major SDR Themes

Two key themes highlighted 2005. One was that vendors were trying to provide a complete SDR development platform. Hand-in-hand was the admission that no one firm had all of the tools to achieve this goal, so everyone was announcing partnerships or working relationships.

During the year, Green Hills Software announced that the SCARI++ Software Suite from Communications Research Center Canada (CRC) was available for Green Hills' INTEGRITY OS. They also introduced the Green Hills Platform for Software Defined Radios, "a complete and integrated solution for the development and deployment of next-generation software-configurable radios." Pentek released a complete SDR development platform meeting Software Communications Architecture (SCA) compliance, with hardware featuring their 7640 software radio transceiver PCI card in a PC workstation, plus the Linux OS and CRC's SCARI++ development suite.

Zeligsoft announced relationships with Harris, I-Logix and Object Interface Systems (OIS). They also teamed with Spectrum Signal Processing to support the latter's *flex*Comm SDR-3000 development platform. With Harris, they announced a complete SCA-based design and development environment. With I-Logix, they signed an interoperability and marketing agreement for their Component Enabler (CE) and I-Logix' Rhapsody Model-Driven Development (MDD) environments. OIS

Figure 1

Spectrum Signal Processing's SDR-4000 family is designed for harsh tactical MILCOM environments. It includes the PRO-4600 SDR processing engine and XMC-3321 dual transceiver modules (center), a five-slot air-cooled cPCI chassis with power supply (left) and the software required to develop systems.

teamed up with Zeligsoft to offer an integrated communications middleware and development tool for SDR.

And it is rumored that shortly Xilinx and ISR Technologies will unveil an off-the-shelf development kit to accelerate implementation of SDR modems for JTRS. The kit is expected to leverage the low-power DSP features of Xilinx's Virtex-4 FPGAs along with their partial reconfiguration capabilities.

Other Commercial News

Elsewhere, the SDR Forum selected Mercury Computer Systems to develop a reference waveform for the DoD's SCA. This reference waveform is an example application that will help promote increased proficiency for designers/developers implementing SCA.

PrismTech's Spectra Integrated Circuit ORB (ICO) demonstrated how a CORBA ORB could be embedded natively in an FPGA and used to control logic within it. Version 1.1 of PrismTech's Spectra SE waveform development and test tool added the ability to reverse engineer pre-existing waveforms.

In hardware news, Spectrum Signal Processing was very active with a plethora of SDR announcements including a next-generation SDR product family for harsh tactical MILCOM environments—the SDR-4000 rugged 3U CompactPCI line. Its initial hardware offering (Figure 1) is comprised of the PRO-4600 SDR processing engine and XMC-3321 dual transceiver I/O mezzanine card. Together, these products provide a wireless modem that supports up to two channels per slot. Spectrum also entered into an agreement with General

JTRS—What's Next?

JTRS, the DoD's Joint Tactical Radio System, is a multi-year program designed to allow warfighters from different service branches to communicate seamlessly with each other and with their allies. Initially, it embraced the concept of Software Defined Radio (SDR), established a Software Communications Architecture (SCA), awarded a number of contracts for research and development of products, and encouraged international industry cooperation and adoption of its standards.

By late 2004 it was obvious that the JTRS program was in trouble, with concerns about delivery delays and cost overruns and rumors of budget cuts. By then, the JTRS program had evolved into a waveform development program plus three hardware programs with similar requirements and fielding schedules—commonly called Cluster 1 (radios for ground platforms, Apache, Chinook and Blackhawk helicopters), Cluster 5 (handheld and manpack radios for land warriors) and AMF (Airborne, Marine and Fixed Station radios).

Early in 2005, the JTRS Joint Program Office (JPO) was moved from the Washington, DC area to San Diego and reconstituted as the Joint Program Executive Office (JPEO) under Dennis Bauman. It was given full authority over all development of radios, waveforms and ancillary equipment, systems engineering, performance and standards as well as R&D funding. JPEO was also told to develop a new organizational structure, to access all of the existing "Clusters" and to make recommendations on how to meet its goals.

In August 2005, in a presentation to the Object Management Group (OMG), members of the new JPEO described their actions to date and gave a glimpse of their expected roadmap. Among their actions in the first five months were:

- Creation of an overall JTRS management structure
- An assessment of the Clusters and other programs and the status of waveforms
- Initiation of a draft replan of the existing programs and waveforms, with an eye to reducing high-risk programs to moderate risk

Way Ahead Program Priorities

- Develop and deliver incremental Transformational capabilities to the warfighter
  - Mobile ad-hoc networking
  - Cross-banding
- Return programs to executability through proper:
  - Discipline in requirements, resourcing and acquisition
  - Risk management
    - Technical
    - Cost
    - Schedule
- Establish an open JTRS technology base to promote:
  - Interoperability
  - Affordability (e.g., reuse, portability, etc.)
  - Speed to capability

(Source: JPEO JTRS Overview to OMG, August 18, 2005)

Figure
The Way Ahead—New JTRS JPEO Program Priorities

Their new program priorities, described in August, are shown in the Figure. On October 31, 2005, Dennis Bauman made a presentation to the American Institute of Engineers (AIE) Military Radios Conference entitled, "JTRS Status and Way Ahead." In many ways his presentation was a shortened version of the August one, but it emphasized the idea of the Global Information Grid (GIG) and stated, "Without JTRS, the tactical warfighter is not connected to the GIG."

At that time, there were expectations that shortly there would be a public disclosure of plans by JPEO, perhaps as early as mid-November. But, then came rumors that the proposed decisions were deemed unacceptable, and November, December and January have come and gone without news. Now, some observers are saying that it will be March before we hear anything about Clusters 1 and 5 and maybe as late as June for AMF. And one source is convinced that Cluster 5 will be pulling back from the concept of handheld radios. In the meantime, we hear that Congress has made significant cuts to the JTRS budget, which might well explain the delays in hearing from the JPEO.

Some observers suggest that the JTRS vision is not practical and the program can never deliver what it promised. Others feel that the problem is in the implementation and the program needs to be replanned to provide a more incremental approach.

However, in the past year several other problems have become apparent. First, the JTRS program has backed way off from its concept of

Dynamics Canada and planned to jointly introduce an upgraded modem for U.S. Navy Digital Modular Radios (DMR). This upgrade allows the DMR, a software defined radio, to host new wideband JTRS waveforms.

Radstone's subsidiary, Interactive Circuits and Systems (ICS), announced the IMP1A-571, a 3U cPCI Blade, single-slot, fully rugged ADC/DAC with a PowerPC processor. ICS also broadened their offerings with the ICS-8554 and ICS-8552 ADC PMC modules. And Sundance announced the availability of a new SDR development platform, based on the TI TMS320C6416T digital signal processor (DSP), to facilitate the design and development of two-way communications radios.

JTRS News

Not all announcements were of tools and platforms; some related to the JTRS program. In December 2005, Boeing—the manager of JTRS Cluster 1—received first deliveries of radios (Figure 2) for the Army's Future Combat Systems (FCS). Seven pre-engineering development models were shipped to the Boeing integration facility for software integration and were delivered to the FCS program at the end of January 2006. Boeing plans to distribute 40 radios for experimentation this year.

Thales Communications' Cluster 2 JTRS Enhanced Multiband Inter/Intra Team Radio (MBITR), or JEM, achieved SCA certification. The JEM Operating Environment has been certified as "SCA Compliant with Waivers," making it the first JTRS radio to be certified by the JTRS Joint Program Executive Office (JPEO) for SCA compliance.

General Dynamics C4 Systems (GDC4S) chose Altera's Cyclone II and MAX II devices for the JTRS Cluster 5 design. GDC4S selected the Altera programmable logic devices (PLDs) for use in handheld, manpack and other small form-factor radios.

Finally, Vanu received a study contract from JTRS Joint Waveform Program Office (JWPO) to analyze the degree to which waveform software portability is currently achieved. At the SDR Conference, Vanu was presented the Industry Achievement Award in recognition of their outstanding contributions, research and development in the field of SDR. ▮

Figure 2

JTRS Cluster 1 radios provide warfighters with secure capabilities, including real-time voice and text transmission/receipt, live video and audio streaming, drawing and sharing of maps, Net-Meetings and Voice over Internet Protocol (VoIP). *Source: Boeing Corporation.*

a partnership with international industry and has brought everything back into the JPEO, effectively shutting off the flow of information to all except those companies actively involved with existing Cluster programs. The Technical Advisory Group (TAG), an industry group that was providing input to the change management process for SCA, was shut down. Tools—like the NSA security testing of SDR technology—have been classified and now require security clearances, making it difficult for many non-U.S. firms to gain access to them.

Second, the lack of a business model for waveform software makes it extremely difficult to take advantage of waveform portability. There seem to be two approaches: one in which waveforms are intellectual property for which money can be charged and envisions that they will run on commodity hardware, and the other that believes that waveforms should be open-source commodities and that the money should be charged for hardware. Although either might work, unfortunately it appears that the government may desire both commodity hardware and waveforms, leaving industry wondering how to make money. These issues—the pullback to JPEO and the lack of a business model for waveforms—may prove to be detrimental to a full and rich development of SDR.

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Adaptivity in Action for SDR and Cognitive Radio

Adaptivity at all levels—from functions to services—is a highly desired attribute in SDR and cognitive radios. Although users will be exposed to adaptivity at service and application levels, adaptivity at component and function levels is also necessary for implementation.

Manuel Uhm, Senior Marketing Manager
Xilinx, Inc.

Software defined radios (SDRs) and cognitive radios (CRs) are touted for their flexibility, which enables interoperability, upgradeability and future-proofing. This flexibility also enables a highly desired attribute—adaptivity. Adaptivity can range from a cognitive radio's ability to adapt to its spectral environment to a software defined radio's ability to adapt a waveform to compensate for channel fading.

Just like flexibility, adaptivity is enabled by the reprogrammable and reconfigurable processors used in SDRs/CRs. These processors usually consist of a field programmable gate array (FPGA), a digital signal processor (DSP) and/or a general-purpose processor (GPP). Unfortunately, this flexibility comes with a power and cost penalty. However, recent advances in technology are making this flexibility more affordable. For example, partially reconfigurable FPGAs (PR FPGAs) can implement multiple, independent applications in a much more optimal fashion than non-partially reconfigurable FPGAs, resulting in power and cost savings. This article discusses the capabilities of platform FPGAs with embedded GPPs and DSP engines that provide a range of adaptivity to an SDR or CR, while lowering the power and cost penalty.

Adaptivity in SDRs and CRs

Adaptivity, a key capability of SDRs/CRs, particularly for military or homeland security purposes, can take many forms, including:

- Changing waveforms to interoperate with other friendly communications devices
- Creating a mesh network through ad-hoc networking
- Adapting to the RF environment by using spectral awareness to transmit in an open spectrum area
- Collaborating with multiple radios to receive a weak signal that could not otherwise be detected by individual radios
- Jamming or nulling an interfering signal
- Degrading gracefully so that a radio can accommodate damage to some of its processing resources, and reconfiguring the remaining resources to support the most critical services

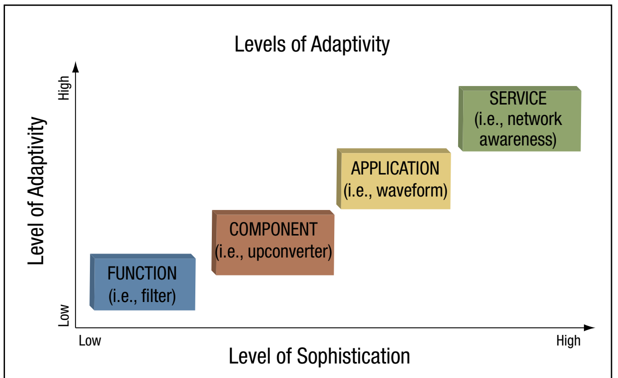

Figure 1

Levels of adaptivity in an SDR/CR.

For the purposes of an SDR/CR, adaptivity can be broadly classified into four levels, as illustrated in Figure 1.

At the lowest functional level of adaptivity are functions such as filters or transforms. Examples include Kahlman filters, finite impulse responses (FIRs) and fast fourier transforms (FFTs). These low-level functions are basic building blocks of most SDRs/CRs, so it is likely that the parameters of a function such as an FIR would have to be adapted to support a waveform that is changing bit rates.

The next functional level of adaptivity is at the component level. In an SDR/CR, common waveform components include digital down-converters (DDCs)

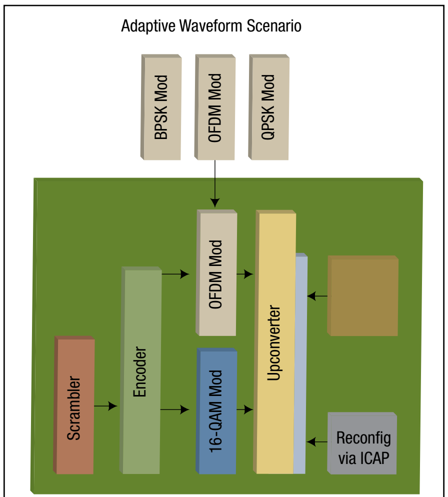

Figure 2

Adaptivity at the application level in a PR FPGA. (ICAP is the Internal Configuration Access Port, a widget internal to Xilinx FPGAs.)

and digital up-converters (DUCs). These components are made up of a number of different functions. It is common for waveforms to support different bit rates or sampling rates and, when a change occurs, the waveform components would have to adapt to support the new rate.

In an SDR/CR, adaptivity at the function or component level is "under the hood," transparent to the user. At those levels, the user does not see the modifications necessary to support the service required. But the next two levels are visible to the user and, as such, the user may desire some form of control over adaptivity.

The application level is a common functional level of adaptivity in SDRs/CRs. At this level, adaptivity refers to modifications that would occur within a given application. The most common applications in an SDR/CR are waveforms such as Wideband Networking Waveform (WNW). Depending on the mission profile, the user may need to switch waveform modes, so the radio needs to be able to accommodate this switch.

The highest functional level of adaptivity is services. At this level, the services adapt to changing conditions by calling on available applications as needed. Common examples of services include radio, network awareness, ad-hoc networking and even anti-jam. Again, the services required are a function of the mission profile and the SDR/CR will need to be able to adapt accordingly.

Note that these levels of adaptivity are not mutually exclusive. Rather, in many ways they are interdependent because adaptivity at each level depends on the previous levels for implementation. For example, the user might call on the radio service to transmit data. The service would include adapting to the available spectrum by scanning RF and then selecting the best waveform for sending the data. If the waveform is an adaptive waveform, then certain channel characteristics might require modification of waveform components and functions in order to compensate.

Supporting Adaptivity in FPGAs

Due to their processing throughput and ability to be reconfigured, FPGAs are common processing devices used today in SDRs/CRs. However, even with FPGAs, there are varying levels of capability to support adaptivity.

At the lowest level, FPGAs can be one-time configurable, hence not reconfigurable. Obviously, such devices are not ideal for SDRs/CRs as they cannot adapt to support new functionality after the first time they are programmed.

The next level of configurability is reconfigurability. As the name implies, these types of FPGAs can be configured multiple times. In fact, they can be dynamically reconfigured on the fly, making them suitable for SDRs/CRs. However, in many cases, these FPGAs have to be completely reconfigured, which limits the capability of the FPGA to support adaptivity at the component or function level since these levels involve more granularity. As a result, support is generally limited to adaptivity at the application or services level. Most reconfigurable FPGAs today fit into this category, including Xilinx's Spartan FPGA family.

Partially reconfigurable FPGAs allow for the next level of adaptivity. Like reconfigurable FPGAs, PR FPGAs can be dynamically configured multiple times. However, only a portion of the device needs to be configured at any given time. This provides a level of granularity suitable for adaptivity at the component and even at the function level. The Xilinx Virtex-II and Virtex-4 families are examples of PR FPGAs.

Finally, the "ultimate" level of reconfigurability is the ability to reconfigure the smallest atomic programmable unit of an FPGA, the configurable logic block (CLB), on an individual basis. This allows for even finer levels of granularity for adaptivity at the function level. However, it is not clear that the benefit of such a fine-grained approach outweighs the cost of implementation associated with such a high level of sophistication.

Use Cases

There are many use cases for enabling the adaptivity of a PR FPGA in SDRs/CRs, from the function level to the service level. We'll cover two cases: a typical case for an SDR supporting an adaptive waveform, which demonstrates application-level adaptivity, and a multi-INT platform providing multiple applications to the user, demonstrating service-level adaptivity.

In the first case, a user is transmitting voice or data on an adaptive waveform from an SDR to another radio. At some point, perhaps due to environmental conditions, the channel starts to fade. To the SDR, this is characterized by an increased bit error rate beyond a certain threshold. In order to maintain the channel, the radio determines that the waveform needs to be adapted to the new environment. Adaptivity could take many potential forms including changing the modulation technique, the method of forward error correction and/or the bit rate. For the example in Figure 2, assume that the radio has determined that a change in modulation technique is optimal. The modulator is represented as a 16-Quadrature Amplitude Modulation (QAM) modulator. It needs to be swapped out with another available modulator component—a Binary Phase Shift Keying (BPSK), Quadrature Phase Shift Keying (QPSK) or Orthogonal Frequency Division Multiplexing (OFDM) modulator. The OFDM modulator is chosen for its re-

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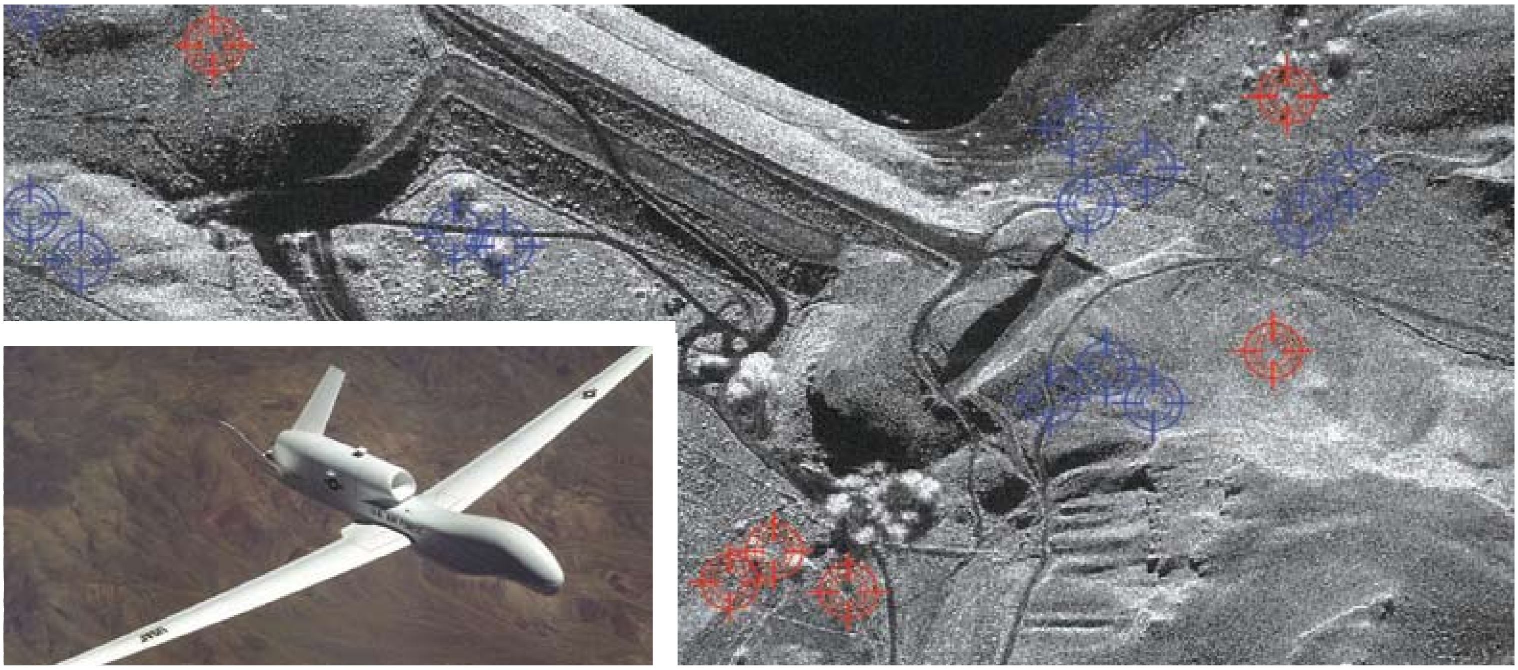

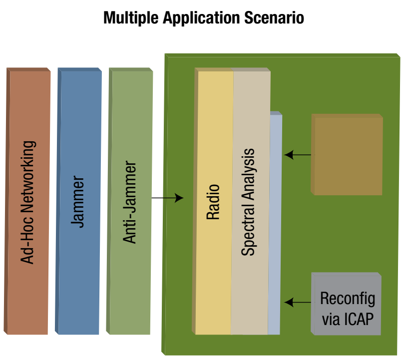

Figure 3

Adaptivity at the service level in a multi-INT platform. (ICAP is the Internal Configuration Access Port, a widget internal to Xilinx FPGAs.)

sistance to multi-path. With a regular reconfigurable FPGA, to support this type of component-level adaptivity, the FPGA would have to be sufficiently large to load all possible components, even if many of them are not being used at any single point in time. Reconfiguring the entire device would result in losing the communications channel—an unacceptable outcome. By contrast, a PR FPGA would only have to load the OFDM modulator in an available portion of the device and then make the switch from 16-QAM to OFDM modulator. The 16-QAM modulator could then be unloaded to free up resources for another application or component. The outcome is the same, but the PR FPGA can be much smaller, resulting in a significant power and cost savings.

The second case involves a multi-INT platform (supporting COMINT, ELINT, etc.) that uses services to invoke many applications including radio, spectral analysis, surveillance, jamming and anti-jamming, as shown in Figure 3. Although multi-INT platforms are not commonly used today, the advent of CR will bring about this next revolution in communications. In this scenario, a user may be receiving data. The radio service is being utilized to call on two applications: the spectral analysis application to characterize the spectrum and identify potential threats or signals of interest, and the radio application to receive the data. At some point, an interfering signal may be jamming the receiver, severely impairing the ability of the user to receive crucial intelligence. In such a case, the user may call on the anti-jamming service to null the interfering signal. This service would characterize the interfering signal, using the spectral analysis application, and would then load the anti-jammer application to null the interferer. Once the jamming signal goes away, the anti-jammer application can be unloaded by the anti-jamming service. Other services could then load available applications, such as an ad-hoc networking application to create a mesh network, on an as-needed basis.

It's clear that adaptivity at all levels, from functions to services, is a highly desired attribute in SDRs/CRs. Although users will be exposed primarily to adaptivity at service and application levels, adaptivity at component and function levels is necessary for implementation. As CRs and multi-INT platforms become more prevalent, the need for dynamic adaptation will increase and will ultimately become a competitive advantage for those vendors who are able to accommodate different levels of adaptivity. PR FPGAs are ideally suited for adaptivity at all levels and have sufficient granularity to allow users to reconfigure portions of the device down to the size of typical functions in an SDR/CR. ▮

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Main Feature

Software Defined Radio

Software Assurance Is Critical to SDR Success

There is a fear that software radios will inherit the problems of PCs, including their unreliability and their vulnerability to malicious code. But, digital signature technology coupled with high-assurance COTS operating systems can enforce a wide range of SDR security requirements.

Bernard C. Eydt, Associate
Booz Allen Hamilton

To date, much security work for software defined radio (SDR) focuses on traditional communications security issues, particularly the confidentiality of voice and data transmissions. So when people hear "security," they think about data encryption, key management and the separation of classified and unclassified data. However, SDR security involves a broader range of issues, many under the rubric of software assurance. In short, radio users need to have confidence that radio software will perform as advertised—to know that the code was developed using reliable software development methods, was thoroughly tested by someone they trust and wasn't changed after the testing was completed.

Radio Software Assurance

Ultimately, software assurance may be more important to many radio users than traditional communications security. In today's world, the risk that an adversary will expend resources to crack the cryptography protecting real-time or tactical wireless communications is small relative to other threats. Conversely, the risk that bad code could cause a radio to malfunction or cause interference with other legitimate radio communications is very real. In a worst-case scenario, bad code may have worm-like replicating behavior, impacting the radio communications of an entire organization or community of users. In the absence of appropriate controls, adversaries interested in compromising communications security may find that replacing SDR code on a radio platform is much easier than cracking its cryptosystem. To explain the difference between communications security and software assurance, Table 1 lists potential attacks on both.

Assurance is significantly more difficult for SDR than it is for traditional hardware-based radios. Once a hardware radio design has been certified to meet functional and security requirements, users can be confident that radios off the production line will meet the requirements through the radio's lifetime. Tampering with radios is possible, but it can only be done to one radio at a time. The adversary must have physical contact with the radio and technical expertise.

SDR changes the threat. Software updates can modify multiple radios simultaneously. Physical contact is not necessary because malicious code can be inserted during the development process or during remote software downloads. User-friendly software tools may allow adversaries to modify radio code and its behavior with relatively little expertise.

Software Certification

Software certification can provide required levels of assurance. Comprehensive SDR certification could ensure that adversaries cannot circumvent security controls. It should include examination of

Attacks on Radio Communications	Attacks on Radio Software
• Eavesdropping • Jamming • Man-in-the-middle • Impersonation/spoofing	• Insertion of malicious code • Exploitation of buffer flows and other coding flaws • Privilege elevation • Covert channel analysis

Table 1

Potential SDR Security Attacks

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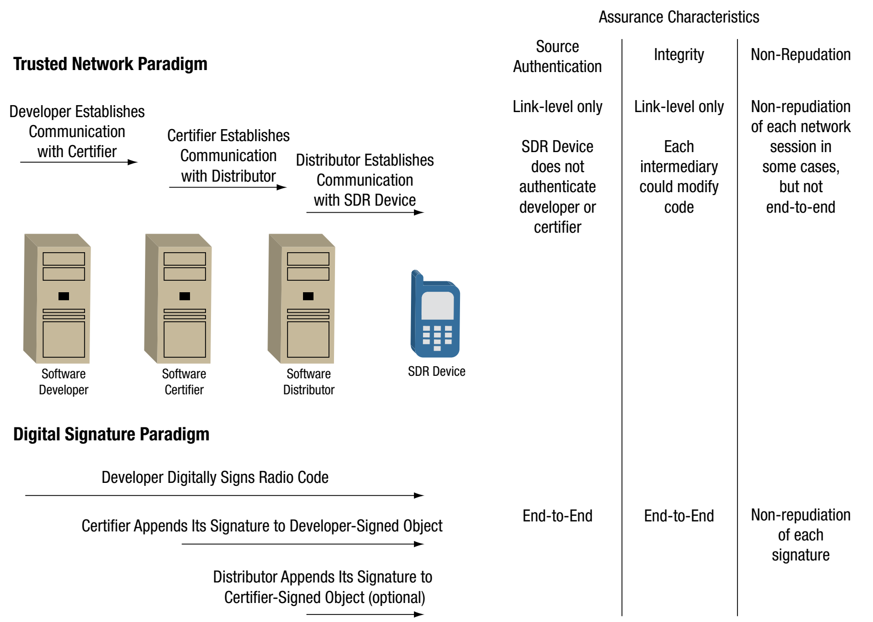

Figure 1

Comparison of Trusted Network and Digital Signature approaches to secure software distribution.

the SDR device boot procedure and mechanisms to achieve process separation and memory isolation. Table 2 lists potential controls and countermeasures that should be tested during certification.

SDR certification is largely in its infancy. The National Security Agency (NSA) provides the most comprehensive program—security testing of SDR technology developed for the Joint Tactical Radio System (JTRS). But details of the program are classified, which limits the scope to the U.S. DoD, effectively precluding other SDR users, including U.S. allies, from leveraging it.

The Federal Communications Commission (FCC) also has an SDR certification program, but it has no defined methodology, preferring a case-by-case approach at this stage in the evolution of SDR technology. Only one company—Vanu—has successfully navigated the process to obtain a license. The good news is that most FCC proceedings are public, which means others will benefit from advances made in this area. The not-so-good news is that FCC's interests are narrowly focused on illegal radio interference, which is only one aspect of the range of SDR security issues to be addressed. Typically, FCC activities are not applicable to military or non-U.S. communications.

For the commercial aviation industry, the U.S. Federal Aviation Administration's Advisory Circular 20-115B establishes Radio Technical Commission for Aeronautics (RTCA) DO-178-B guidelines as a de facto assurance standard for software development. But these guidelines do not specifically address radio software or security considerations, focusing instead on development practices and documentation.

The SDR Forum has plans to develop protection profiles that could be used in certifications of SDR implementations under the Common Criteria. Common Criteria certification has a number of valuable characteristics—certifications are internationally accepted and the process is widely viewed as rigorous. However, the certification process is lengthy (several months to a year) and expensive (typically over $250,000)—perhaps prohibitively so for an emerging technology experiencing rapid change. In addition, the SDR Forum is unlikely to complete its protection profile work before 2008, meaning that Common Criteria certification is a medium-term solution at best.

Software testing and certification is a critical component of software assurance. SDR users should be advocates for its continued progress, but maturity is still years away. In the interim, both the developers and consumers of SDR technology need to build internal controls to ensure that SDR technology risks are mitigated.

Code-Signing Radio Software

An important tool in software assurance is the application of digital signatures to software objects. A digital signature on radio code binds the identity of the signatory to a specific instance of the code. This action has several important characteristics. First, it provides a high degree of integrity assurance—the software has not changed since it was signed. Second, it provides non-repudiation—a signatory cannot later deny signing the object. These properties of digital signatures derive from features of asymmetric or public key cryptography and therefore will be accompanied by a public key infrastructure (PKI).

Onboard Communications Security Controls	Onboard Software Assurance Controls
• Mutual authentication • Cryptographic confidentiality protections (symmetric key algorithms) • Cryptographic integrity protections (hash algorithms) • Frequency hopping/agility	• Secure boot procedure (including software integrity checks) • Process separation • Access control • Digital signature verification • Independent levels of security

Table 2

Software Radio Controls and Countermeasures

Signed code is not necessarily good code. The signature may signify nothing more than that a particular entity is choosing to associate with the code—most likely a developer meeting a security requirement to sign its product. However, other organizations might only sign code if it first passes a rigorous series of tests. Indeed, the assurance that the signature provides depends more on what operational practices are required to obtain the signature than on the signature's cryptographic strength.

Fortunately, the code-signing model provides user communities a path to enhance assurance over time. Near term, signatures can provide assurance of the code's integrity and that it comes from a known source. Long term, signatures provide evidence of security certification. From the perspective of the radio platform, both levels of assurance can be obtained using the same cryptographic modules for digital signature verification, which could be relatively easily obtained today using widely available COTS software libraries and tools.

Security professionals are nearly unanimous that the code-signing approach is ideal for SDR. The SDR Forum, European End-to-end Reconfiguration (E2R) Project and university researchers all recommend a concept of operations based on digital signatures. Most also envision multiple signatures on software objects. For example, the radio platform manufacturer might sign executable code to signify its compatibility with its systems, an independent lab might sign to signify that certain security functionality is present, while a government agency might sign it to signify that it is suitable for a particular application. Multiple countries might sign software for international applications. The permutations are endless, but they need not be predetermined because digital signature mechanisms could be designed to support all of them.

Manufacturers and users are embracing the approach, albeit much more slowly than preferred. For example, the Security Supplement to the JTRS Software Communications Architecture (SCA) requires that SDR devices "shall only accept cryptographic algorithms/algorithm packages signed by NSA," that "NSA shall digitally sign all Security Policy XML files," and that "the [operating system] invocation method shall be a NSA digitally signed script." However, SDR middleware and tools vendors supporting JTRS customers do not yet support digital signature features within their products, although they express openness to including such features in future releases. Similarly, user and manufacturer representatives in the SDR Forum's Public Safety SIG are trying to identify alternatives to digital signatures before committing to such an approach, largely due to perceptions about PKI technology complexity.

The Trusted Network Approach

One alternative to digital signatures is to distribute radio software over a trusted network. The idea is that if strong authentication is required to attach to the network and the data that traverses the network is encrypted, this provides assurance that the code comes only from known sources and is not modified during distribution. The FCC rules on SDR explicitly allow such an approach, which Vanu implemented for its Anywave Base Station. Military and commercial aviation sources suggest that secure networks, combined with well-defined operational practices, may adequately protect the radio software integrity during distribution.

Unfortunately, the trusted network approach is at best an interim solution restricted to highly vertical integrated SDR service providers—organizations that have control over everything from development of the software to its operation in the field. Vanu is such an organization because it both builds and operates its SDR solution, but in the future its ambitions may push it beyond this limiting model. Military SDR communications can also fit into this model if its personnel and various contractors are perceived as a single unit, but the resemblance breaks down as the number of vendors proliferates and with requirements for joint operations and radio communication with allies.

The core problem of the trusted network approach is that it assumes that radio code can be limited to such a network. In the real world, this restriction poses a significant burden on all parties that need to touch the software at some point in its life cycle—developers, auditors, certifiers, network operators and users. The model fails to provide non-repudiation for specific instances of code and does not work well with Mobile Ad-hoc Networks (MANETs), whose infrastructure cannot be predetermined by definition. The code-signing approach, on the other hand, preserves the integrity of code and certification bindings even when the software is retrieved off an enemy's server, a characteristic that enables enormous flexibility in its distribution. The only requirement is that each signatory maintains the secrecy of its private key, which should never be shared with another entity in any case. Figure 1 illustrates relationships between various entities in the code-signing and trusted network paradigms.

The Dilemma of Software Patches

An important value proposition of SDR is reconfigurability. While hardware radio retrofits are rare, software radios expect to receive periodic upgrades. Ideally, the updates will be to enhance functionality or performance, but some updates will be required to correct an error or security vulnerability discovered after the software is installed.

Software patches are problematic. On the one hand, assurance requirements dictate full testing of the patch followed by appropriate digital signatures. On the other hand, operational requirements dictate that patches be

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applied quickly to avoid mission failure, a security breach, revenue loss or some other adverse consequence. A significant risk exists that the patch could cause more damage or introduce a greater vulnerability than the code it replaces—that the cure might be worse than the disease—which is made all the more probable when patches are written hastily in a crisis environment.

In most environments, assurance requirements are subordinate to immediate operational needs. Adversaries will try to exploit this situation if they know that security controls are significantly reduced or even ignored for patches. Designing for high-assurance SDR environments requires procedures and mechanisms that resolve the tension between responding in a timely manner and preserving the integrity of information assurance processes. The best way is to develop expedited testing processes for emergency patches and include an expiration date in signed patches that effectively forces entry into the complete assurance process after the emergency has passed.

The Future of SDR Security

The long-term vision for SDR includes modular, reusable and portable software components. Realizing this vision enables exciting new business models in which companies can focus on aspects of radio functionality, rather than integration of entire communications devices. The SDR industry may begin to look like the early personal computer industry, with similar levels of growth and technical innovation. Yet in the vision is also the fear that radios will inherit the problems of PCs, including their unreliability and their vulnerability to malicious code. Fortunately, this time around we are much better prepared. Today, digital signature technology coupled with high-assurance COTS operating systems can enforce a wide range of SDR security requirements. The future of SDR security depends largely on whether SDR vendors and customers will choose to use them.

Bernie Eydt is chairman of the SDR Forum's SDR Security Working Group.

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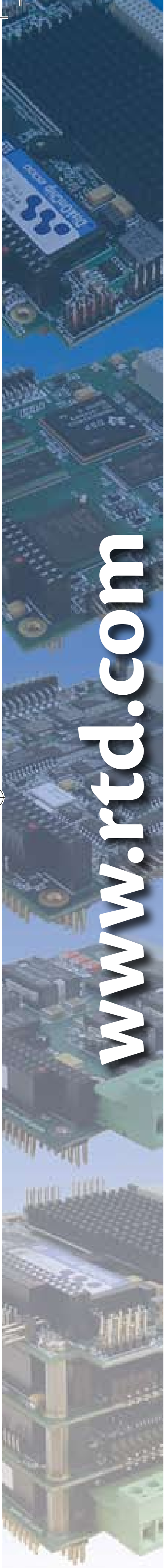

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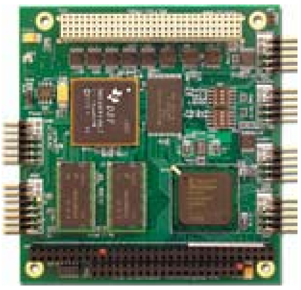

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		Pentium® M			Intel® Celeron®				VIA Eden™				AMD Geode			486DX	
Bus	AT Expansion Bus				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bus	PCI Universal Expansion Bus	✓	✓	✓		✓		✓		✓		✓		✓	✓		
Bus	PCI Bus Masters	4	4	4		4		4		4		4		4	4		
Bus	APIC (add'l PCI interrupts)	9	9	9	9	9	9	9									
CPU and BIOS	CPU Max Clock Rate (MHz)	1400	1100	1000	650	650	650	650	1000	1000	1000	1000	333	333	333	100	100
CPU and BIOS	L2 Cache	2MB	2MB	512k	256k	256k	256k	256k	64k	64k	64k	64k	16k	16k	16k	16k	16k
CPU and BIOS	Intel SpeedStep® Technology	✓	✓														
CPU and BIOS	ACPI Power Mgmt	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0					
CPU and BIOS	Max Onboard DRAM (MB)	512	512	512	512	512	512	512	512	512	512	512	256	256	256	32	32
CPU and BIOS	RTD Enhanced Flash BIOS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CPU and BIOS	Nonvolatile Configuration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CPU and BIOS	Quick Boot Option Installed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CPU and BIOS	Fail Safe Boot ROM				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CPU and BIOS	USB Boot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Peripherals	Watchdog Timer & RTC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Peripherals	IDE and Floppy Controllers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
Peripherals	SSD Sockets, 32 DIP	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
Peripherals	Audio	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Peripherals	TFT Panel TTL or LVDS	✓	✓	✓			✓	✓			✓	✓	✓	✓			
Peripherals	SVGA Interface	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Peripherals	AT Keyboard/Utility Port	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Peripherals	PS/2 Mouse	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Peripherals	USB Mouse/Keyboard	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
I/O	RS-232/422/485 Ports	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
I/O	USB 2.0 Ports	2	2	2													
I/O	USB Ports				2	2	2	2	2	2	2	2	2	2	2		
I/O	10/100Base-T Ethernet	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
I/O	ECP Parallel Port	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
I/O	aDIO™(Advanced Digital I/O)	18	18	18	18	18	18	18	18	18	18	18	18	18	27		
I/O	multiPort™(aDIO, ECP, FDC)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
SW	ROM-DOS Installed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SW	DOS, Windows, Linux	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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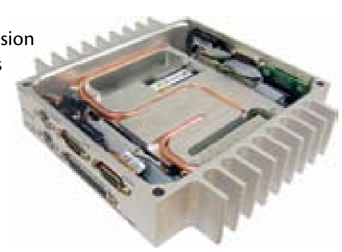

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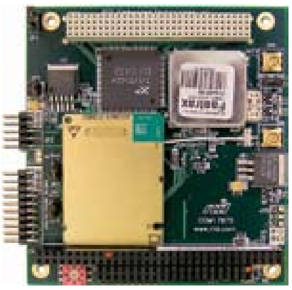

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Bus	AT Expansion Bus	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PCI Expansion Bus Master			✓	✓			✓	✓						✓
	McBSP™ Serial Ports		✓	✓	✓			✓	✓						
Analog Input	Single-Ended Inputs	16	16	16	16	16	16	16	16						
	Differential Inputs	8	8	8	8	8	8	8	8						
	Max Throughput (kHz)	500	1250	1250	1250	500	100	1250	100						
	Max Resolution (bits)	12	12	12	12	12	16	12	16						
	Input Ranges/Gains	3/4	3/7	3/7	3/7	3/4	1/4	3/6	1/4						
	Autonomous SmartCal™	✓	✓	✓	✓										
	Data Marker Inputs	3	3	3	3	3		3							
Conversions	Channel-Gain Table	8k	8k	8k	8k	8k	8k	8k	8k						
	Scan/Burst/Multi-Burst	✓	✓	✓	✓	✓	✓	✓	✓						
	A/D FIFO Buffer	8k	8k	8k	8k	8k	8k	8k	8k						
	Sample Counter	✓	✓	✓	✓	✓	✓	✓	✓						
	DMA or PCI Bus Master	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓
	SyncBus		✓	✓	✓			✓	✓						
Digital I/O	Total Digital I/O	16	16	16	16	16	16	16	16	16	48	32	64	32	48
	Bit Programmable I/O	8	8	8	8	8	8	8	8	8	24				48
	Advanced Interrupts	2	2	2	2	2	2	2	2	2	2				2
	Input FIFO Buffer	8k	8k	8k	8k	8k	8k	8k	8k						2M
	Opto-Isolated Inputs											16	48	16	
	Opto-Isolated Outputs											16	16		
	User Timer/Counters	2	3	3	3	2	2	3	2	3	3				10
	External Trigger	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓
	Relay Outputs													16	
Analog Out	Analog Outputs	2	2	2	2	2	2	2	2	4					
	Max Throughput (kHz)	200	200	200	200	200	100	200	100	200					
	Resolution (bits)	12	12	12	12	12	16	12	16	12					
	Output Ranges	4	4	4	4	3	1	4	1	4					
	D/A FIFO Buffer		8k	8k	8k			8k		8k					

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SDR Forum Targets International Acceptance of SCA

Open SDR standards provide significant benefits to all stakeholders, including: platform and system developers, application developers, system integrators, regulators, service providers and end users. The SDR Forum has chartered the SCA Working Group to facilitate broad international acceptance of SCA as an open standard for wireless communications.

Mark Turner, Director Software and Secure Products Engineering, Harris Corporation

The SDR Forum recently established an SCA Working Group to facilitate broad international acceptance of the Software Communications Architecture (SCA) across all SDR domains around the globe, including civil, commercial and military sectors. The SCA was developed by the U.S. DoD as a foundational element of the Joint Tactical Radio System (JTRS) Program, providing an open architecture framework enabling programmable radios to load waveforms, run applications and be networked into an integrated system.

There are significant benefits to be derived from the development and adoption of open standards for SDR including enabling interoperability within and between market sectors and sharing platform knowledge, which can reduce the costs and risks commonly associated with innovation. Further benefits include the facilitation of software reuse—reducing development costs and product time-to-market—and aiding market competitiveness, which makes possible the use of third-party products as cost-effective solutions. Finally, open SDR standards facilitate the development and integration of advanced applications such as Cognitive Radio and the coordination of the myriad regulatory concerns around the globe.

Figure 1

50W AN/PRC-152 from Harris Corporation.

Software Communications Architecture

The SCA Specification and its associated supplements define a standard set of rules and protocols for SDR applications (such as waveforms), utilizing Component Based Development (CBD) as the underlying software technology. Software applications are assembled from a set of discrete software components with defined properties, interconnected via externally specified interfaces. Components inherit much of the characteristics of objects in the Object Oriented (OO) paradigm, but decouple the external specification from internal mechanisms and implementations. Therefore, components are not bound to specific applications, programming languages or platforms, making them ideal for broad software reuse. CBD technology has the potential to facilitate the "industrial revolution of software development."

The SCA consists of an Operating Environment (OE) and applications. The OE provides an infrastructure that abstracts the underlying software and hardware of the radio platform, including:

- A POSIX-compliant operating system
- Middleware for distributed processing
- Core Framework (CF) applications for system configuration and control
- Services/Devices that provide radio platform capabilities to applications through APIs

For the JTRS Program, several military waveform applications that are under development are intended for reuse across different radio platforms. As the

Group or Board	Purpose	Chair
Configuration Control Board (CCB)	Review, approve and release revisions of work products.	Mark Turner, Harris Corporation; Christian Serra, Thales Group
Architecture Control Board (ACB)	Ensure technical correctness and consistency across work products.	TBD
Technical Advisory Group (TAG)	Technical responsibility for advising with regards to the SCA specification. Develop clarifications, resolve contradictions, generate and review change proposals.	Steve Bernier, Communications Research Center; Murat Bicer, Mercury Computer Systems
API Group	Develop APIs, provide clarifications, resolve contradictions, generate and review change proposals.	Rick Woodring, Nova Systems Solutions
Test & Evaluation Group	Facilitate test, evaluation and certification methods for SCA-based SDRs, increasing capacity for U.S. DoD, EU MoDs and commercially developed SDRs.	Pete Cook, Hypres, Inc.; Ruediger Leschhorn, Rohde & Schwarz
Standards Management Board	Establish and maintain policy, processes and procedures for development, approval and maintenance of standards.	Terry Anderson, ITT Industries
SCA Transition Ad Hoc Group	Establish procedures, set up infrastructure, perform analysis of SCA information.	Dominick Paniscotti, PrismTech
SCA Scalability Ad Hoc Group	Identify and describe broad set of SDR operating domains to be covered by SCA. Define extensions (or contractions) of specifications to meet requirements.	Max Robert, Virginia Tech University
JTRS JPEO Liaison Group	Primary interaction with JTRS JPEO; ensure JPEO objectives and interests are represented.	Bruce Fette, General Dynamics Corporation
International Liaison Group	Identify relevant international organizations and establish liaisons, ensure objectives and interests are represented.	Pekka Heikkinen, Elektrobit Ltd.; Co-chair TBD

Table 1

SCA Working Group Organization

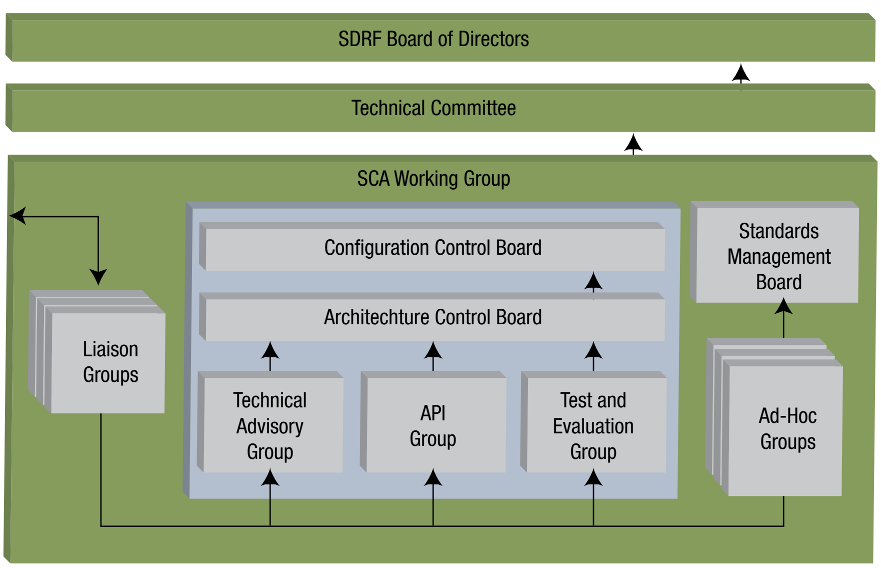


Figure 2

SCA Working Group Operations and Work Flow

result of a recent reorganization, the JTRS Joint Program Executive Office (JPEO) is now responsible for the development and integrity of the SCA.

SCA implementations are not limited to JTRS Programs. A number of SCA-based military radio demonstration systems have been developed internationally (in Finland, Sweden, France and Italy), and at least one commercially developed SCA radio product, the AN/PRC-152, is being sold for U.S. military applications by Harris Corporation. Figure 1 shows a picture of a 50W vehicular configuration of the AN/PRC-152. The current revision of the SCA Specification is available through the JTRS Web site (http://jtrs.army.mil/).

SCA Working Group

The SDR Forum is an international industry association dedicated to supporting the development, deployment and use of SDR technologies for advanced wireless systems in civil, commercial and military domains. The SDR Forum's numerous working groups and special interest groups are focused on all facets of SDR technology—including market, regulatory and technical issues.

The SCA Working Group was established as an organization within the SDR Forum Technical Committee and provides the SDR community with a venue to participate in open discussion of SCA requirements, architecture characteristics and Application Programmer Interfaces (APIs), to review and recommend changes to existing specifications, and to create supporting and complementary specifications. It also provides SCA education through specification clarifications, guidance and reference implementations in conjunction with establishment of frameworks for certification methods, tools and capacity outside of the DoD.

The SCA Working Group is chartered with facilitating the structural harmonization of the SCA and its elements with other associated standards, helping the industry converge on a consolidated set of solutions. It will address the scalability of the SCA as it is currently defined and propose evolutionary changes to ensure the full breadth of SDR domain coverage in conjunction with alignment to emerging SDR advanced applications such as Cognitive Radio. As part of its activities, the Working Group is generating the policy, processes and procedures to support the development and adoption of relevant SDR standards, with the SDR Forum becoming a full-functioning international standards organization.

The SCA Working Group is responsible for the development, review, approval and configuration control of group work products, including SCA change proposals, API definitions, supporting specifications and reference implementations. The Working Group is intended to serve in an advisory capacity for the SCA Specification, providing evaluation and industry perspective on SCA change proposals, in conjunction with generating other pertinent change proposals. The development and promulgation of standard APIs that can be utilized outside the DoD (including international environments) is essential in order to gain broad acceptance of the SCA. So the Group is developing API strategies and ultimately full API definitions to meet these requirements.

The SCA Working Group provides recommendations to the SDR Forum Technical Committee and Board of Directors for final approval of all work products to be released for SDR community access. It is open to participation by any interested organization (commercial companies, government or nonprofit organizations); however, the approval and adoption of work products by the SCA Working Group is restricted to SDR Forum members through a formal voting process. The Working Group is co-chaired by Mark Turner (Harris Corporation) and Pekka Heikkinen (Elektrobit) and operates through a series of interrelated groups and boards, each with a defined charter and set of roles and responsibilities. Table 1 identifies the current set of groups and boards established by the SCA Working Group, the purpose of each group or board and the appointed chair or co-chairs.

The Configuration Control Board, Architecture Control Board, Technical Advisory Group, API Group and Test & Evaluation Group collectively form the core of the SCA standards development activity. These groups are standing organizations that function in accordance with the policy, process and procedures developed by the Standards Management Board. Ad Hoc Groups are formed as necessary, with a focus on a particular topic area or task. The completed work of an Ad Hoc Group will typically flow into one of the standing groups for further action or finalization. The Liaison Groups provide interfaces with external stakeholder organizations, such as the JTRS JPEO. Figure 2 depicts operations and workflow through the SCA Working Group organization.

SCA Working Group Operations and Work Flow

SDR is an enabling technology, facilitating the advancement of communications capabilities and applications across the full breadth of the wireless domain. The development and promulgation of open SDR standards can provide significant benefits to all SDR stakeholders, including: platform and system developers, application developers, system integrators, regulators, service providers and end users. The SDR Forum, as a representative for all SDR stakeholders, has chartered the SCA Working Group to facilitate convergence on a consolidated set of solutions through broad international acceptance of SCA as an open standard for wireless communications. The SCA Working Group, through participation of the SDR Forum membership and in cooperation with other wireless industry organizations, is working toward achievement of this important objective through a combination of technological, regulatory and market-driven perspectives.

Mark Turner is on the board of directors for Software Defined Radio Forum and serves as co-chair of the forum's SCA Working Group.

Harris Corporation
Rochester, NY.
(585) 244-5830.
[www.harris.com].

JTRS
[www.jtrs.mil].

SDR Forum
Denver, CO.
(303) 628-5461.
[www.sdrforum.org].

Network Issues Drive UAV Control Strategies

Until their onboard processing densities enable near-complete autonomy, communications technologies remain a critical issue for Unmanned Aerial Vehicle control systems.

Jeff Child
Editor-in-Chief

Airborne data link rates and processor speeds are in a race to enable future UAV capabilities. For the near-term, U.S. Military strategy is to relay virtually all airborne data to the ground and process it there for interpretation and decision making. But eventually, onboard processing power will outstrip data link capabilities and allow UAVs to relay the results of their data to the ground for decision making. At that point, the requirement for data link rates in certain applications, particularly imagery collection, should drop significantly.

Tasked to capture and download secure, encrypted surveillance data, today's advanced surveillance UAVs require a lot of communications overhead (Table 1). If processing of data and decision making can be performed onboard the UAV itself rather than performed via a communication link with the ground, the more efficiently the craft can be used.

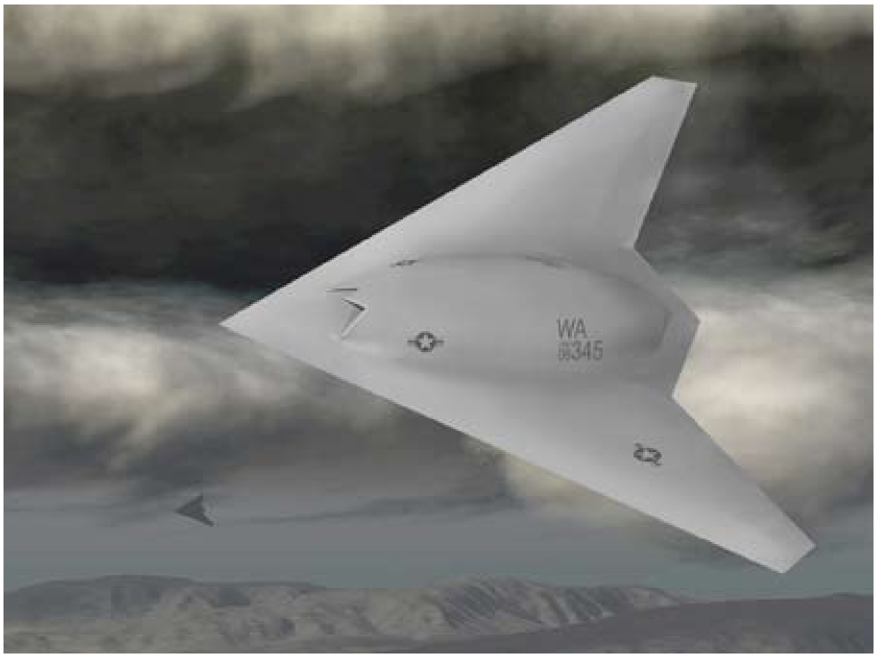


Figure 1

The X-45C unmanned combat air vehicle, a concept aircraft based on the current X-45A, is designed to meet both the Air Force's evolving need for greater range and loiter capability and the Navy's requirements for potential carrier suitability and other Navy-unique needs. The first flight of the X-45C air vehicle is scheduled for early this year. (Image courtesy of DARPA.)

The communications technologies used for UAVs call for flexibility, adaptability and cognitive controllability of the bandwidth, frequency and information/data flows. This means that the systems will be net-centric and that network services—like command and control, data management and flow control—will have to be integrated into the systems and concepts of operations. One way of addressing bandwidth and spectrum constraints is by reusing certain communications paths in new ways. Communications technologies might be repartitioned to address apertures, RF Front ends, software-defined modems/bandwidth-efficient waveforms, multiple signals in space, crossbanding, digital interfaces, new communications approaches like free space optics, and hybrid approaches.

Data Compression Required

Meanwhile, data compression remains an important adjunct as long as band-limited communications exist, but it is unlikely compression algorithms alone will solve the near-term throughput requirements of advanced sensors. For now, compression is a concession to inadequate bandwidth. In the case of radio frequency (RF) data links, limited spectrum and the requirement to minimize airborne system size, weight and power (SWAP) have been strong contributors for limiting data rates. Rates up to 10 Gbits/s (40 times currently fielded capabilities) are considered possible at current bandwidths by using more bandwidth-efficient modulation methods. At gigahertz frequencies, however, RF use becomes increasingly constrained by frequency congestion. This is especially true for the 1-8 GHz range, which covers L, S and C bands. Currently fielded digital data links provide an efficiency varying between 0.92 and 1.5 bps/Hz, where the theoretical maximum is 1.92.

Airborne optical data links, or lasercom, will potentially offer data rates two to five orders of magnitude greater than those of the best future RF systems. However, lasercom data rates have held steady for two decades because their key technical challenge was adequate pointing, acquisition and tracking (PAT) technology to ensure the laser link was both acquired and maintained.

Although mature RF systems are viewed as lower risk, and therefore attract investment dollars more easily, Missile Defense Agency funding in the 1990s allowed a series of increasingly complex demonstrations at Gbit/s rates. The small apertures (3 to 5 inches) and widespread availability of low-power semiconductor lasers explain why lasercom systems typically weigh 30% to 50% that of comparable RF systems and consume less power. The smaller apertures also provide for lower signatures, greater security, and provide more jam resistance. Although lasercom could surpass RF in terms of airborne data transfer rate, RF will continue to dominate at the lower altitudes for some time into the future because of its better all-weather capability. Forecasters of both technologies expect that RF and optical technology development should continue to progress out to 2025.

Classes of U.S. Military Reconnaissance UAVs

Tactical		Specialized		Endurance	
Over-the-Hill	Close Range	Maritime	Penetrating	Medium Range	Long Range
Dragon Eye FPASS Raven	Hunter Shadow	Pioneer *Fire Scout*	*J-UCAS*	Predator	Global Hawk

Table 1

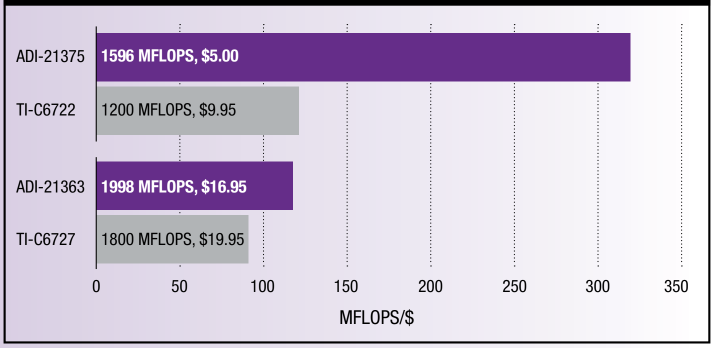
Reconnaissance and surveillance are the main mission of today's proven UAVs listed here. Designed to capture and download secure, encrypted surveillance data, today's advanced surveillance UAVs require a lot of communications overhead. As more processing of data and decision making can be performed onboard the UAV itself rather than via a communication link with the ground, the craft becomes more efficient and flexible. (Systems not yet fielded shown in italics.)

Java Suited for UAVs

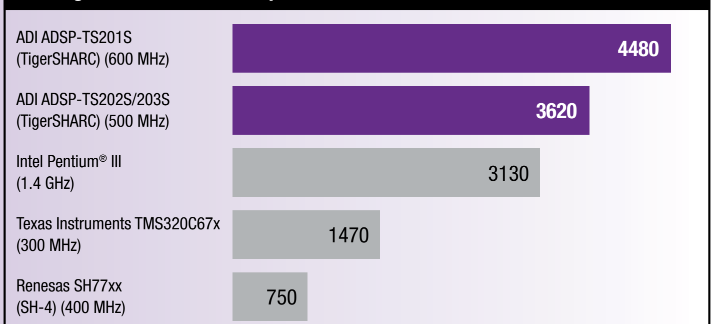
The networking, security and portability of the Java language make it a natural fit for large-scale networked applications like UAV communications and control. Java's unique virtual machine, write once, run everywhere structure fits the bill perfectly for systems like UAVs that must be reprogrammed for different mission tasks. Last fall, Boeing selected Aonix's PERC real-time embedded Virtual Machine (VM) for the Joint Unmanned Combat Air Systems' (J-UCAS) X-45C program.

The J-UCAS program is a joint Defense Advanced Research Projects Agency (DARPA), U.S. Air Force and Navy effort to demonstrate the technical feasibility, usefulness and operational value of networked unmanned combat vehicles. J-UCAS (Figure 1) will employ a Common Operating System, integrating the system components, which will provide the necessary software and services that enable system functionality, while minimizing the impact of platform constraints. High-performance unmanned air vehicles complete with intelligent weapon systems are being designed to suppress enemy air defenses, provide surveillance and execute precision air strikes within the emerging global command and control architecture. ▮▮

SHARC Processor Leadership in MFLOPS/$



Leading Performance vs. Competition



BDTi BENCHMARK PARTNER The BDTImark2005™ provides a summary measure of DSP speed. For more information and scores see www.BDTI.com. Scores© 2005 BDTI.

"Floating-point processing essentially eliminates concerns about dynamic range and ensures precision in the most intensive and demanding signal processing tasks—but it's been an expensive alternative in terms of both cost and power. Architectural advances are now making this capability far more widely accessible."

— Dr. Alan Oppenheim
Ford Professor of Engineering
Massachusetts Institute of Technology

SHARC Advantages

- Broad portfolio of code- and pin-compatible processors starting at $5 and providing 2.4 GFLOPS of signal processing performance
- High precision computation enabled by SHARC's 32-bit fixed- and floating-point architecture
- Up to 400 MHz core instruction rate
- Single-Instruction Multiple-Data (SIMD) computation architecture
- Simplified system design and lower system cost via a wide array of integrated peripherals

TigerSHARC Advantages

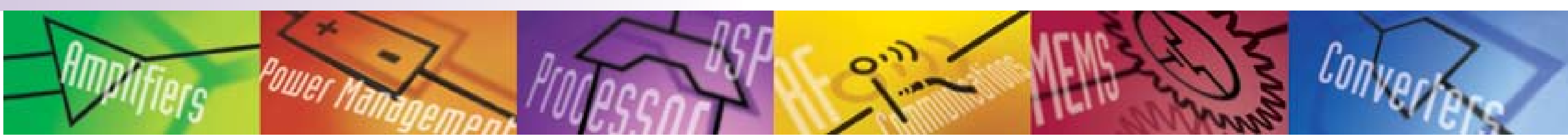
- Optimal balance of computational performance, large on-chip memory, and I/O bandwidth maximizes sustainable FFT performance
- Memory integration up to 24 Mbits accessible at core frequency enables internal execution of FFTs of 64 K points maximum
- Glueless, scalable multiprocessing capability with 5 Gbytes/sec aggregate throughput
- Interlocked pipeline for "out-of-the-box" execution of ported workstation code
- 24 Mbits of on-chip RAM—three times more than the closest competition

Mackie TT24™ Digital Live Console
Mackie uses SHARC's on-board DSP power to provide audio dynamics, equalization, and effects processing in a way that's practical, intuitive, and fast enough for live sound.

BMW M5 Series
BMW chose SHARC Processors for control of its sophisticated 500 hp V-10 motor. The V-10 engine control unit performs an amazing 200 million calculations per second to ensure optimal performance.

R&S® Radio Communication Tester CMU
With ADI floating-point processors, Rohde & Schwarz provides a versatile mobile radio test platform that conforms to multiple international standards and delivers maximum measurement speed for extensive testing of current and future mobile radio networks.

iCyt™ Cell Separation Instrument
TigerSHARC Processors are used in a high throughput, biological cell separation instrument designed and built by iCyt Visionary Bioscience, Inc. while utilizing Bittware's TigerSHARC development boards.



Visit **www.analog.com/perform** for information on special bundled board offers from BittWare, Inc. and Analog Devices.

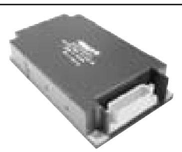
Military Power Conversion Directory

Welcome to *COTS Journal*'s second annual Military Power Conversion Products Directory. Designers must rely on printed-circuit-board-mounted DC/DC converters, slot-card power supplies and other power conversion components as their building blocks for crafting distributed power schemes. This directory compares a sampling of today's power conversion products including military DC/DC converters; power supply modules (bricks); and slot-card power supplies (in VME, cPCI and other form-factors).

In order to advance up the power density curve, power conversion product vendors innovate by wringing whatever improvement they can from the magnetics and discrete components that comprise their products. Such innovations significantly reduce the stresses on the power switching elements—the FETs. By moving to higher frequencies, all the reactive components in their supplies can be much smaller with less heat dissipation. That enables power supply component vendors, in turn, to make power supplies ever smaller.

To help system designers choose the right power conversion device for their military system design, we provide here an "apples-to-apples" sampling of today's current crop of power products including DC/DC converters, power supply module "bricks" and slot-card power supplies. Concurrent with this print version, we also offer an on-line version featuring contact info, URL links and downloadable datasheets for the companies listed in this directory.

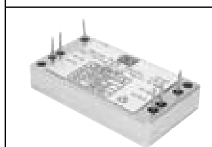
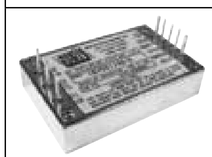
Jeff Child, Editor-in-Chief
jeffc@rtcgroup.com

Manufacturer URL	Product Name	Price @ Quantity	Type of Product	Input Voltage Range	Output Voltage Range	Output Power Range	Efficiency (max)	Weight	Dimensions or Form-Factor	Operating Temperature Range (ºC)	MIL-STD-810 Screening
Abbott Technologies www.abbottpower.com											
	TR400A-15	$2,800 @10	Transformer Rectifier	108 to 118 VAC	24 to 300 VDC	1680W	95%	192 oz.	6.75 x 7.50 x 4.75 in.	-55° to +70°C	Yes
	AS500	$2,043 @ 10	AC/DC Switcher	85 to 260 VAC	12 to 48 VDC	500W	90%	88 oz.	10.12 x 6 x 1.25 in.	-40° to + 70°C	Yes
	AS200	$774 @ 10	AC/DC Switcher	95 to 260 VAC	12 to 28 VDC	200W	80%	32 oz.	6 x 3.5 x 1.25 in.	-40° to +70°C	Yes
Aeroflex Plainview www.aeroflex.com/power											
	ACT8616	$9,500 @ 10	DC/DC Converter	22 to 34W	2.375 to 5.25 VDC	70W	75%	1.15 lbs.	6.8 x 5.3 x 0.6 in.	-55° to +85°C	No, to MIL-STD-883

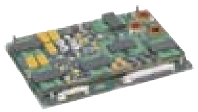
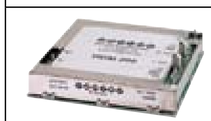
Manufacturer URL	Product Name	Price @ Quantity	Type of Product	Input Voltage Range	Output Voltage Range	Output Power Range	Efficiency (max)	Weight	Dimensions or Form-Factor	Operating Temperature Range (°C)	MIL-STD-810 Screening
Analytic Systems www.analyticsystems.com											
	PWS1510mil-xx	$2,462 @ 24	Waterproof Power Supply	Autoranging	12 or 24 or 28 VDC	52A, 26A, 26A	75%	16.0 lbs	16 x 8.2 x 3.5 in.	-40° to +50°C	Yes
	IPS1500mil-xx-xxx	$1,988 @ 24	Pure Sine Inverter	110 or 220 VAC	20-40 VDC	13.0 cont., 19.6 peak	80%	37 lbs	13 x 9.0 x 7.8 in.	-40° to +50°C	Yes
	LIAC600-xx	$2,576 @ 24	Waterproof Li-Ion Battery Charger	Autoranging	28 VDC nominal	22A Cont.	75%	14.4 lbs	17 x 8.2 x 3.5 in.	-40° to +50°C	Yes
Astec Power www.astecpower.com											
	DS Series	$180	1U Distributed Power Front Ends	90 to 264 VAC	12 VDC	450 to 850W	84%	—	1.5 x 3 x 13.3 in.	10° to 45°C	No
	APC Series	$11.50	DC/DC Converters	10 to 14 VDC	0.75 to 5.50 VDC	25 to 75W	92%	—	1.3 x 0.53 x 0.35 in.	-40° to +85°C	No
	MP Series	$240	Internal Switching Power Supplies	85 to 264 VAC 120 to 350 VDC	2 to 60 VDC	360 to 1200W	80%	1.06 lbs.	2.5 x 5 x 10 in.	-20° to +50°C	Yes
BTCPower www.btcpower.com											
	RPM800-48A	$256 @ 1,000	AC/DC Power Supply	85 to 264 VAC	48 VDC	0 to 700W	85%	3200g	11.52 x 5.54 x 1.63 in.	-40° to +75°C	No
	S15-48-12D	$29.50 @ 1,000	DC/DC Converter	36 to 75 VDC	±12 VDC	0 to 15W	89%	20.7g	1.6 x 1.0 x 0.35 in.	-40° to +100°C	Yes
	HQ35A-48-5N	$72 @ 1,000	DC/DC Converter	36 to 75 VDC	5 VDC	0 to 175W	89%	40g	2.28 x 1.45 x 0.45 in.	-40° to +125°C	No
Cherokee International www.cherokeepwr.com											
	CAR1212	$235 @ 1,000	Front End	85 to 264 VAC	12 VDC	1250W	89%	3 lbs.	1.61 x 4 x 11.2 in.	-10° to 70°C	No
	CBQ5	$32 @ 1,000	DC/DC Converter	38 to 55 VDC	7.1 to 11 VDC	350W	96.5%	1.3 oz.	1.45 x 2.3 x 0.45 in.	-40° to 85°C	No
	Polaris 2	$99 @ 1,000	DC/DC Converter	36 to 75 VDC	1.2 to 5 VDC	144 to 275W	91%	2.9 oz.	2.425 x 2.4 x 0.45 in.	-40° to 85°C	No

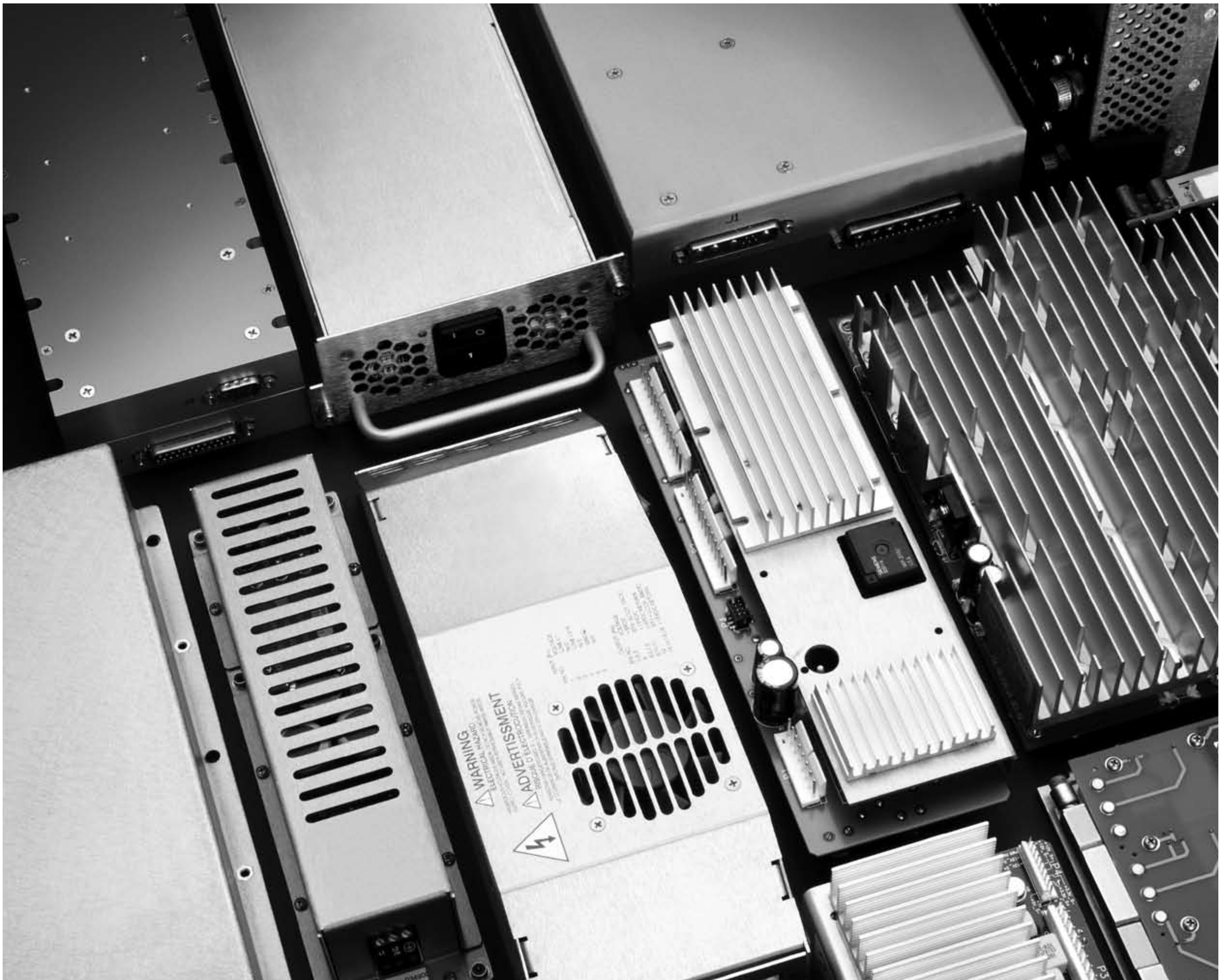
Military Power Conversion Directory

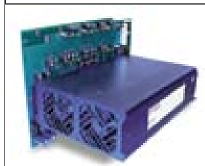
Manufacturer URL	Product Name	Price @ Quantity	Type of Product	Input Voltage Range	Output Voltage Range	Output Power Range	Efficiency (max)	Weight	Dimensions or Form-Factor	Operating Temperature Range (°C)	MIL-STD-810 Screening
Chroma Systems Solutions www.chromausa.com											
	Model 52911	$2,800 Each	PXI/cPCI Programmable Power Supply	115 VAC or 48 VDC	0 to 30 VDC	30W per channel	90%	4 lbs.	3U PXI card, single slot	0 to +40°C	No
Inova Computers www.inova-computers.com											
	ICP-PSU-AC70-x0-LG	$260 @ 100	AC/DC Power Supply	110 to 230 VAC	3.3 to 12 VDC	70W	85%	770g	3U cPCI	-25° to +85°C	No
	ICP-PSU-AC120-00-LG(-U)	$390 @ 100	Auto-Ranging AC/DC Power Supply	85 to 253 VAC	3.3 to 12 VDC	120W	85%	1.25kg	3U cPCI	-25° to +85°C	No
	ICP-PSU-DC60-00-LY	$300 @ 100	DC/DC Power Supply	16.8 to 36 VDC	3.3 to 12 VDC	60W	85%	750g	3U cPCI	-40° to +85°C	No
	ICPe-PSU-AC100-00	$280 @ 100	AC/DC Power Supply	110 to 230 VAC	3.3 to 12 VDC	100W	85%	770g	3U cPCI Express	-25° to +85°C	No
International Rectifier www.irf.com											
	AFL Series	$1,050 @ (1-9)	DC/DC Converter	18 to 400 VDC	Single: 3.3 to 28 VDC Dual: ±5V to ±15 VDC	Single: 66 to 120W Dual: 80 to 100W	87%	90g	2.5 x 1.5 x 0.38 in.	-55° to 125°C	—
	ATR Series	$565 @ (1-9)	DC/DC Converter	16 to 40 VDC	Single: 3.3 to 15 VDC Dual: ±12 to ±15 VDC Triple: 5 to ±15 VDC	Single: 25 to 30W Dual: 30W Triple: 30W	80%	58g or 65g	2.7 x 1.35 x 0.41 in.	-55° to 125°C	—
	ASA Series	$450 @ (1-9)	DC/DC Converter	16 to 40 VDC	Single: 5 to 15 VDC Dual: ±5 to ±15 VDC	Single: 4 to 5W Dual: 5W	71%	26g	1.075 x 1.075 x 0.27 in.	-55° to 125°C	—

Manufacturer URL	Product Name	Price @ Quantity	Type of Product	Input Voltage Range	Output Voltage Range	Output Power Range	Efficiency (max)	Weight	Dimensions or Form-Factor	Operating Temperature Range (°C)	MIL-STD-810 Screening
Lambda Americas www.lambdapower.com											
	PSS series	$34.10 @ 100	DC/DC Converter	4.5 to 76 VDC	3.3 to 30 VDC	1.5 to 10W	84%	4 to 14g	1.1 x 0.8 x 0.31 in.	-40° to +85°C	No
	PAE100S485/V	$58 @ 100	DC/DC Converter	36 to 76 VDC	1.44 to 5.75 VDC	36 to100W	90%	25g	0.89 x 0.33 x 2.27 in.	-40° to +85°C	No
	PAF600PAF280 series	$172 @ 100	DC/DC Converter	200 to 400 VDC	7.2 to 57 VDC	600W	91%	250g	2.4 x 0.5x 4.6 in.	-40° to +100°C	No
Linear Technology www.linear.com											
	LTC3703	$3.10 @ 1,000	DC/DC Controller	9V to 100V	0.8 to 100 VDC	80W	96%	—	SSOP – 28	-40° to +85°C	No
	LTC3770	$3.55 @ 1,000	DC/DC Controller	4V to 32V	0.6 to 32 VDC	50W	95%	—	SSOP – 28	-40° to +85°C	No
	LTC3782	$4.70 @ 1,000	DC/DC Controller	6V to 40V	Up to 50 VDC	200W	96%	—	TSSOP – 28	-40° to +85°C	No
Martek Power Abbott www.martekpowerabbott.com											
	CB5S	$136 @ 10	DC/DC Converter	14 to 40 VDC	2 to 15 VDC	5W	78%	15g	1.0 x 1.0 x 0.38 in.	—	Yes
	CB30S	$227 @10	DC/DC Converter	16 to 40 VDC	2 to 28 VDC	30W	80%	45g	1.1 x 2.0 x 0.38 in.	—	Yes
	CB75S	$257 @10	DC/DC Converter	16 to 40 VDC	2 to 28 VDC	75W	84%	90g	1.45 x 2.28 x 0.50 in.	—	Yes

Military Power Conversion Directory

Manufacturer URL	Product Name	Price @ Quantity	Type of Product	Input Voltage Range	Output Voltage Range	Output Power Range	Efficiency (max)	Weight	Dimensions or Form-Factor	Operating Temperature Range (°C)	MIL-STD-810 Screening
North Atlantic Industries www.naii.com											
	55PQ1	$2,040 @ 100	DC/DC Converter	16 to 36 VDC	3.3 to 12 VDC	Up to 200W	75%	32 oz.	6U VME, single slot	-55° to +100°C	Yes
	56SQ1	$3,340 @ 100	AC/DC Power Supply	100 to 242 VAC	3.3 to 12 VDC	Up to 430W	75%	96 oz.	6U VME, two slot	-55° to +85°C	Yes
	44KS1	$2,011 @ 100	DC/AC Inverter	24 to 32 VDC	26 to 28 VAC	65 VA	73%	38 oz.	5.5 x 3.0 x 2.65 in.	-55° to +85°C	Yes
OceanServer Technology www.ocean-server.com											
	EK-03	$417.90 Each	Combination Smart Battery Controller with ATX output	1 to 24 VDC	3.3 to 12 VDC	95 to 190 W-Hrs	95%	3 lbs.	4.6 x 3.6 in.	0 to 50°C	No
	EK-02	$518.84 Each	Smart Battery Controller and Regulated DC/DC Converter	1 to 24 VDC	3.3 to 12 VDC	95 to 380 W-Hrs	95%	3.5 lbs.	PC/104	0 to 50°C	No
	EK-01	$348.23 Each	Smart Battery Controller	1 to 24 VDC	12 to 16.6 VDC	95 to 380 W-Hrs	95%	3.2 lbs.	PC/104	0 to 50°C	No
Rantec Power Systems www.rantec.com											
	HDM-BT	$215 @ 100	DC/DC Converter	14 to 50 VDC	50 to 65 VDC	185W	95%	2.5 oz.	2.4 x 2.3 x 0.5 in.	-55° to +95°C	Yes
	HDM-LLP	$270 @ 100	DC/DC Converter	180 to 420 VDC	1.5 to 28 VDC	25W	85%	1.4 oz.	1.45 x 2.3 x 0.5 in.	-55° to +95°C	Yes
	HDM-200	$310 @ 100	DC/DC Converter	180 to 420 VDC	1.5 to 28 VDC	200W	87%	2.7 oz.	2.4 x 2.3 x 0.5 in.	-55° to +95°C	Yes



Manufacturer URL	Product Name	Price @ Quantity	Type of Product	Input Voltage Range	Output Voltage Range	Output Power Range	Efficiency (max)	Weight	Dimensions or Form-Factor	Operating Temperature Range (ºC)	MIL-STD 810 Screening
RO Associates www.roassoc.com											
	UV300-12	$149 @ 100	DC/DC Converter	220 to 400 VDC	10.8 to 13.2 VDC	0 to 24000W	86%	7oz.	2.4 x 3.6 x 0.5 in.	-40° to 100°C	No
	NV300-5	$115 @ 100	DC/DC Converter	220 to 400 VDC	4.5 to 5.5 VDC	0 to 100W	80%	96g	2.4 x 2.3 x 0.5 in.	-40° to 100°C	No
	PFC-1000	$149 @ 100	AC/DC Converter	85 to 265 VAC	380 VDC	0 to 1000W	94%	9 oz.	2.4 x 4.6 x 0.5 in.	-40° to 100°C	No
Tracewell Systems www.tracewellsystems.com											
	TTX-400-24VDC	$525 @ 10	Slot-Card Power Supply	18 to 36 VDC	3.3 to 12 VDC	350W	80%	1.01 lbs.	3U x 160 mm x 4HP or 6U x 160 mm x 4HP	-40° to +50°C	No (optional)
	DH-226 VXI/PXI	$3,200 @ 10	Slot-Card Power Supply	26 to 42 VDC	2 to 24 VDC	1485W	90%	6 lbs.	6U x 320 mm x 6HP	0 to +45°C	No (optional)
	STF2000	$3,300 @ 10	Modular Power Brick	90 to 264 VAC	2 to 48 VDC	2000W	75%	11 lbs.	3.5 x 8 x 12 in.	-20° to +50°C	No (optional)
	HF-243 Front End	$1,995 @ 10	AC/DC Front End	180 to 264 VAC	59 VDC	2500W	90%	10 lbs.	14 x 7.6 x 3.5 in.	0° to +45°C	No (optional)

Military Power Conversion Directory

Manufacturer URL	Product Name	Price @ Quantity	Type of Product	Input Voltage Range	Output Voltage Range	Output Power Range	Efficiency (max)	Weight	Dimensions or Form-Factor	Operating Temperature Range (ºC)	MIL-STD 810 Screening
Vicor www.vicorpower.com											
	2nd Gen Micro	$253 @ 100	DC/DC Converter	18 to 375 VDC	2 to 48 VDC	50 to 100W	90%	2.3 oz.	2.28 x 1.45 x 0.5 in.	-55° to 100°C	Yes
	2nd Gen Mini	$346 @ 100	DC/DC Converter	18 to 375 VDC	2 to 48 VDC	100 to 250W	90%	4.0 oz.	2.28 x 2.2 x 0.5 in.	-55° to 100°C	Yes
	2nd Gen Maxi	$505 @ 100	DC/DC Converter	18 to 375 VDC	2 to 48 VDC	160 to 500W	90%	8.0 oz.	4.6 x 2.2 x 0.5 in.	-55° to 100°C	Yes
VPT www.vpt-inc.com											
	DVHE DC-DC	$655 each	DC/DC Converter	16 to 40 VDC	1.9 to 5 VDC	19 to 50W	89%	52g	2.110 x 1.125 x 0.427 in.	-55° to +125°C	MIL-PRF-38534
	DVPL	$232 each	DC/DC Converter	3.0 to 5.5 VDC	0.8 to 3.3 VDC	0 to 16.5W	95%	11g	0.975 x 0.800 x 0.270 in.	-55° to +125°C	Same as above
	DVCH	$215 each	DC/DC Converter	12 to 50 VDC	Single: 3.3 to 15 VDC Dual: ±5V to ±15 VDC	0 to 1.5W	81%	11g	0.975 x 0.8 x 0.27 in.	-55° to +125°C	Same as above

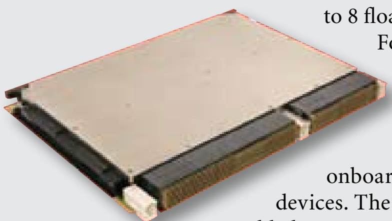
COTS

Products

PowerPC SBC and DSP Engine Are First to Offer VITA 46

The much anticipated VITA 46 specification—now given the marketing name: VPX—is a high-speed serial interconnect with a form-factor and feature set specifically crafted for next-generation military/aerospace applications. At last month's Bus & Board conference, Curtiss-Wright Controls Embedded Computing introduced its first two VPX-based boards: the VPX6-185, a PowerPC-based single board computer and the CHAMP-AV6, a VPX-based DSP engine.

The 6U VPX6-185 provides a nominal backplane bandwidth of 8 Gbytes/s via four Advanced Switching Interconnect (ASI) ports, two PCI Express VITA 42 XMC/PMC sites, the processing power of Freescale's 8641 single/dual-core PowerPC processor, and an extensive list of standard features such as Gbit Ethernet, serial ports and mass storage interface options. The VPX6-185's processing engine is the Freescale 8641 single/dual-core PowerPC device. With its dual integrated 64-bit memory controllers, the 8641 offers vastly increased memory performance compared to prior generations of PowerPC processors, translating directly to reduced execution times for user application software. For numeric-intense processing the 8641 offers the powerful Altivec instruction set extension, which performs up to 8 floating-point operations per cycle. For a dual-core device operating at 1.5 GHz this results in 24 GFLOPS of peak floating-point performance.



The CHAMP-AV6 features four onboard 8641 single-core PowerPC devices. The 8641, FreeScale's latest Altivec-enabled processor, has dual integrated 64-bit memory controllers. Multi-processor systems based on the CHAMP-AV6 will benefit from the 10 Gbyte/s full duplex bandwidth provided by the board's four Serial RapidIO ports; this represents a data throughput rate approximately 10x faster than today's best VME/StarFabric implementation. Streaming data applications will benefit from the board's 8.5 Gbyte/s memory bandwidth and up to 2 Gbytes of DDR-II SDRAM. Pricing for the VPX6-185 starts at $10,500, and pricing for the CHAMP-AV6 starts at $16,500. Evaluation units for each will be available in Q4 2006.

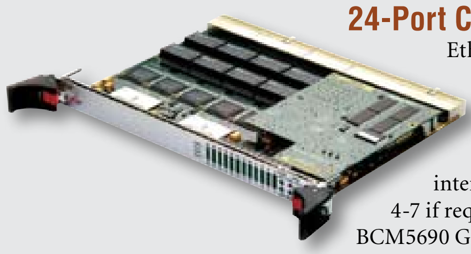
Curtiss-Wright Controls Embedded Computing, Leesburg, VA. (703) 779-7800. [www.cwcembedded.com].

PCI-104 Card Integrates Full 1.4 GHz Pentium M Solution

Designed for the laptop market, the Pentium M processor's blend of high performance and low power make it attractive to embedded applications. In the front ranks of those embedded users are military designers hungry for high levels of compute density in a small form-factor. Packing a full-featured Pentium M SBC into a PCI-104 form-factor is no easy task. RTD did just that with their new PCI-104 1.4 GHz Pentium M cpuModule, model number CMX58886PX1400. The processor includes 400 MHz source-synchronous Front Side Bus (FSB), on-die 2 Mbyte L2 cache and data pre-fetch logic. The processor features Enhanced Intel SpeedStep technology, which enables real-time dynamic switching between multiple voltage and frequency points. The video interface is provided by an Analog SVGA output and an LVDS flat panel output. The two outputs are independent, and can display separate images and display timings. Maximum resolution is 2048 x 1536.

Among the high-speed peripheral connections onboard is a USB 2.0 port, with up to 480 Mbit/s data throughput. An ATA-100/66/33 IDE controller provides a fast connection to the hard drive. Network connectivity is provided by an integrated 10/100 Mbit/s Ethernet controller. Other features include two RS-232/422/485 COM ports, Parallel Port and AC97 audio. Also featured is a BIOS Extension socket that allows a DiskOnChip to be attached to the board, either socketed or soldered. A MultiPort can be configured as a standard EPP/ECP parallel port, a floppy drive port or an Advanced Digital I/O (aDIO) port. An advanced watchdog timer is provided that can generate and interrupt or reset when the timer expires. 512 Mbytes SDRAM are soldered directly to the board for high-vibration resistance. The Pentium M module's operating temperature is -20° to 70°C and extended temperature is available in fanless IDAN, HiDAN and HiDAN-plus rugged enclosures. The CMX58886PX1400 board is priced at $2,850 in OEM quantities.

RTD Embedded Technologies, State College, PA. (814) 234-8087. [www.rtd.com].



24-Port CompactPCI Managed GbE Switch is Conduction Cooled

Ethernet is a de facto standard in both commercial and defense systems, but military applications often have special needs, such as extended operating ranges. With this in mind, GE Fanuc has introduced the CP920-24/M, a CompactPCI Layer 2/3 managed Gigabit Ethernet switch that is conduction cooled.

The CP920-24/M offers full Layer 2/3 management capabilities via SNMP, Telnet or a Web server interface, and features extended operating temperatures of -40° to +85°C. It also supports higher Layers 4-7 if required. An extension of GE Fanuc's CP920 product family, the switch is based on the Broadcom BCM5690 Gigabit Ethernet switch chip and Motorola's XPC8240 processor.

The CP920-24/M is fully compliant with PICMG 2.16 and offers 24 rear I/O ports, making it ideal for extensive Ethernet connectivity in harsh environments. Pricing starts at $8,500.

GE Fanuc Embedded Systems, Huntsville, AL. (256) 880-0444. [www.gefanuc.com].

Transceiver Platform Aids Military Radio Development

Thanks to sophisticated development tools and solutions on the market, military system designers no longer have to start from scratch—even when designing something as complex as a military radio. Satisfying such needs, Pentek has unveiled the latest member of its RTS 2500 development platform systems for real-time wideband data acquisition, signal processing and recording. The RTS 2502 adds playback capability to the family, using the same data-capture front end as the company's popular RTS 2501 and adding four D/A channels with two up-converters for playback. The unit comes preconfigured as a data recording system with a graphical user interface (GUI) to make the RTS 2502 ready to use out-of-the-box. The RTS 2502 is a fully programmable development platform that targets transceiver applications such as military radios and commercial wireless base stations.

As with other members of the RTS 2500 family, Pentek's SystemFlow software allows developers to easily customize features, interfaces and operations. The software's modular design includes code for the data acquisition system as well as user control software for the GUI on the host PC. An RTS 2502 base system starts at $29,995 for hardware only and $41,495 with bundled SystemFlow and GateFlow software.

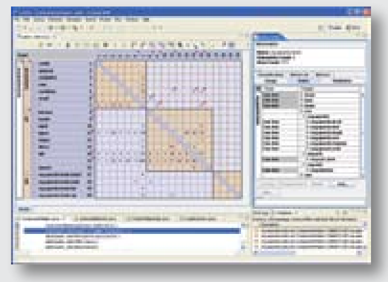
Pentek, Upper Saddle River, NJ. (201) 818-5900. [www.pentek.com].

Seven-Slot 3U cPCI System Aims at Mobile Apps

Embedded computers must meet special requirements when they're tasked to ride aboard military vehicles. Aimed at just such applications, Inova Computers has rolled out its Hercules industrial computer. Designed for the most rigorous of transportation applications, this rugged 7-slot, 3U CompactPCI system goes to great lengths to maintain system integrity in both hardware and software in order to prevent unexpected failures. It features a special aluminum heat sink, for example, that conducts heat away from a high-frequency CPU to the chassis walls, where it is safely dissipated through a set of cooling fins.

Running Windows XP Embedded, Hercules comes equipped with a CPU board with either a 1 GHz ULV (Ultra-Low Voltage) Celeron M or 1.4 GHz Pentium M; an intelligent PSU (power supply unit) board providing 3.3V at 4A, 5.1V at 6A and 12V at 0.25A; and five vacant backplane slots. Hercules has a standard -20° to +50°C operating temperature range (-40° to +85°C optional), and it's comfortable with non-condensing humidity up to 95% at 40°C. The system is screened against EMI emission and immune to EMI from external sources. In OEM quantities, Hercules pricing begins at $1,675 each.

Inova Computers, Glendale, AZ. (602) 863-0726. [www.inova-computers.com].



Eclipse Tool Targets Mission-Critical Software

Military embedded software projects are getting ever more complex. To help get control over such beasts, Lattix announced the availability of Lattix LDM for Eclipse as part of the new 2.5 version of Lattix LDM. With this new Eclipse plug-in, Lattix further extends the developers' capabilities to visualize and maintain the architecture during application development by delivering the power of Lightweight Dependency Models (LDM) to formalize, communicate and control the architecture of Eclipse projects.

Lattix LDM for Eclipse uses a dependency structure matrix for a highly compact and scaleable representation of the entire system. With the Lightweight Dependency Model approach, architects and developers can analyze their architecture in detail, edit the structure to create what-if scenarios and then specify design rules to formalize and communicate that architecture to the entire development organization. The product features the capability to seamlessly go from the big picture to the detail, select a subsystem and examine the code associated with its dependencies. Lattix LDM for Eclipse and Lattix LDM v2.5 are immediately available for Java and C/C++, with prices starting at $995 per developer license.

Lattix, Andover, MA. (978) 474-5022. [www.lattix.com].

SoC Serves Up Complete Data Recording Solution

Advanced applications such as UAVs, signals intelligence, imaging, and surveillance applications all have something in common. They all put issues of weight, power and size as top priorities. TEK Microsystems and QinetiQ Real-Time Embedded Systems teamed up to address exactly those needs with their latest product developed as a result of the alliance between the companies. Called the JazzStore SoC, the product is a complete data recording solution available as a "System-on-a-Chip."

Firmware used in the JazzStore SoC utilizes the unique Tekmicro real-time FAT32 file system, which enables users to swap out a disk and simply mount it on a PC for review, analysis and playback if required. JazzStore SoC includes a QinetiQ-developed Fibre Channel core that takes advantage of the PowerPC 405 processors present within a Xilinx Virtex II Pro FPGA. All JazzStore components, including enclosures and RAIDs, are available in commercial grade as well as ruggedized versions for harsh environments. Under a commercial alliance, TEK Microsystems and QinetiQ jointly develop, market and sell high-performance carrier, payload, PMC/XMC and computer boards in the United States. The JazzStore SoC is available today as an add-on option and is priced at $5,000.

QinetiQ, Farnborough, Hampshire, UK. +44 (0)8700 100 942. [www.qinetiq.com].

TEK Microsystems, Chelmsford, MA. USA. (978) 244.9200. [www.tekmicro.com].

VME Carriers Blend FPGAs and Serial RapidIO

Applications such as synthetic aperture and phased array radar, software defined radio and SIGINT have an endless appetite for DSP processing and data throughput. Feeding that need, Micro Memory has introduced the CoSine-on-Othello MM15x0 (shown) and MM-16x0 VME carriers for FPGA processing on serial switch fabrics. The MM-1500 and MM-1600D are the first VME boards to include the Xilinx V-4 SX and V-4 LX series of FPGAs. The boards both feature two high-speed mezzanine sites, each of which can be configured for a PMC or XMC. Configured for PMC support, each PCI bus can operate in PCI 2.3 mode at up to 66 MHz or in PCI-X mode at up to 133 MHz. While configured for XMCs, the sites can support the Aurora protocol or Serial RapidIO x4.

Both boards include two independent CoSine Compute Nodes, which consist of two interface ports, two embedded PowerPC processors, a CoSine Companion Device (V-4 SX55 or V-4 LX160), seven independent memory arrays and two processor programmable flash arrays. Available in air-cooled and conduction-cooled models, the boards are designed for optimal heat dissipation and deployment in environments that undergo severe shock and vibration. Initial list pricing for Micro Memory's CoSine-on-Othello MM15x0 and MM-16x0 VME carriers is $34,500 per unit.

Micro Memory, Chatsworth, CA. (818) 998-0070. [www.micromemory.com].

Single-Chip Radio Is Designed for WiMAX

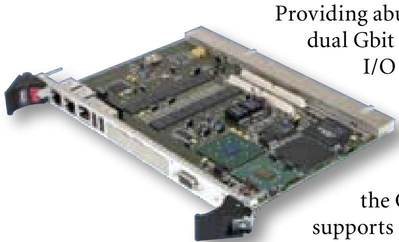
Enticed by the idea of a long-range wireless datalink technology that's almost certain to gain widespread commercial acceptance, military technology decision makers are keeping a close eye on the WiMAX 802.16 standard. For its part, Atmel has announced the first of its MAX-Link series of transceivers designed specifically for WiMAX applications. The AT86RF535A is a single-chip radio operating at 3.5 GHz with multiple bandwidth options. Additional members of the MAX-Link family are being developed to cover other WiMAX frequency bands and will interface with multiple baseband vendors.

These devices combine a low-noise amplifier, power amplifier driver, receive/transmit mixer, receive/transmit filters, voltage-controlled oscillator, synthesizer, receive gain control and transmit power control, all completely digitally governed. All of the transceivers will provide excellent RF performance with low current consumption and a small die size. The AT86RF535A is available now to select customers. Production volumes will be available early in the second quarter of 2006. Pricing is $18 in quantities of 10,000.

Atmel, San Jose, CA. (408) 441-0311. [www.atmel.com].

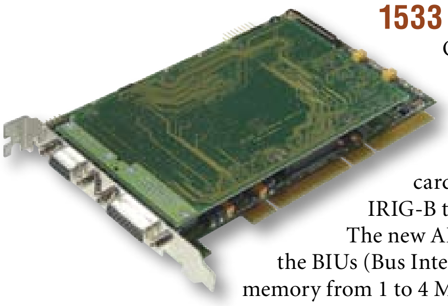
Pentium M cPCI SBC Offers Rich Set of I/O

Because military programs have such long life cycles, system designers want to use the most up-to-date processor and I/O technologies available. Feeding that need, SBS Technologies has added the 6U CompactPCI CE9 to its line of SBCs. Using a 1.8 GHz Intel Pentium M processor, the CE9 integrates up to 2 Gbytes of 333 MHz DDR SDRAM with ECC and features a 400 MHz system bus to processor. This SBC can be used in a system or non-system slot within a CompactPCI backplane. The company's Ready Driver VxWorks software ensures that the CE9 will integrate easily with systems applications designed with SBS Technologies' SBCs such as the CP9, CR9 and CT9.



Providing abundant I/O, the CE9 includes dual Gbit Ethernet ports, two serial I/O ports, four USB 2.0 ports and a CompactFlash or 2.5-inch hard disk. For system designers needing additional I/O capability, the CE9 includes a PMC site that supports the IEEE 1386.1 standard, allowing system designers high flexibility for expanding I/O capability with SBS Technologies' extensive line of WAN and LAN I/O PMC modules. The CE9 pricing starts at $1,730 in OEM quantities and is available now.

SBS Technologies, Albuquerque, NM. (505) 875-0600. [www.sbs.com].



1533 Cards Marry PCI-X and XScale CPUs

Old it may be, but the MIL-STD-1553 bus standard remains a popular, reliable solution as a deterministic control interface technology. AIM-USA continues to support 1553 fans with its new pair of fourth-generation, PCI-X-compatible cards for test, simulation and monitoring applications. The APX1553-2 is a dual stream, dual redundant card while the APX1553-1 is a single stream, dual redundant card. Both are provided on a PCI-X-compatible, short-length card format. The APX1553 cards are available as Full Function, Single Function and Simulator-only versions and include an onboard IRIG-B time code generator/decoder and can monitor/stimulate up to eight discrete I/O signals.

The new APX1553 cards offer unparalleled performance by using one or two 400 MHz XScale Processors for the BIUs (Bus Interface Units) and an additional 400 MHz Intel IOP80219 Application Support Processor. Global memory from 1 to 4 Mbytes is provided plus 128 Mbytes of application support processor memory. An onboard IRIG-B time generator/decoder is included, having a sinusoidal output and free wheeling mode for time tag synchronization on the system level using one or more APX1553 cards. Both boards are able to stimulate/monitor eight general-purpose discrete I/O (GPIO) signals.

AIM-USA, Elkhorn, NE. (866) AIM-1553. [www.aim-online.com].

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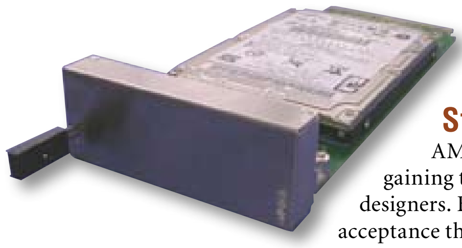

AMC Modules Provide SATA and SAS Storage Solutions

AMC and MicroTCA are gaining the interest of military designers. But in order to gain acceptance there needs to be a broad set of AMC product functions available, and that includes storage. SANBlaze Technology has rolled out the first in a series of Advanced Mezzanine (AMC)-based products. The SB-AMC-HD is an AMC hard drive module providing storage options for AdvancedTCA and MicroTCA-based platforms. The modules are available with either a single SATA or SAS drive, in varying sizes. SATA-based options provide for storage up to 100 Gbytes, as well as an extended duty drive option. SAS versions of the product deliver 36 Gbyte or 73 Gbyte options, providing a higher performance, more robust storage solution than SATA, when required.

By offering two drive interfaces, as well as a range of capacity options, the SANBlaze SB-AMC-HD family will be able to address most embedded system storage design requirements. Compliance to AMC.0 and AMC.3 standards, as well as integrated IPMI support, ensures that the product integrates easily into ATCA and MicroTCA-based designs. The SANBlaze SB-AMC-HD modules support all major operating systems. Single piece pricing begins at $695, and varies with hard drive capacity options.

SANBlaze Technology, Maynard, MA. (978) 897-1888. [www.sanblaze.com].

Synchro/Resolver Instrument Is LXI-Compatible

Gone are the days when military systems designers had to make their own custom measurement instruments. There's a rich set of high-performance instruments available off-the-shelf for most any need. An example is North Atlantic Industries (NAI) new synchro/resolver angle measurement instrument. The model 8810A provides fully independent dual-inputs, high-resolution touch screen controls, 0.001-degree resolution, 0.004-degree accuracy and autoranging inputs. The unit also offers an optional 2.2 VA reference supply, LXI compatibility, 47 Hz to 20 KHz operating frequency, auto-phase correction, and interface compatibility with Ethernet, USB, IEEE-488 and parallel ports.

The unit automatically accepts and displays input voltages from 1.0 to 90 VL-L and Reference voltages from 2 to 115 Vrms over a broad frequency range of 47 Hz to 20 KHz. The use of an intelligent DSP design eliminates push buttons and allows all programming to be done either via an integrated touch screen or a mouse interface. The 8810A can be set up to measure two independent angle inputs or multi-speed Synchros or Resolvers. The 8810A is available with an operating temperature range of 0° to +70°C. Its power supply requirement is 85 Vrms to 265 Vrms, 47 to 440 Hz. Pricing for 100 pieces starts at $5,000 each.

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

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VXS I/O Controller Offers XMC/PMC and Fibre Channel

The list of applications that require a mix of real-time multiprocessing with high-speed serial communications is long. Everything from ELINT, COMINT, SIGINT, SAR (radar) to MTI, SDR and numerous recording applications fall into that category. Designed for just those needs, VMETRO offers the Phoenix M6000 single board computer and VXS-enabled I/O controller that features intelligent PMC/XMC carrier and system controller functions. Dual Switched PCI Express x8 XMC sites enable users to high-performance connectivity by easily integrating XMC modules into a VXS/VME environment.

The Phoenix M6000 also incorporates traditional PMC sites with independent PCI-X local buses for maximum performance and flexibility. Additional I/O is available via Gbit Ethernet, RS-232, RS-422 and the VME P2 connector. In addition, the dual onboard 4 Gbit/s Fibre Channel interfaces are capable of up to 800 Mbyte/s I/O bandwidth directly for powerful storage, recording and playback as well as other Fibre Channel applications. An optional TransComm communications toolkit for use with the Phoenix PowerPC and FPGA-based products provides a set of software and firmware components and utilities. This includes a communications harness for PowerPC to PowerPC, FPGA to FPGA and FPGA to PowerPC communications. Pricing for the board starts at $7,995.

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

1.8 GHz Intel Pentium M Climbs Aboard 3U cPCI

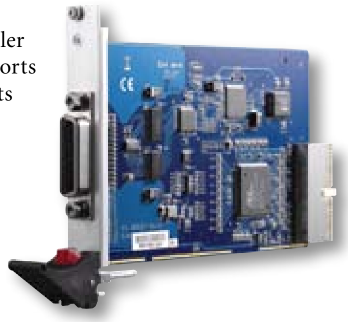
Compact PCI, particularly its 3U flavor, has secured a considerable following among military system designers. For space, weight and power-constrained applications—like UAVs for example—it has an edge over other currently available options. Concurrent Technologies' latest 3U CompactPCI offering is a single board computer supporting the Intel 1.8 GHz or 1.6 GHz Pentium M, or the Intel 1.0 GHz Celeron M processors. The TP 30x/32x family combines the performance of the Pentium M processor with the Intel 855GME GMCH chipset and up to 1 Gbyte of soldered 333 MHz DDR SDRAM. Additional features include dual EIDE ATA100, dual Serial ATA150, dual Gigabit Ethernet, stereo audio and graphics interfaces.

The TP 30x/32x embraces all of the benefits of the 3U form-factor, and the board is hot-swap-capable. For harsher applications, operation over -40° to +85°C or -25° to +70°C temperature ranges is supported using the 1.0 GHz Celeron M processor. A 2048 x 1536 front panel graphics interface is implemented using the Intel 855GME GMCH and includes a 1400 x 1050 rear panel DVI-D interface. Prices start at approximately $2,400.

Concurrent Technologies, Ann Arbor, MI. (734) 971-6309. [www.gocct.com].

PXI Interface Controller Aims at Test & Measurement

High-performance PXI test and measurement systems require easy, drop-in system configuration for compatibility with existing test and measurement applications. ADLINK Technology's PXI IEEE 488 interface controller card was designed with that ease in mind.



The PXI IEEE 488 interface controller card is a PXI-bus GPIB card that supports application development environments such as VB, VC++, Delphi, LabVIEW and TestExec. Windows 98/NT/2000/XP is supported, and the card's driver library is compatible with industry-standard VISA and instrumentation protocols. Suitable for most PXI platforms, the PXI IEEE 488 supports a 32-bit, 3.3V or 5V PXI bus. It provides an interface between GPIB instruments and PXI-equipped systems compliant with IEEE488.1 and IEEE488.2 standards.

One Kbyte of onboard FIFO for read/write operations and a high-speed bus, accelerated by an onboard CPLD, results in a maximum data transfer rate of 1.5 Mbytes/s for high-volume data transfers. The card is priced at $345 and is available from stock with volume discounts.

ADLINK Technology, Irvine, CA. (866) 423-5465. [www.adlink.com].

Compact, Rugged Panel Computer Targets Mission-Critical Apps

The mission-critical monitoring systems used in defense and homeland security applications demand high performance and reliable operation. The ARP-2606AP LCD panel computer from Arista was designed with those needs in mind.

Equipped with a 6.4-in. LCD and a 3.5-in. embedded board that incorporates a VIA Eden 667 MHz processor, the ARP-2606AP is ideal for facility monitoring and environmental monitoring. System memory for the unit is one 144-pin SO-DIMM socket with up to 512 Mbytes. The Local Area Network (LAN) uses a Realtek 8139 C PCI PnP Base-T Ethernet controller. Video support features a built-in VGA controller with up to 32 Mbytes of shared memory for display.

The system comes with three RS-232 ports, a 4-wire resistive touch screen and an optional PCMCIA slot for wireless applications. In addition, the ARP-2606AP has an onboard CompactFlash Type-1 socket, an optional 2.5-in. HDD and a 16-bit PC/104 extension connector. Pricing for the ARP-2606AP series starts at $1,000.

Arista, Camarillo, CA. (510) 266-1800. [www.aristaipc.com].

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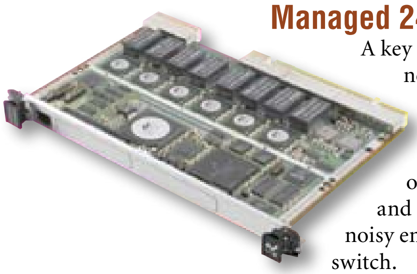


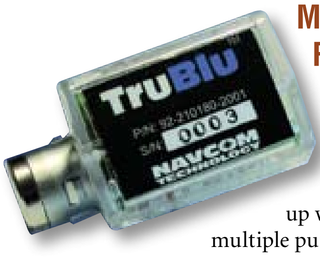
Managed 24-Port Gigabit Ethernet Switch Supports IPv6

A key requirement of future programs within the DoD's Global Information Grid is the support of IPv6 for network-centric warfare. A 24-port Gigabit Ethernet switch from Radstone Embedded Computing that provides fully managed Layer 2/3 switching also supports IPv6.

With a non-blocking shared memory architecture, the CPX24 features the standard 24 copper GbE ports. Twenty of the ports are PICMG 2.16-compliant, and the other four are available through an optional high-speed J4/J41 connector. All 24 ports can be converted to fiber via a mix of onboard optics and Radstone's OXB20 Optical Expansion Board, allowing operation over long distances or in electrically noisy environments. Two externally available 10 GbE ports allow two CPX24s to be coupled as a 48-port GbE switch.

Additional flexibility can be provided by bringing out the two 10 GbE ports to a separate, optional 10 GbE expansion board for very fast subsystem I/O. IPv6 support delivers expanded available IP address space (128-bit addressing) and improved end-to-end security, facilitating mobile communications, enhancing quality of service (QoS) and easing system management. The CPX24 can be ordered in any of five ruggedization levels. Price for a single, level-one unit is $7,380.

Radstone Embedded Computing, Towcester, UK. +44 (0) 1327 359444. [www.radstone.com].



Module Connects GPS Receivers with Bluetooth-Enabled Computer Controllers

During field operations, warfighters need to quickly set up wireless computer connectivity for multiple purposes, without worrying about ease of movement and tangled or damaged cables. A tiny module from NavCom makes this a done deal by providing wireless control and logging of up to 10 Hz position records in a Bluetooth-enabled computer controller.

The TruBlu wireless transceiver enables cable-free communications between Bluetooth-enabled computer controllers and NavCom's GPS receivers equipped with the latest 26-channel NCT-2100D GPS engine. The module is FCC and CE certified when used with NavCom GPS receivers. For real-time position/data transfers greater than 10 Hz, and for downloading the internal memory, a serial cable should be used.

The module is a sealed unit with a water-resistant casing measuring only 1 5/8 in. x 1 1/8 in. x 7/8 in. Its range is up to 30 meters, and it is powered directly from the GPS unit's COM port, requiring no additional batteries. Pricing is at $395 per unit.

NavCom Technology, Torrance, CA. (310) 381-2000. [www.navcomtech.com].

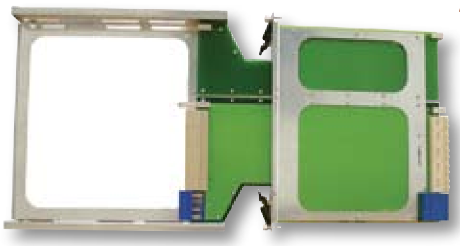
High-Performance SBC Sports 64-bit Dual-Core Opteron

High-demand, compute-intensive military systems need huge amounts of processing power in a small space, and the new multicore processors are helping to lead the way. A new board based on AMD's 64-bit single-core and dual-core Opteron processors is one of the first to harness that power.

The CPC5564 from Performance Technologies is a CompactPCI compute blade especially suited to the high-end packet processing or multi-threaded software found in defense applications. Two processor options are available: single-core 2.2 GHz or dual-core 1.8 GHz. Memory options include 2 Gbytes, 4 Gbytes or 8 Gbytes. The board features PICMG 2.16 and PICMG 2.9 compatibility, an onboard managed Ethernet switch, a dual Gigabit interface, a PMC (64-bit PCI-X)/XMC (PCI Express 8-lane) slot, 4 channels SATA or 1 channel PATA routed to RTM, an optional onboard HDD and USB 2.0 support.

Designed to run Linux, Solaris and Windows, the CPC5564 is available now. Volume pricing starts at $2,995.

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



ATCA Test Extender Board Speeds Mil Design Prototyping

In order to gain full access for testing or debugging to a circuit card under test, the card must come completely out of its card cage or enclosure. A new ATCA test extender board from Elma Bustronic extends both the power and Intelligent Platform Management Bus (IPMB) signals, to speed prototyping.

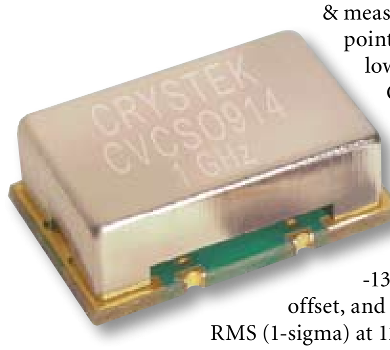
With a 10-layer stripline design, the ATCA extender board is designed for the fully populated fabric slot (5 ZD connectors, P20 through P24) and the power connector J10. The Zone 3 section is served by a blind board assembled to Zones 1 and 2 through the frame. The flexible design of the Zone 3 area allows customization for a minimum cost, since only the blind board must be changed to the required configuration. The complete keying system, including the Zone 3 area, is assembled.

The ATCA extender board has a sturdy metal frame with latching handles. The injector/ejector handles provide a secure and reliable connection to the chassis. Pricing is under $1,000 in volume, depending on configuration.

Elma Bustronic, Fremont, CA. (510) 490-7388.
[www.elmabustronic.com].

1 GHz Voltage-Controlled SAW Oscillator Targets Defense Apps

When it comes to voltage-controlled SAW oscillators (VCSOs), military engineers designing applications such as PLL frequency translation, test & measurement, avionics, point-to-point and multi-point radios need low noise and low phase jitter. Crystek Crystals has designed the CVCSO-914-1000 using FR5 PCB and SAW crystal technology to provide a low-noise, low-jitter VCSO with true SineWave output.



The oscillator features -135 dBc/Hz phase noise at 10 KHz offset, and maximum phase jitter of <1ps RMS (1-sigma) at 12 KHz ~ 80 MHz. The CVCSO-914-1000 comes in a 9 x 14 mm SMT package. It uses a +5V supply and generates a true sinewave with +7 dBm minimum output power and +/- 50 ppm minimum APR pullability. Linearity is ±20% maximum, output power is +10 dBm minimum into a 50-ohm load, and start-up time is 2 ms typical, 10 ms maximum.

The VCSO has no sub-harmonics; second harmonic is -20 dBc typical, and -15 dBc maximum. The CVCSO-914-1000 operates from 0° to 70°C. Price is $125 in small volumes.

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

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OPTO I/O Card Targets PC/104 High-I/O, High-Voltage Apps

Many high-performance, high-voltage defense applications need I/O flexibility as well as excellent signal isolation. The new Micro/sys OPTO104 expansion card can accept any combination of digital or analog I/O modules, and offers high-voltage isolation options.

The OPTO104 accommodates eight industry-standard digital or analog OPTO plug-in modules, as well as PC/104 CPU or I/O cards. The 4.53-in. x 6.50-in. EPIC form-factor board operates at extended temperature ranges of -40° to + 85°C. Up to four boards can be connected in a slave configuration using a 26-wire ribbon cable, making 32 available slots for OPTO 22 G4 modules for AC or DC digital I/O, and/or Grayhill G5 modules for analog I/O. All of these modules offer opto-isolation up to 4000V.

The board operates at 5V ± 5%. Alternately, a selection of DC/DC converter options allows input voltages of 9V to 75V. A user-selectable jumper can bleed off common mode leakage current to the negative inputs or to ground to reduce susceptibility to ESD. Onboard or off-board contrast adjustment for the character LCD is also provided, as well as a flexible I/O base address range and 16-bit pass-through connector. Price is $375 in single quantities. OEM discounts are available.

Micro/sys, Montrose, CA. (818) 244-4600. [www.embeddedsys.com].

4 Gbit Fibre Channel, 16-Bay SATA-II RAID Subsystem Is SAN-Ready

Military system designers who require high speed, high capacity and reliability in storing and accessing data are turning more and more often to RAID technology. A rugged, 16-bay SATA-II RAID subsystem from Phoenix International combines the high performance, reliability and scalability of 4 Gigabit Fibre Channel host interfaces with the low cost and high capacity of 3 Gbit/s SATA drive technology.

At 400 Mbytes/s, the SAN-ready PES16 SATA-II doubles the performance speed of storage area networks while maintaining backward compatibility with 1 Gbit and 2 Gbit systems. The PES16 SATA-II's enhanced, cableless, backplane-based, high-density 3U chassis provides massive storage capacity, up to 8 Terabytes, while assuring the highest level of data availability.

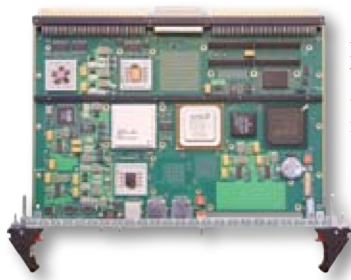
The PES16 SATA-II supports advanced enterprise-class RAID features. Logical drives, volumes and partitions within it can be configured to use any RAID level including RAID 6. Subsystem components include up to sixteen 3 Gbit/s SATA-II HDDs and dual-speed fans. Features include a Java-based, RAIDWatch, browser-based, GUI manager; hot-swap battery backup units for cache memory; SAN-ready LUN filtering and multiple logical drive configurations; auto HDD detection; auto rebuild; and hot spare and hot swap capability. Pricing starts at $15,000 for a PES16 SATA-II subsystem with 4 Terabytes of capacity.

Phoenix International, Orange, CA. (800) 203-4800. [www.phenxint.com].

Rugged G5 VME Blade Server Is IBM Clone

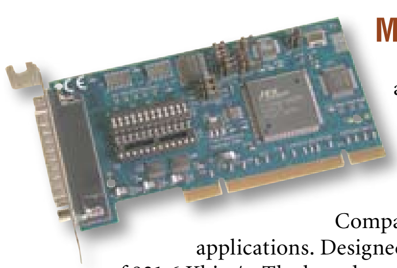
A new 6U VME blade server is a ruggedized version of the IBM G5 PowerPC JS20 blade design. The PowerNode5 processor SBC from Thales Computers provides high performance and full binary compatibility with the dual-PPC970 JS20.

The PowerNode5 features two PPC970FX G5 CPUs operating at 1.6 GHz, with an operating temperature range of 0° to +55°C. It features up to 2 Gbytes of DDR SDRAM ECC memory and peak memory bandwidth of 6.4 Gbytes/s as well as peak PCI memory bandwidth of 850 Mbytes/s. For connectivity and expansion, the PowerNode5 includes a 64-bit PMC site, a USB port and two 10/100/1000BASE-T Ethernet ports. It supports the PPC64 version of Linux and includes an onboard Serial RapidIO switch fabric.



A pre-integrated version, the PowerMP5, is also available, with full data transport and management software. Both Red Hat Linux and Wind River VxWorks are supported. The PowerNode5 is available in both conduction-cooled and convection-cooled versions. Pricing for the PowerNode5 starts at $11,260.

Thales Computers, Raleigh, NC. (919) 231-8000. [www.thalescomputers.com].



Multi-Interface PCI Serial I/O Board Is RoHS-Compliant

The need to connect to a variety of interfaces on different data collection devices can put limitations on data acquisition in the field. A single-port PCI bus serial I/O adapter card that makes field-selectable connections to PLCs, bar code readers and other data collection devices is compliant with the European Union Restriction of Hazardous Substances (RoHS) directive. The ULTRA 530.LPCI multi-interface PCI serial I/O board from Sealevel Systems offers a selectable RS-232/422/485/530 interface and is universal bus-compatible (3.3V or 5V).

Compatibility with MD1 low-profile specifications makes the board especially useful for small form-factor applications. Designed using the XR16C850 UART, the ULTRA 530.LPCI supports standard PC data rates and boasts a top speed of 921.6 Kbits/s. The board provides a 128-byte FIFO for error-free data communications applications. UART options include a version that allows external clocking. Sealevel's RS-485 auto-enable circuit automatically handles RS-485 driver control to facilitate compatibility with standard COM drivers.

The ULTRA 530.LPCI ships with Sealevel's SeaCOM suite of drivers for Windows 95/98/ME/NT/2000/XP. Also included is the WinSSD application for testing and diagnostics. Price is $229 in low volumes. A non-RoHS version is also available.

Sealevel Systems, Liberty, SC. (864) 843-4343. [www.sealevel.com].

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Coming Next Month

COTS JOURNAL

It's hard to believe that *COTS Journal* is now in its 8th year. Over the past eight years, we've continued to provide coverage of key military technology issues in a way that you can't find elsewhere. Exemplifying that unique character is our *Annual End-of-Life Directory*. Now in its 7th year, the EOL Directory lists both key DoD organizations and commercial firms involved in solving the problems of component obsolescence. Here's what else we've got on deck for our March issue:

- *Switched Fabrics: Military Update*. Switched serial fabric technologies—PCI Express, InfiniBand, Serial RapidIO and others—continue to jockey for position as the favorite for high-end military embedded computing applications. This section explores how system designers can benefit from the marriage of switched fabrics with embedded computing form-factors like VPX, VXS, Compact PCI Express, MicroTCA and AMC.
- *VME for the Next 25 Years*. This is the year VME celebrates its 25th birthday. The redoubtable VME bus architecture is keeping ahead of the performance curve by riding the wave of the various switched fabrics. As these get rolled into VSO specs such as VITA 41, VITA 42, VITA 46 and others, efforts remain to keep VME as compatible as possible with previous-generation boards, backplanes and boxes. This feature section explores the details behind those trends and updates readers on the technology trends shaping VME's future.
- *FPDP and FPDP II Boards*. Sometimes simple ideas are the big winners. Such is the case with the Front Panel Data Port (FPDP) interconnect standard. Using an inexpensive ribbon cable, FPDP links boards without eating up more that a tiny amount of board space. It's particularly useful in military applications like radar and sonar where FPDP is used as the interface to sensor networks. The Tech Focus section updates readers on FPDP/FPDP II trends and provides a product album of representative board-level products.

COTS

Editorial

Jeff Child, Editor-in-Chief

The Long Fermentation of Fabrics

The list of reasons why the COTS movement has been proven vital and beneficial could fill a pretty hefty book. More than a few chapters of such a book ought to be dedicated to the role the board-level embedded computing community has played in that movement. In particular, that community has shown an ability to develop, weed out and then productize technologies critical to the military market and do so long before military system designers know what they want or need. It's becoming clear that serial switched fabrics have emerged as the most vivid example along those lines. Like good wine, fabric technologies have been formulated and have fermented their way into the rugged embedded computing realm.

Switched fabric technologies have been around for several decades in niche, high-end embedded applications. But even when they started to migrate into the mainstream embedded computing realm around six or so years ago, the military market expressed absolutely zero interest in them, and rightfully so. Given the decades-long design cycles in the defense arena, it's too risky to take any long-term development project on an interconnect scheme that won't be around in a few years. Indeed, most of the current VME systems deployed use the traditional VME64. On the other hand, the inherent performance limitations of parallel buses like ordinary VME64 and PCI, telegraphed an eventual shift toward serial fabrics.

Fortunately the VME community, to its credit, started the ball rolling a couple years ago on the underlying spec development to bring serial switched fabrics into the VME space. Among those standards currently under development are VITA 41, VITA 42 and VITA 46. At the Bus and Board conference last month, several announcements revolved around fabrics. A teaming of Elma Bustronic, TEK Microsystems and QinetiQ unveiled a new VXS, VITA 41-based mesh architecture. The companies plan to propose the mesh architecture to the VITA Standards Association as a new standard to define alternative backplane topologies for VXS.

Elma Bustronic has designed, in collaboration with TEK Micro and QinetiQ, a 12-slot chassis to implement the VXS processor mesh. The hybrid backplane implements two VME64x slots, three VME64x / VXS payload slots and six VXS switch slots. Each switch slot implements twenty x4 links for a total of 25 Gbytes/s per switch slot. The system architecture supports up to 7.5 Gbytes/s of throughput between the I/O front end and the processing mesh and a total of 112.5 Gbytes/s of aggregate throughput within the processing mesh itself.

Meanwhile, the VITA 46 spec—now dubbed VPX (a more marketing-friendly term), promises a more revolutionary upgrade to military subsystem architectures with high-speed switched serial backplanes that support Advanced Switching Interconnect (ASI) and Serial RapidIO. Curtiss-Wright's embedded group announced the first pair of VPX products at the show, although the products aren't scheduled for release until Q4 of this year.

The VME realm isn't the only arena where switched fabrics are making a presence. It's been a busy year for switched fabrics—PCI Express in particular—across all areas of standards-based mid- and high-embedded architectures. Targeting the military market specifically, PICMG approved the CompactPCI Express spec last summer. Making use of the same connector specified for ATCA, it provides a migration path for designers who use the CompactPCI form-factor but want the added performance of PCI Express. The specification defines the connector, electrical and mechanical requirements of 3U/6U system boards, peripheral boards, switch boards and backplanes.

PICMG also brought the Computer-On-Module (COM) Express spec under its wing. COM Express is an architecture for integrating all the components necessary for a bootable host computer, packaged as a super component. Interfaces will provide a smooth transition path from legacy parallel interfaces to LVDS (Low Voltage Differential Signaling) interfaces. These include the move from PCI bus and parallel ATA to PCI Express and Serial ATA. Even the PC/104 community stepped into the world of switched fabrics last year with its new EPIC Express spec.

This broad infiltration of switched fabrics into the embedded board universe comes as no real surprise to us. Like the embedded board-level community itself, the editors of *COTS Journal* and its sister publication, *RTC* magazine, were looking at switch fabrics long before they were fashionable. We've published more articles on all the various switched fabrics—and all of their ins and outs—than any publication in the industry. So we've been on top of the evolution of fabrics all the way through. Now that the ever-cautious military market has begun to warm to them, it's clear that switched fabrics have broken free from their status as exotic, risky solutions. For us, it's rewarding to see these technologies move into center stage and become real. ▮