Daily Briefing: News Snippets

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OCTOBER 2011

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COLUMNS

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November 9, 2011 • 11:00 a.m. EST
Presented by: Real-Time Innovations, Inc.

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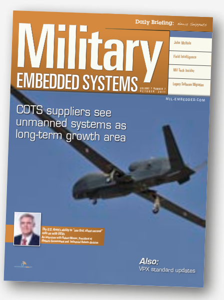
The Global Hawk Unmanned Aerial Vehicle (UAV) from Northrop Grumman makes use of Commercial Off-the-Shelf technology. Global Hawk photo courtesy of Northrop Grumman.



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www.milcom.org

SDR'11 – WInnComm
November 29-December 2, 2011 • Washington, DC
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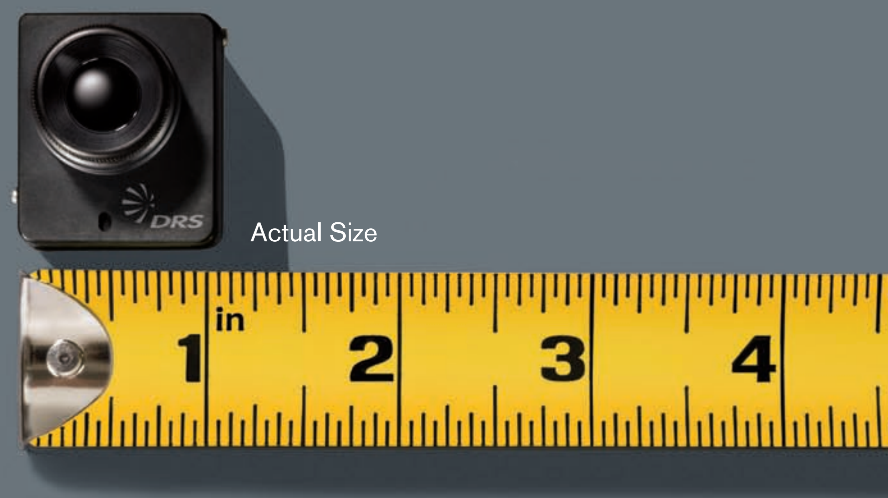

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Creating common standards for satellite payload designs

By John McHale, Editorial Director

Designers of satellite payloads primarily use custom and proprietary electronics hardware designs when building spacecraft, which can be quite costly and time consuming when it comes to testing and qualification. However, a new collaboration between the Air Force Research Laboratory (AFRL) and industry – Next Generation Space Interconnect Standard (NGSIS) – is looking to mitigate payloads design costs and reduce development time through common standards.

Essentially NGSIS will create an optical interconnect standard for future spacecraft applications, thus avoiding increases in Size, Weight, and Power (SWAP) of copper interfaces. It will leverage common protocols such as RapidIO, SpaceWire, and 10 GbE for satellite payloads.

Patrick Collier, an engineer with the AFRL at Kirtland Air Force Base, NM, gave a presentation on the NGSIS to the VITA Standards Organization (VSO) last month in Scottsdale, AZ. The NGSIS effort will "develop a scalable photonic bus that provides adequate bandwidth to accommodate current and future imaging payloads and develop an industry physical and logical interface standard for increasing interoperability between manufacturers and integrators," he says. Collier is making the rounds of different standards bodies to get their buy-in and participation in developing the NGSIS. "We are looking to build on work already being done by other standards organizations rather than do everything from scratch," he explains.

Collier's group needs expertise on their mechanicals such as designing the physical layer, the board sizes, and connectors, which is where VITA comes in, says Ray Alderman, Executive Director of VITA in Scottsdale, AZ. VITA can also provide the technical experience necessary for dealing with heavy shock and vibration and other extreme environmental conditions. NGSIS could "help VITA to a great degree on the optical stuff we're working on and in small form factor electronics."

"We have a lot of experience doing this at [the] physical layer and the other side of what we want to do is take space applications for small form factor and optical" and bring them down to the VITA level in commercial and military avionics and then down to ground combat vehicles, Alderman continues. It is not as big a leap as it is "easier to downgrade a spec to lower levels than to upgrade it to space," he says.

Collier says the problem facing spacecraft designers right now is that "current and future satellite payloads generate data that will require current copper data communication infrastructures to increase [SWaP] in order to simply move the data." The development time and costs associated with designing physical and logical interfaces for a proprietary satellite bus also can be reduced through common standards, he adds.

Everything is custom on a satellite, which makes getting it launched expensive and time consuming, Alderman says. NGSIS will leverage technology standards so instead of customizing every component, they can get the equipment from vendors who can meet specific qualifications, he adds. NGSIS will "not be pure COTS, because there are a lot of other requirements that are just not commercial," Alderman continues. "However, it is based on a COTS foundation. What goes into Patriot missile systems is not truly COTS, but has a COTS foundation."

Collier says they will be seeking standards for connectors, cabling, shielding, and so on for space applications.

"Collier and his group have the protocols sorted out at systems level" and he has come to VITA to help sort out the engineering details at the physical layer.

The group plans to have a draft outline of the specification completed by the end of November, a final outline by the end of January 2012, and the draft of specifications completed in sections by March 2012.

The NGSIS Executive Committee Member Organizations include AFRL, SMC/XR, NASA Jet Propulsion Laboratory, NASA Goddard Space Flight Center, NASA Johnson Space Center, Naval Research Laboratory, and the National Reconnaissance Office (NRO). Companies participating in the NGSIS Requirements Committee include Lockheed Martin, Boeing Space Systems, BAE Systems, Honeywell, Cisco, LGS Innovations, General Dynamics-AIS, Sandia National Labs, Ultra Communications, and SEAKR Engineering. Completed experiments so far include transmitting Ethernet packets over fiber links with SpaceWire control, transmitting GbE video over fiber links with two cameras used, and inserting a processing unit and testing image recognition and analysis algorithms.

Upcoming research and experiments include replacing SpaceWire with Ethernet as control plane protocol, researching the use of RapidIO cores in place of Ethernet, and inserting passive optical components to replace active optical switch for subsequent tests, Collier says.

The VITA liaison designated to work with the NGSIS group is Greg Powers, Market Development Manager for the Electronic Systems and Space segments within the Global Aerospace, Defense & Marine business unit of TE Connectivity. Powers also wrote an article for this month's issue on "Expanding options in VPX connectivity" on page 48. Also writing on VPX this month are Bob Sullivan and Ivan Straznicky of Curtiss-Wright Controls, with an article on how VPX standards – VITA 46, 65, and 68 – are using high-speed fabrics to improve performance (page 44).

This issue also includes an interview with Robert Moses, President of iRobot's Government and Industrial Robots division, on the proliferation of Unmanned Ground Vehicles (UGVs) on page 52 and an article by me on how COTS vendors are viewing potential major cuts to the defense budget on page 20.

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COTS technologies ready for UAV deployment

By Duncan Young

Unmanned Aerial Vehicles (UAVs) are vital elements in the gathering of Intelligence, Surveillance, and Reconnaissance (ISR) data. UAVs carry a payload of electro-optical sensors plus lasers, radar, or signals intelligence. These sensors generate masses of data that are transmitted securely to the ground over limited-capacity data links. Assistance is needed on the ground to identify and classify targets so that the UAV can direct its sensors and alter its flight profile to track targets of interest. UAVs are in constant use and continuously evolving to detect and counter new threats. Operators and integrators are urgently seeking greater, proven capability, which is being provided by COTS products and related enabling technologies.

UAV requirements

A surveillance UAV is essentially an unmanned sensor platform with well developed autonomous flight control allowing it to take off, follow flight plans, avoid obstacles, and land, but with limited mission autonomy. Size, Weight, and Power (SWaP) parameters can be so critical that COTS embedded computing standards might not be prime choice for the payload/sensor processing chain. However, because of the rapid design cycles needed to maintain tactical superiority, the infusion of proven and deployable enabling technologies – specifically COTS based – has become an essential development practice.

Sensor processing chain

There are many elements in a typical sensor processing chain: image stabilization, video compression, image processing, analysis, tracking, classification, and engagement. Electronic stabilization smooths out the effects of vibration and atmospheric disturbance. With video in and out connections, image stabilization can now be accomplished on a COTS module no larger than an SD memory card, for use in the smallest sensor platforms or within the camera mounting itself.

Video compression

Air-to-ground bandwidth is a key issue. Only the largest UAVs support high-bandwidth SATCOMMs because of the weight and power requirements of terminals. Yet even mid-sized UAVs carry multiple sensors, relying on digital radio to transmit video to troops on the ground for immediate tactical evaluation. To preserve bandwidth, video streams are compressed, typically using H.264 to allow a number of regular 30 Hz TV channels to be transmitted over a data link. The daq8580 module from GE Intelligent Platforms is a complete compression subsystem integrated into a rugged box, supporting two channels of HDTV, or four regular TV, plus a network connection to the radio equipment. Shown in Figure 1, it is already in use by NASA Dryden Flight Research Center (DFRC) for atmospheric research.

Enhanced mission autonomy

Some parts of the processing chain are onboard the UAV, but many – such as image processing, analysis, or classification – are ground based and hence limited by link bandwidth, human resources, security, and military doctrine; this can cause mission-critical control loop times to vary from seconds to hours. Reducing this latency to identify, classify, and track multiple targets from multiple sensors without ground assistance requires a massive increase in onboard computing power, such as that offered by the new generation of many-core processors. An integrated multisensor vision system using these devices, packaged on 3U VPX (VITA 46) modules, is able to analyze incoming video streams in real time, saving air-to-ground bandwidth by sending processed target data to the ground for further analysis and classification. Next generations of many-core processors will bring the goal of autonomous mission and target engagement, with minimal man-in-the-loop intervention, closer to realization.

Figure 1 | GE Intelligent Platforms daq8580 video compression module

Increasing endurance

An additional goal is to extend mission duration with in-flight refueling from tankers or from UAV to UAV. A unique, deployable 3D vision system using a pair of cameras has been demonstrated using COTS modules that will automatically fly the UAV and engage with the refueling drogue, maintaining its position until fueling is complete.

Tailored packaging

Rugged, open systems embedded computing vendors are extending their portfolios with complementary product lines and technologies to meet many new application niches. These are not necessarily based on open standards such as VPX, as this is not always appropriate packaging for small, light, self-contained UAV subsystems. Rapid evolution of the UAV ISR market, widespread network connectivity, and the demands of SWaP are driving the creation of new breeds of COTS-based technologies with diverse packaging options tailored to their intended deployed platforms.

To learn more, e-mail Duncan at duncan_young1@sky.com.

Defense trends lead to a COTS renaissance

By Steve Edwards

Responding to economic restraints and new strategic goals, the DoD's 2012 budget promises an altered landscape for the embedded COTS industry. There will be fewer new programs and a greater emphasis on technology refresh, keeping existing platforms operational longer. New programs will continue to emerge, driven by factors such as unexpected changes in global realities or technology breakthroughs. But increasingly, the goal will be platform life extension while adding advanced capabilities to enable technology and network connectivity to keep pace with the demands of the digital battle space. The good news is that the defense COTS industry is ideally positioned to meet the DoD's changing demands, providing affordable, mature, commercial technology-based alternatives that ensure levels of reliability and product road maps beyond those available directly from commercial sources. The new budget trends are, in fact, helping to encourage a new "COTS renaissance" in which the true benefits of COTS are being embraced and newly appreciated.

Shifting missions, shifting budgets

One of the 2012 budget trends is less tolerance for high development costs (NRE) and less funding available for ground-up R&D projects. With shifting missions and budget reorganization, the DoD is now more attracted to demonstrable, mature technologies and less interested in risky, unproven technology. In 2012, the challenge for system integrators and vendors will be to deliver these proven, demonstrable technologies. The DoD is turning to industry to share the R&D burden, with vendors investing more of their own resources to develop finished, capable technologies. An example of this trend can be seen in the Ground Combat Vehicle (GCV) program, where the government is seeking affordability by setting the budget for development and unit cost per vehicle in advance. This "should cost" approach to budgeting will help promote lower, predictable costs.

The technology readiness assessment approach

To ensure access to more affordable, more mature technology sooner, the military has instituted the Technology Readiness Assessment (TRA), a metrics-based methodology for ascertaining the maturity and risk of critical technologies. The TRA determines a Technical Readiness Level (TRL) to any technology under development, with TRL 1 being the least mature and TRL 9 the most mature. A TRL 1 technology has the greatest risk, which can significantly raise its development time and cost, but TRL 9 is the soonest to become obsolete. COTS vendors have a unique advantage that directly addresses these requirements. Mapping COTS products to the proper TRL level results in the intersection of classic technology readiness assessment and the realities of COTS product development.

"Responding to economic restraints and new strategic goals, the DoD's 2012 budget promises an altered landscape for the embedded COTS industry."

Once deployed, a COTS product earns a fairly high TRL because that technology has been demonstrated in the same or in a similar operational environment to the new program. This enables COTS vendors to provide a product road map that offers the mature technology today with a path to the next-generation technology when it becomes the next mature technology.

Military procurement evolves

To support the TRA process, Curtiss-Wright Controls Embedded Computing (CWCEC) has developed a Technology Readiness Road map (TRR) that clearly indicates the TRL level of existing and upcoming products (www.cwcembedded.com/TRL). A TRR also addresses another emerging trend in military procurement, "Buy Less, More Often." Rather than predict the purchasing requirements for a program's expected life and contract for those components at the beginning of the program, the "Buy Less, More Often" mantra recognizes that technology changes every three years or so, and improves technology refresh strategies by calling for smaller purchases on a regular schedule. This reduces the deliverable quantity of any one product but results in more frequent refreshes, spreading out purchases to access improved capabilities.

COTS and TRL connect constrained resources

As the military looks at reducing the size of the force to address budget constraints, it increasingly depends on force multipliers that enable increased efficiencies and effectiveness for existing resources across the battlefield. COTS and the TRL model will help to deliver the additional electronics needed to share and connect these constrained resources in an increasingly net-centric battleground.

The danger is that the drive to reduce costs can push system developers toward commercial products. The double risk this presents is that commercial-grade electronics cannot meet the environmental requirements nor the longevity of supply required in military embedded systems because of commercial products' rapid obsolescence. Companies such as CWCEC have a proven track record of supplying reliable, mature, open-system technologies based on COTS products, thereby reducing program and technical risks for customers.

To learn more, e-mail Steve at Steve.Edwards@curtisswright.com.

Legacy Software Migration

By Kim Rowe

Legacy system migration without virtualization

For the past 15 years, a substantial number of deeply embedded military systems were deployed that used C/C ++ and POSIX. For systems developed with POSIX APIs or similar APIs, three choices exist for migration, which can be superior to traditional virtualization approaches. The first involves exploiting Microcontroller Unit (MCU) technologies and porting applications. The second approach exploits Microprocessor Unit (MPU) technologies and porting several applications into a new MPU. Exploiting multicore and FPGA hardware is the third alternative, which involves mapping functions to hardware and restructuring applications onto this hardware. The following explores these alternatives.

By exploiting C/C++ implementations and POSIX, along with hardware advances, systems can be restructured using one or more of the three aforementioned approaches. In all cases, the Size, Weight, and Power (SWaP) requirements will be reduced, offering a more mobile, agile, and faster end system. Because virtualization is not used in the same way, resources are better allocated and performance is improved.

Exploiting MCU technologies

By replacing boards from a few years ago with Microcontroller Units (MCUs) that offer System-on-Chip (SoC) capability, the same systems become smaller, lighter, and lower power. Substantial cost savings are also achieved. If the development environment for the original system was a POSIX-based operating system, the migration to an MCU environment is straightforward.

If the previous operating system was not POSIX but had a POSIX optional layer, all the device I/O, communication, and synchronization must be replaced with calls to an MCU-based POSIX operating system. The application should port readily. The major costs are integration and test. The approach of replacing boards with SoC MCUs is the easiest way to upgrade existing systems.

Exploiting MPU technologies

The power of microprocessors has substantially increased and this leads directly to the ability to take several applications that ran on several boards and amalgamate them into a single Microprocessor Unit (MPU) board. With integrated peripherals, lower voltages, lower line widths, and multicore to reduce power consumption, there is SWaP savings here as well. Again, cost reduction is significant.

The key to this type of implementation is to condense all the peripheral support onto a single system. Services such as network interfaces, file systems, bus interfaces, and displays must be shared unless they are 100 percent duplicated. This is a similar problem to that encountered with a virtualization approach. Redesign must be completed to the extent that the I/O is now shared and performance goals must still be met.

One primary difference is that while a virtualization approach offers processor partitioning using some metric for the entire application in a given virtual machine, the POSIX approach allows for prioritization of individual threads for all the applications running together. The POSIX amalgamation migration strategy offers substantial performance improvements on the same hardware for this reason. Now the threads can run at any priority, getting the most out of the hardware while reducing SWaP and cost.

The reason that this approach is possible is because there is a common set of Application Programming Interfaces (APIs). Applications are left unchanged, excluding redesign to share peripherals, and applications can communicate more directly to improve performance.

Exploiting multicore and FPGA capabilities

The ability to migrate multiple applications to a multicore platform is perceived as difficult because the multicore programming models are not clearly known. If the applications use POSIX and the OS provides transparent access to all threads on all cores along with transparent I/O, the port is simple. Operating systems involving hybrid models that do not provide a uniform or transparent API for all cores or do not offer universal I/O limit this approach.

The ability to migrate to FPGA technologies is often seen as mapping functionality to hardware, often using a C-to-FPGA compiler. This is still true; however, using one or more soft cores or an included MCU or MPU core running POSIX can support the porting of the remainder of multiple applications and consolidate many features onto a single hardware platform.

Unified capabilities

Better than a traditional virtualization approach, legacy migration can be simplified with operating systems such as RoweBots Research Inc.'s Unison OS, which provides a unified approach to exploiting MCU, MPU, or FPGA/multicore migration strategies. The Unison OS offers MCU, MPU, transparent multicore, and FPGA support using POSIX with C/C ++. Extensive I/O libraries and tools ensure fast and easy application integration on a broad range of embedded hardware.

Kim Rowe *is the founder and CEO of RoweBots Research Inc. He can be contacted at kim.rowe@rowebots.net.*

Daily Briefing: News Snippets

By Sharon Hess, Managing Editor

www.mil-embedded.com/dailybriefing

UAS paradigm shift is up in the air

Long in vogue for ISR missions, UASs are now being evaluated by the U.S. Armed Forces for suitability for cargo delivery to troops in remote locales and on the battlefield; such a paradigm could eliminate the dangers of IEDs to supply-delivering Marines, for example. Key to moving this potential paradigm shift forward is Lockheed Martin's successful completion of a recent Quick Reaction Assessment (QRA) of the K-MAX UAS (Figure 1), as part of the U.S. Navy's Cargo Unmanned Aircraft Systems (UAS) program. A spinoff of Kaman Helicopters' K-MAX manned helicopter, the K-MAX UAS flies autonomousy or via remote-control operation. Next up: A Commander Operational Test and Evaluation Force (COMOPTEVFOR) report is to be issued within 30 days of the QRA, followed by the USMC's and U.S. Navy's assessment of the K-MAX UAS's deployment feasibility.

Figure 1 | Shifting from the long-established UAS-for-ISR tradition, Lockheed Martin successfully finished a recent QRA of the K-MAX UAS built for cargo-carrying purposes. Next up: COMOPTEVFOR issues a QRA report to the USMC/U.S. Navy so they can evaluate deployment suitability. Lockheed Martin photo

RDT&E funding: It's still out there

Though DoD Research, Development, Test and Evaluation (RDT&E) funds appear to be rapidly dwindling, they recently surfaced, incarnated as an RDT&E contract between the U.S. Missile Defense Agency (MDA) and Teledyne Brown Engineering, Incorporated. Sporting a maximum value of $595 million, the contract stipulates that Teledyne Brown Engineering develops a scalable-, modular-, composable-, reconfigurable-architecture single-objective simulation framework system as a replacement for the current hardware-in-the-loop single-simulation framework systems and the presently used digital simulation architecture. The contract's completion is anticipated in September 2016.

Ground Combat Vehicle development forges ahead

The Ground Combat Vehicle's (GCV's) Technology Development (TD) phase is underway, thanks to a nearly $450 million U.S. Army contract with BAE Systems as prime. The GCV's TD phase will ensue for 24 months, with the goal of moving the technology into and past the preliminary design review stage. The U.S. Army issued two industry team contracts for GCV TD, and the BAE Systems team includes Northrop Grumman as C4ISR lead, with iRobot Corporation, QinetiQ, Saft, and MTU onboard. The team's goal is to design an adaptable platform that meets requirements now and in future decades and to provide additional mobility, survivability, and mission versatility at a reasonable price. The key element in the BAE/Northrop Grumman iteration is a hybrid electric drive propulsion system facilitating a lower weight and heightened force-protection capabilities.

Boeing to refresh the A-10 Thunderbolt

In keeping with the U.S. DoD's emphasis on modifications and upgrades, the USAF and Boeing recently put pen to paper, spawning a $2.9 million, one-year contract for a modified Digital Video Audio Data Recorder (DVADR) for the A-10. As an A-10 Thunderbolt Life-cycle Program Support (TLPS) task order contract, the specified ware is anticipated to "provide a near-term solution to supportability issues with a major subcomponent in the DVADR system," according to a media statement issued by Boeing. The contract is Boeing's sixth USAF TLPS contract for the A-10. Meanwhile, the single-seat, twin-engine "Warthog" (aka "A-10 Thunderbolt II" – see Figure 2) features myriad ground-target munitions and stays close to ground forces. It was first deployed in 1976.

Figure 2 | A recent Boeing/USAF contract specifies a modified Digital Video Audio Data Recorder (DVADR) for the A-10 Thunderbolt. USAF A-10 Thunderbolt II photo by Tech. Sgt. Michael R. Holzworth

Army hardware procurement and repair speed up

Getting the right hardware into the hands of soldiers – and having it repaired in a timely fashion when needed – is critical to mission success. Supporting that assertion is a whopping $3.7 billion contract between the U.S. Army and General Dynamics C4 Systems, for Common Hardware Systems-4 (CHS-4). The IDIQ contract spans five years and covers tactical IT services and hardware procurement via either cost plus fixed fee or firm fixed price contracts for noncommercial wares' service. The goal comprises battlefield sustainability, interoperability, lower life-cycle costs, and compatibility by centralized COTS acquisition. Maintenance, logistics, and repair are provided on a regional basis for procured items such as network devices, notebooks, handheld devices, servers, cables, peripherals, and more (Figure 3). Quantifiable benefits of CHS include timely hardware delivery 99 percent of the time, along with 72-hour turnarounds on hardware replacements or warranty repairs. The end result: operational availability of 97 percent, according to the DoD.

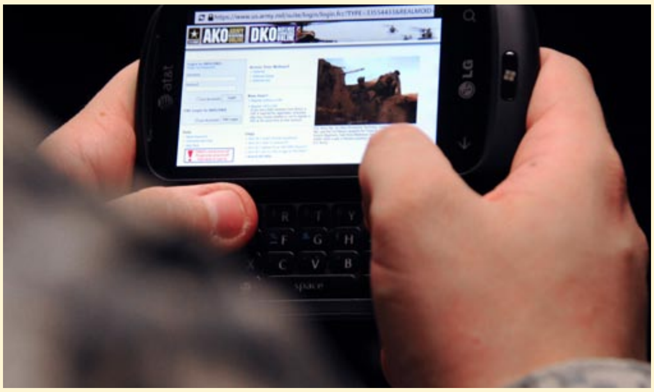

Figure 3 | A $3.7 billion U.S. Army/General Dynamics contract for Common Hardware Systems-4 (CHS-4) covers repair, replacement, tactical IT services, and hardware procurement of items such as network devices, notebooks, handheld devices, and more with 99 percent on-time hardware delivery and 72-hour turnaround on repairs. U.S. Army photo by C. Todd Lopez

Raytheon's jammer eliminating manned aircraft?

The ability to reduce the number of aircraft in a conflict yet still achieve the desired results is, clearly, a real plus. And the USAF's recent successful demonstration of the Raytheon Company-built Miniature Air Launched Decoy Jammer (MALD-J) in a simulated environment could eliminate or lessen the necessity of using manned jamming aircraft in future real-world scenarios. Specifically, the demonstration illustrated MALD-J's manned-aircraft protection savvy, as multiple MALD-Js flew in the demo, performing electronic attack missions and exhibiting proficiency in a manned aircraft strike scenario. MALD-J's range is about 500 nautical miles, and the air-launched, modular flight vehicle tips the scales at under 300 lbs. Next on the docket: a Functional Configuration Audit (FCA) by the government. Thereafter, the USAF is in a position to authorize production later this year, if all goes well, Raytheon reports.

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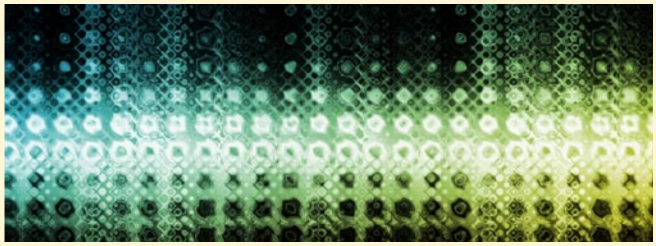

Figure 4 | A recent USAF/Georgia Tech Applied Research Corp. contract has Georgia Tech Applied Research Corp. providing sensor technology evaluations – including against vendor performance claims – and recommendations in light of present and future threat capabilities.

USAF to track new/existing sensor tech, evaluate vendor claims

ISR is vital to successful military ops, and sensors are a key part of the picture. Accordingly, the USAF recently awarded Georgia Tech Applied Research Corp. a nearly $50 million contract spun completely around sensor technology. Under the contract, Georgia Tech is to "perform testing and user evaluations in order to determine the performance of various sensor systems, often against vendor performance claims, and develop recommendations regarding initial or continued use," per the DoD website. Additional duties under the contract include evaluating new sensor concepts for possible use in fielded systems; developing and prototyping innovative sensor concepts; assessing sensor technologies and quantifying their readiness for Army use; disseminating DoD and other sources' sensor technology information; offering analysis of current and future threats and recommending sensor technologies that would best thwart them; and educating Rapid Equipping Force, in addition to other federal personnel, about sensor technology use (Figure 4).

DARPA issuing a duo of contracts

DARPA has been busy, as evidenced by a couple of recent contracts. The first is a nearly $37 million contract to Ball Aerospace Corp. in conjunction with the Moire Program, which has the goal of rendering missile launch tracking and detection – along with real-time, persistent tactical video – to warfighters via diffractive membrane optics. The hope is that the optics will enable inexpensive geosynchronous imaging, and work is slated for completion by early 2013. The second contract is nearly $7 million, extended to SiOnyx, Inc. for technology development under the Portable Photovoltaic Device Program. The goal is to solve issues related to the expense and mass of portable photovoltaic devices while affording a higher level of efficiency in converting power. Contract fulfillment is anticipated by March 2013 (Figure 5).

Figure 5 | DARPA issued two contracts recently, including one for nearly $37 million to Ball Aerospace Corp. under the Moire Program, in addition to a second nearly $7 million contract to SiOnyx, Inc. for Portable Photovoltaic Device Program work. U.S. Army photo by Spc. Advin Illa-Medina

COTS vendors, while concerned about extensive DoD budget cuts, see opportunities for retrofits, unmanned systems

By John McHale, Editorial Director

Congress may make sweeping cuts in the next DoD budget, affecting every level of supplier. However, COTS vendors see a silver lining as DoD officials will need to upgrade existing naval, air, and ground platforms if no replacements are funded.

The military electronics market for the most part has remained resilient during the economic downturn, functioning as a financial oasis for those fortunate enough to play in the industry – especially COTS hardware and software suppliers. Many COTS vendors doing business in the commercial and military worlds found that their military business kept them profitable during the recession.

Now with possible DoD budget cuts ranging as high as $600 billion, major programs could be cut, severely affecting the main COTS users – prime contractors and system integrators. As a result, everyone from the primes on down to the third-tier COTS suppliers is nervous, wondering if the programs to get cut will be the ones they are working on.

"I think everybody in the industry has concerns about funding for DoD programs in the short term," says Steve Edwards, Chief Technology Officer for Curtiss-Wright Controls Embedded Computing in Leesburg, Va. "There is a chance that Congress could cut hundreds of billions off the top of the defense budget over the next several years, which is bound to affect spending on equipment and research and development – but *how much* is the question."

"Congress needs to come to resolution on the budget issues by [the] November timeframe or else a financial team will come into each segment of government – including defense – and mandate cuts," says Joe Wlad, Senior Director, Aerospace & Defense, at Wind River Systems in Alameda, Calif.

"They will have to cut billion-dollar programs," says Ray Alderman, Executive Director of VITA, located in Scottsdale, Ariz. The prime contractors have already begun laying people off due to the big cuts at NASA and ending the Space Shuttle program, that will continue as the DoD cuts are made, he says.

Global Hawk photo courtesy of Northrop Grumman

> Now with possible DoD budget cuts ranging as high as $600 billion, major programs could be cut, severely affecting the main COTS users – prime contractors and system integrators.

"Some prime contractors and system integrators may delay purchases, waiting to see what will be cut from the DoD budget and if the market starts rebounding," Alderman says.

"There are possibilities that the Ground Combat Vehicle (GCV) program could go the same way as the Future Combat System (FCS) program, and companies with technology investment in that program would need to adjust if that came to pass," Edwards says (Figure 1).

"No one wants to see layoffs in any industry, but historically when companies do downsize personnel, they outsource many of those resources because the work still needs to be done," Wlad says.

Silver lining for COTS vendors?

"Budget cuts could actually help established COTS vendors," mentions Doug Patterson, Vice President of Business Development for Aitech Defense Systems. Military vehicles and platform programs will always need upgrades to counter new enemy threats and "in reality, it's less costly to upgrade with existing technologies than create and develop new technology from scratch," which is what helps COTS vendors, he explains.

"It is not a doomsday situation, it's actually more of the same lately, which is a wider adoption of COTS as defense budgets get trimmed and controlled," Patterson says. "One can only surmise that development dollars for large prime contracts will get cut, but this may not be an epidemic for the primes or their COTS vendors.

"The primes are being smart and using this lull in funding to figure out what they can do better, how to increase efficiency, and how to address their customers' anticipated needs," Patterson says. "As a result, there is a resurgence in proposal activity."

"I think that there is definitely an upside for the COTS industry," Edwards says. "There's probably going to be fewer completely new programs designed from the ground up. However, without new programs, older platforms will need to be upgraded, which presents a significant opportunity. The goal will be to make existing systems last longer, which provides opportunities for COTS vendors to provide newer hardware as primes deal with obsolescence."

"The pain and suffering related to component obsolescence are why some of the primes and government labs are turning toward COTS vendors who offer established product life-cycle management programs for obsolescence mitigation,"

Figure 1 | Defense companies are hoping that the Ground Combat Vehicle (GCV) program, which is planned to replace current platforms such as the Bradley Fighting Vehicle (pictured here), doesn't get cut by Congress. BAE Systems photo

Patterson says. "The single-point government contracts aren't going to fund the primes for these efforts, so it is up to the subsystem or board vendors to implement a component obsolescence risk mitigation plan [that] addresses the demand for long-term product availability to support the programs in which they participate."

During the Clinton administration, research and development funding was scaled back in the DoD, yet COTS suppliers still found success during that time. Additionally, COTS was still relatively new as a procurement strategy, with many in the primes not trusting any equipment labeled as *COTS*.

"People in the defense and aerospace community have no qualms now about using COTS software and hardware, whereas in the past when [the] COTS procurement mandate was first introduced, they always wanted to customize," Wlad says. "Now program managers, once they utilize COTS, realize their system life can be extended and they can be more competitive.

Internally the primes are somewhat split on how much they value COTS. Some primes keep designs in house, but more of them are actually seeing that it is more cost efficient to leverage COTS equipment, Edwards says. He calls it an 80 percent solution "whereas if you get eighty percent for twenty percent of the cost, don't go for 100 percent and pay five times that."

"The industry also needs to make sure military systems are being designed to meet cost and environmental requirements and not requiring equipment to be super rugged when it doesn't need to be," Edwards says. They will have to ask whether systems "are rugged enough for the task at hand. Many systems that are not operating in super harsh environments are still being designed with requirements as if they were, which can significantly raise costs.

"It is also important to note when people use the word *ruggedized,* it gives the perception that ruggedization occurs after the fact, when in reality boards and components are designed from the beginning to meet rugged requirements, not after market modifications," Edwards adds.

COTS software technology positioned well

"I see of a lot of positives in the marketplace" from a software perspective, says John Warther, Vice President of Government Programs at Green Hills Software in Santa Barbara, Calif. It is essential to have secure software for cyber warfare applications, unmanned systems, and military communications. "Even if the government cuts back on its work with prime contractors for major programs, many military organizations will still need the safety certification and security work done and will still rely on major software vendors," he adds.

"Many of the primes are preparing for the worse-case scenario by cutting back on personnel and, as a result, will rely more on outside resources for servicing existing software suites," Wlad says. "With a lack of new programs, there will not be as much of a need for new developmental suites, but existing systems will still need to be serviced.

COTS opportunities

"There are many key areas where the U.S. military is spending money," Edwards says. "Critical weapons systems, unmanned systems, surveillance, security, and anything that protects the warfighter and increases equipment survivability are examples."

"Even though larger programs might be scaled back, there will be opportunities in

Figure 2 | The retirement of the U.S. Space Shuttle program has created layoffs at major primes such as Boeing and Lockheed Martin. Funding for NASA space programs is expected to remain flat for the next five years. NASA photo

the areas of cyber security and unmanned systems," Wlad says.

"It is easier for the military to get funding approved when it comes to protecting human life," Edwards says. "Surveillance and intelligence gathering are an important part of protecting the warfighter and are the areas where we see an upside in funding opportunities. Intelligence, Surveillance, and Reconnaissance (ISR) applications and unmanned systems are two areas where the defense community is taking advantage of COTS technology, but even where not a lot of money is being spent, the DoD is pushing toward affordable computing solutions."

"The avionics and unmanned systems markets have the promise of having the most activity for COTS vendors," Patterson says. "Navy applications – above deck and below deck – are using COTS computers with extended temperatures and rugged COTS above deck. Below deck, the card standards remain VME."

"Unmanned systems are particularly forecasted to be a strong investment area, with about $20 billion more to be spent on autonomous systems by 2018," Wlad says. "As the DoD moves toward a common Ground Control Station (GCS) architecture for Unmanned Aerial Systems (UASs) and away from *ad hoc* designs, there will be opportunities for suppliers of standard COTS software and hardware. Current GCSs are a mix of COTS and proprietary solutions.

In terms of new programs, the growth will continue to be in unmanned systems, which will require not only new software suites, but upgrades to current ground control stations as the systems evolve, Warther says.

The UAS Control Segment (UCS) architecture will primarily be MILS, a service oriented architecture, but with support for many different services including those requiring Linux and Windows, Wlad adds. MILS, which stood for *Multiple Independent Levels of Security,* has been trademarked by the Open Group and is no longer an acronym, he notes.

Space market

The space market may be the stingiest in terms of growth for COTS vendors, as the U.S. retired the Space Shuttle program, forcing layoffs at Boeing and Lockheed Martin and the budget is forecasted to remain flat over the next five years (Figure 2).

"Right now, we are seeing that government-sponsored NASA-based space programs are in some trouble due to the uncertainty caused by the NASA budget being slashed with almost no regard to the ramifications to the industry base that supports it," Patterson says. "The most notable of these is the Space Shuttle cancellation and the cancellation of the Constellation (Orion crew capsule/Ares launch booster) program developments.

"This uncertainty is compounded by the unknowns related to when next year's NASA budget will be approved, or to what the level of funding will be when it does get approved," he continues. "There will be COTS in space, but it will be slower in coming. However, the longer-term requirements and demand are there and it's just a matter of how the U.S. defense and NASA budget dollars will be allocated and when the 2012 Defense Appropriations Bill will be officially signed by the President and released (if ever) with approved funding." **MES**

The impetus for the Quantum3D product lines acquisition, in one word: "Synergy"

Q&A with Ray Niacaris, Director of Operations and Sales at IData Visual Systems Inc., a subsidiary of ENSCO Inc.

Editor's note: Started in 1969 by Dr. Paul Broome, ENSCO is an S Corporation based in Falls Church, Virginia with 600 employees and a focus on national security. Of the company's five divisions focusing on transportation, security, and aerospace and defense, the Innovative Systems Solutions division found that it was often "synergistically" running into the product IData by Quantum3D. ENSCO put together a deal to acquire Quantum3D's IData and IGL 178 product lines and associated employees. The merger was announced earlier this year, shortly before *Military Embedded Systems* talked with Ray Niacaris, Director of Operations and Sales for the newly formed IData Visual Systems Inc. subsidiary of ENSCO Inc.

We know that ENSCO provides scientific and engineering technologies for aerospace and defense, among other industries, but why buy Quantum3D's IData and IGL product lines?

NIACARIS: In a word: synergy. As we moved more and more into certification projects, it became apparent to us that we needed much more certification expertise. And the IData product line needed to add tactical digital moving map products and ENSCO had that technology in house, but not a vehicle to bring that technology to market. The IData product line was the vehicle to accomplish that. Finally, we had essentially the same customer base, so it would be a seamless integration effort with existing IData customers.

What exactly is ENSCO buying?

NIACARIS: ENSCO purchased all the IData intellectual property and all the IGL intellectual property. They also took over all existing customer support agreements and open NRE projects, in addition to all hardware, computer resources, marketing materials, customer databases, trade-show material, and anything else that was associated with the IData and IGL products. ENSCO also took on Quantum3D employees who were dedicated to the IData and IGL product lines.

What is the IData product line, and which problem(s) does it solve in the avionics industry?

NIACARIS: The IData family of products addresses the HMI needs of the avionics industry. Unlike most tools that create an executable file that needs to be linked to the target system's software to create a contiguous executable, IData has an executable library, fully certifiable, that processes data and comprises HMI behavior and graphics. This data can be dynamically downloaded to the target system in real time, while the target system is fully operational, thus negating the need to shut down the target system.

And the IGL product family addresses another set of common issues related to embedded cockpit displays: namely heat, power, and obsolescence. IGL is a software-based GPI that supports the Kronos ES/SC subset of the OpenGL standard. Much of the graphics display work can be accomplished with IGL, such as the primary flight display. IGL is a software library, fully certifiable, that runs on the target system, processes OGL commands, and drives the frame buffer. It can be used in conjunction with a system GPU or run stand-alone. In a partitioned memory application, it can isolate the graphics display tasks and allow different FAA certification levels to be on the same display. Since IGL utilizes CPU cycles to perform its functions, the need for a separate GPU chip and its associated power and heat issues are eliminated. Even more importantly, since IGL is software, it can easily meet the 20-year product life-cycle requirement.

> "… One need not be concerned about the target system when doing the HMI development."

Who/what are the competing solutions to IData?

NIACARIS: With the IGL product line, there really is not a directly competitive product. IGL mainly competes with hardware-based GPUs (chips). In that respect, IGL cannot support all of the functions at the same performance levels that a GPU can. However, for a number of avionics applications, IGL can perform the required functions at the desired level of performance.

Although none of the competition uses the architectural approach of IData, their offerings address the same issues/design problems that IData does. Among these companies are Presagis: VAPS xt, Disti: Glstudio, Altia: Altia Design (mainly focused in the automotive market); Esterel: SCADE Display. I have noticed an increasing desire by manufacturers to use tools, but issues arise when programmers who developed the custom application decide to move on and the knowledge behind that custom implementation moves with them.

What about code reuse?

NIACARIS: There are many applications written with tools no longer supported, and customers are faced with what to do with legacy software. One of the first HMI tools on the market was VAPS. Many applications were written using this tool, and customers would like to have a way to import those legacy applications onto a new platform that provides them a future and increased capability and performance. IData actually has an importer that can read a customer's data files created with a tool like VAPS and convert them to the IData tool set. Recent migrations have resulted in a minimum of a 2x performance increase as a result of the re-hosting. Still other customers have found it rather easy to just redo the display applications in IData.

Since IData does not generate code, but rather data that renders an engine on the embedded target system, the identical HMI design can be used on a multitude of target systems of different capabilities because the target system will use its graphical and CPU resources to display the HMI design and behavior. In other words, one need not be concerned about the target system when doing the HMI development.

Talk about some of the latest market technologies, and how they affect IData and why.

NIACARIS: Our business used to be driven by technologies developed by the gaming industry, and that is still the case to a certain extent. However, what used to be a simple cell phone is no longer the case. The use of a cell phone to make calls is often considered incidental, rather than the key component. It would be a real challenge today to find a cell phone that just makes calls. The challenges of these mobile devices are many, but chief among them is power or battery life. This market in many ways is now driving our industry.

Until a few short years ago, a multi-touch MFD was out of the question and a touch panel was rare, with the preference still being bezel buttons. We are now seeing 3D panels that do not require special glasses, and we now need to write applications that rely on touch and multi-touch GUIs. Android is now considered as a development platform that we are required to support. It seemed to happen almost overnight that EFBs were being built on top of iPad technology, and that product itself was only introduced a year ago. The complexity of the graphics required in cockpit displays requires more and more powerful GPUs, and these GPUs need to be around to support 20-year product life cycles, or be so driven by standards-based design that applications can move seamlessly from one hardware platform to another. Those tools that can address that portability will survive in the years ahead.

HMI tool vendors need to form strategic relationships with hardware vendors and RTOS and middleware vendors to ensure that they are all working in concert to drive new technologies and provide the very best solutions for user/machine interactions.

What do you see the future holding in this area of HMI tools, safety-critical software, and so on?

NIACARIS: As we move forward toward advanced cockpits, we can be fairly certain the future will yield new ways to provide the aircraft pilots complex data about their surroundings in an instantly recognizable format. That format will most likely take the form of some type of graphical display. The trick will be presenting that information in an easy-to-comprehend manner and in a timely fashion.

IData Visual Systems, Inc. is currently working on a concept called "combined vision systems." This is a complex concept that requires combining high-speed sensor technology with high-performance, real-time visual data capture (i.e. satellite imagery), synthesized terrain data, real-time weather data, radio identification data, ground-based situational data, and other types of data still yet to be identified. These data need to be combined in a single display to create a synergistic awareness to the flight deck far beyond the levels of information displays currently in use. Each data feed can fill in or enhance the data present from other sources including, of course, the view out of the flight deck windows and the pilot's inherent knowledge of their surroundings.

What advantages will ENSCO's acquisition of IData provide to the embedded industry?

NIACARIS: To begin with, ENSCO has primarily been a service-based company, while IData has been focused on products. As the products produced by IData evolved more and more into the realm of safety-critical design, it became readily apparent that it must "staff up" to engage in that type of business. However, ENSCO already had the staff, reputation, and track record to provide the type of support necessary to pursue that business. Today IData Visual Systems can support fully certified cockpit display programs.

Additionally, although IData has capability to overlay weather data in its IData HMI product, until the acquisition by ENSCO, IData did not work with sources of weather-related expertise. ENSCO has an extensive weather research group and supplies weather data to NASA as well as a major airline.

IData has not been engaged in the rail industry, yet ENSCO has been working with the rail industry for many years. In fact, a quick visit to the ENSCO website yields many areas where ENSCO's established businesses can benefit from the use of IData products and vice versa. **MES**

***Ray Niacaris** is Director of Operations and Sales at IData Visual Systems Inc., a newly formed subsidiary of ENSCO Inc. He has more than 35 years of experience in real-time embedded systems and computer graphics. Ray has degrees in EE and CS from the Illinois Institute of Technology, where he graduated with honors. He has completed advanced studies in product design and held the position of Studio Professor at the Illinois Institute of Design. Contact him at rayn@idatavs.com.*

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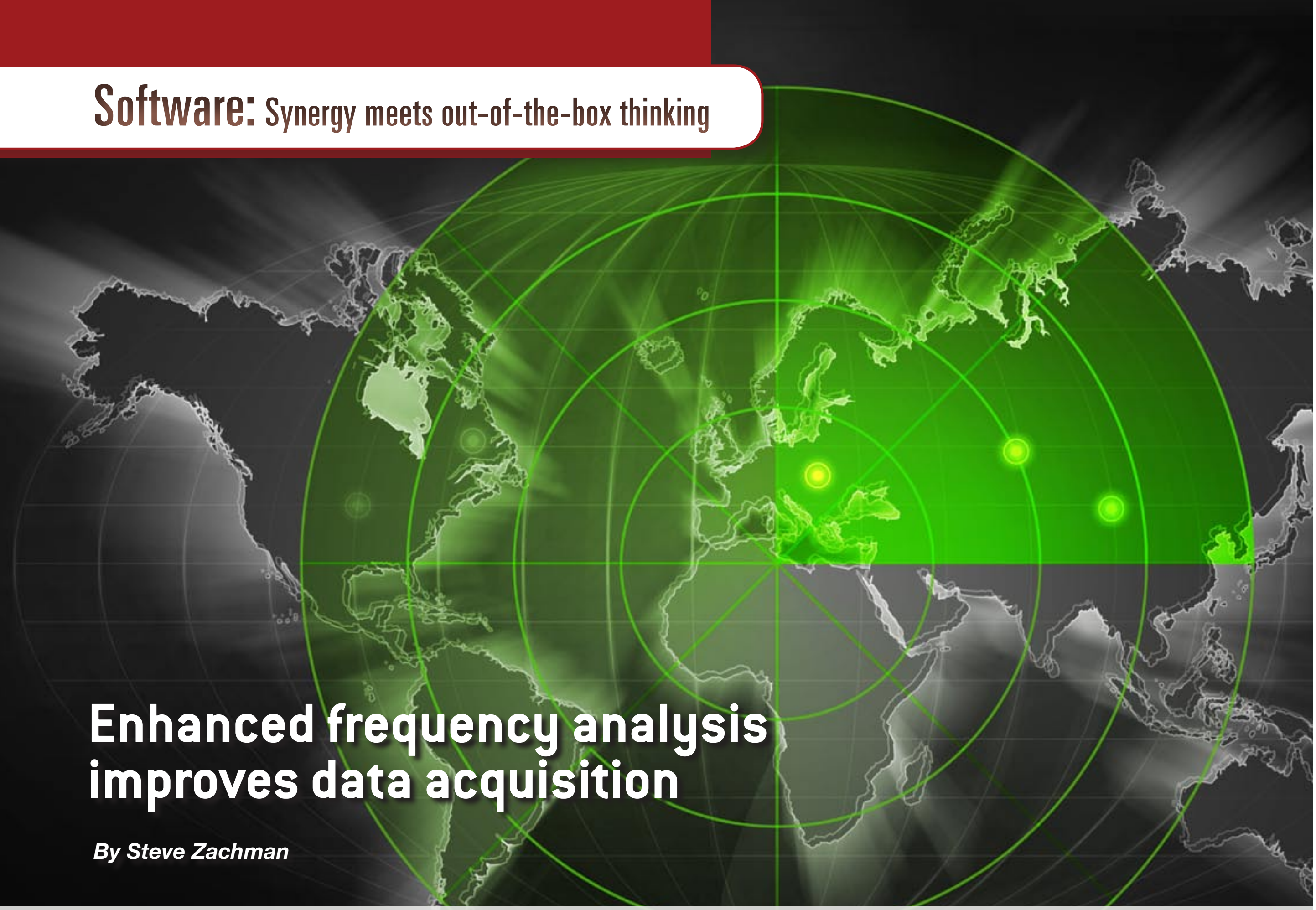

Enhanced frequency analysis improves data acquisition

By Steve Zachman

Often there are some advantages in using frequency domain techniques, as opposed to using strictly time domain techniques, to analyze signals obtained in data acquisition. The merits and possible issues of using a particular frequency-based transform methodology along with subsequent graphical analyses are discussed. Appropriate choices for analyzing signals in the frequency domain can often improve the overall system during the concept, development, and/or testing phase of many data acquisition systems.

Frequency domain analysis plays an important role in the design and testing of many militarized systems, including wireless communications, remote sensing, radar processing, audio processing (such as speech recognition/authentication, watermarking, and compression/VoIP), and more. The development process of an embedded computing military application often requires sampling real-world physical systems through a data acquisition process that results in a digital representation of those signals.

Although the data representing these signals is most often sampled in the time domain, many applications engineers find it easier – and more conceptually clear – to work with the data in the frequency domain. This is because of the many engineering relationships governing information, which are typically described in the frequency domain. A thorough frequency analysis of the data being acquired and processed can facilitate the retrieval of subtle information contained within the signal and provide valuable insight into the real-world environment that will be encountered. Often that subtle information includes signal artifacts with very low Signal-to-Noise Ratios (SNRs), which might be missed in analyzing the data exclusively from the time domain.

However, there are challenges that can arise to complicate the spectrum analysis of a signal, possibly resulting in a misreading of real-world data. Understanding the analysis options that are available and avoiding potential pitfalls can lead to a more robust design implementation that ultimately results in improved performance of the embedded system prior to its deployment in the field. The data acquisition process serves as impetus for signal conditioning, data discontinuities, bandwidth considerations, channel and SNR analysis, and filtering requirements – all of which can be studied in the frequency domain through a detailed graphical analysis. The proper choices for the transform method and graphical analysis selection and associated parameters will often benefit a data acquisition-based system.

Deciding on a transform method

There are numerous methods for extracting the frequency domain information from acquired time domain data. The selection of a frequency domain transform plays a large role in determining how the acquired data is actually portrayed in a frequency-based display, and each has its own trade-offs of advantages and disadvantages. These frequency domain transforms include the Fast Fourier Transform (FFT), the Constant-Q Transform (CQT), and the Goertzel transform.

The FFT is an implementation of a Discrete Fourier Transform (DFT) with the benefit of considerable speed and efficiency. A useful conceptual aid for the FFT is to consider cross-correlating the input signal with a set of sine/cosine waves, starting each pair at a low fundamental frequency and then increasing the frequency of the pair by an integral multiple of the initial fundamental frequency. It delivers its results in the frequency domain in a linear fashion with regard to the frequency axis, and produces a frequency domain data set with length equal to a power of 2. Therefore, to obtain fine resolution in the frequency domain, a large FFT size is needed to get the many points needed, which are distributed linearly from 0 Hertz (DC) to the sampling rate divided by 2.

If only a small portion of the frequency domain is needed, but with good resolution, the FFT might not always be the best choice. The CQT, although not as efficient as the FFT in a brute-force sense, produces frequency domain results in a logarithmic fashion with respect to the frequency axis. It generally attempts to model the human auditory tract, and acoustic/speech applications are sometimes benefited by this approach. A good way to think of the CQT is as a group of logarithmically spaced filters acting on the input signal. The issue here is that the CQT will allow more resolution for lower areas of the resulting spectrum at the expense of the resolution at the higher frequencies; the resolution trade-off is specific to the choice of parameters used in the CQT. For some acoustic/speech applications, the increased resolution of the lower frequencies because of the logarithmic axis allows more relevant details to be seen.

The Goertzel transform can be used to extract frequency domain information defined at arbitrary points in the frequency axis. By selecting and organizing an array of these arbitrary points, it is possible to end up with great resolution for only a small part of the overall signal bandwidth (typically sampling rate divided by two). Thus, although it may be computationally less efficient than the FFT on a point-per-point basis, for some applications it may actually be better as the requirement might be for fewer overall points. The specific trade-offs between resolution and computation time will be dependent upon the choice of desired frequencies made by the engineer for the application. It is the application itself that drives the efficacy of using a particular transform method.

Choosing the graphical analysis

A typical straightforward method of frequency domain analysis involves graphing the data. A simple two-dimensional frequency domain display (or time slice) will plot the magnitude of the signal against either a logarithmic or linear frequency scale. Additionally, the magnitude component itself can be plotted on either a logarithmic or linear scale; a logarithmic scale will accommodate an increased range of the signal to be viewed. Deciding whether to use a log or linear scale is often dependent upon the nature of the signal being analyzed. Having the ability to graphically view the spectrum with each approach can be beneficial in making that determination.

Beyond the standard frequency display is the spectrogram, which uses three dimensions when plotting the data. More often than not, the time domain is used as a horizontal x-axis, with frequency running along a vertical y-axis, and the magnitude component is shown as a third dimension represented along the z-plane as either a color or a height. Again, as with the two-dimensional plot, both frequency and magnitude components can each be viewed on their own logarithmic or linear scale. A significant benefit of the spectrogram is that the time span allowed by this graph includes more than a single frame, or slice, of data – perhaps even hundreds of frames; this can be especially important for noticing time-varying events occurring in signals.

Figure 1 shows a simple before-and-after comparison of an acquired signal alongside its processed counterpart. The

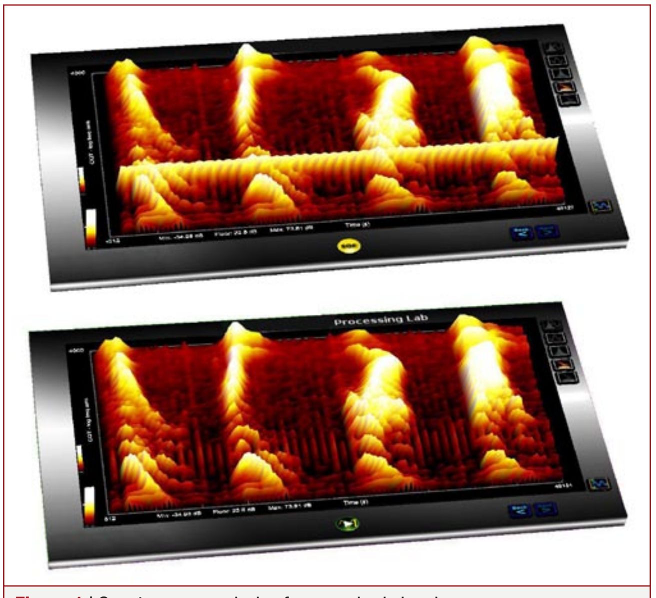

Figure 1 | Spectrogram analysis of an acquired signal

spectrogram display of the acquired signal shows the presence of a sinusoidal noise component comprising a frequency that is easily discerned by a graphical measurement. This information leads to designing a digital filter to remove the unwanted component from the signal.

In addition to the transform used for frequency mapping, some consideration must also be given to transform parameters such as windowing and time domain region of interest choices including zero-filling and truncation.

How window functions affect the resulting data

Although a detailed look at window functions is beyond the scope of this discussion, it is important to note that they are often used to improve the frequency transformation in an application-dependent manner. The simplest window, called *rectangular,* results in just a segment of the time waveform being used. One of the issues with its use is the artificial frequency artifacts that result from the segment's boundaries; the transform will see these boundaries without the benefit of knowing the signal actually continues, and will produce results accordingly. There are numerous other window functions that minimize this effect with a variety of different results, and oftentimes graphical analysis is employed to study the various trade-offs. An analysis of the signal's standard frequency display or spectrogram is often a good method to better understand which type of window to apply and how it affects the resulting data.

Which data is being analyzed: Zero-filling/truncation

One common pitfall associated with frequency domain analysis lies in the incorrect selection or usage of the time analysis region for the data being studied. This can happen when an arbitrary amount of time domain data is plotted (in time) together with a frequency domain display without any indication of which time segment has actually been used for the frequency transform. For example, if the time display is showing a signal with 10,000 points but the frequency display is based on a 512-point FFT, the real time region is likely the first 512 points of the 10,000; if the engineer looking at the display incorrectly assumes it is showing the frequency for the whole 10,000 points, he may make design decisions that are incorrect. In Figure 2, NEXTWave Signal Processing Lab software from NEXTXEN is used to show the effects of varying the time analysis region being processed and zero-filling/truncation on a time-domain signal; note the highlighted region of the time domain waveform being analyzed. As is illustrated in the graphs, choosing a larger time duration as an input to the frequency transform results in a higher resolution of the calculated spectrum as compared to transforms using a shorter time duration.

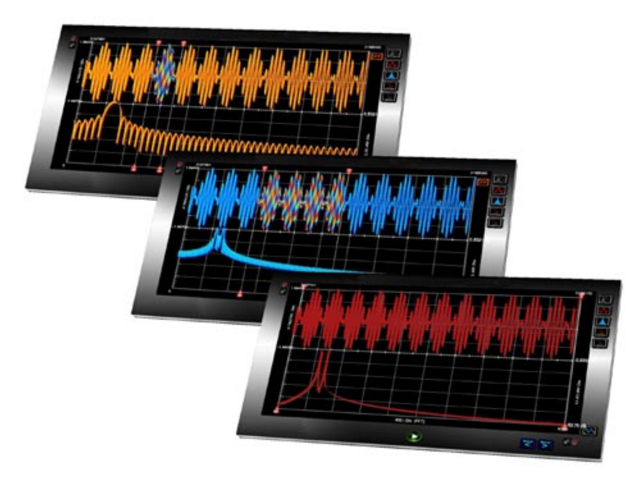

Figure 2 | Effects of time duration, transform size, and zero-filling

Frequency domain analysis improves the system

Many embedded militarized real-time data acquisition systems can benefit from specialized software-based signal processing and frequency domain analysis. From a signal processing perspective, certain limitations exist in the way acquired data can be handled to avoid pitfalls when performing the frequency domain analysis. Being aware of the trade-offs associated with the transform process and how the calculated results are displayed when working with acquired data is an important part of this development cycle. A software approach that makes use of enhanced acquired-spectrum analysis can provide information relevant to embedded application development and lead to a more robust system design. **MES**

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U.S. Air Force photo by Senior Airman Nathanael Callon

Solving the processor challenges for safety-critical software

By Tim King

Multicore, hyperthreading, Dynamic Frequency Scaling (DFS), and DMA are modern processor features aiming to optimize average-case execution times. Such optimizations can result in challenges for safety-critical software designers, who must focus on worst-case behavior, though. However, these issues can be successfully mitigated.

Modern processor features such as multiple cores, hyperthreading, and high-speed DMA are designed to optimize average-case execution times. However, these optimizations often come at the expense of worst-case execution times and make systems more difficult to bound. This situation presents significant challenges to developers of safety-critical software, who must design for worst-case behavior. Thus, the following discussion examines why worst-case behavior is focused on in the software development process, as well as some of the key processor-related challenges facing developers of safety-critical software and ways of addressing them.

Why focus on worst-case behavior?

In a safety-critical software environment, one must ensure three key things:

First, each periodic thread (or task) must always execute at its defined rate (for example, 100 Hz). This is important because each thread must perform at a given rate or else the system can become unstable and, hence, unsafe.

Second, each periodic thread must be allocated a fixed time budget that it cannot exceed (for example, 200 microseconds at 100 Hz). This is important because it allows the underlying RTOS to enforce time partitioning.

Third, each periodic thread's fixed time budget must be adequate to cover the thread's worst-case behavior. This is important because many safety-critical threads must execute to completion in every period. If they do not, the system can become unstable and, as a result, unsafe.

Note that this set of requirements stands in stark contrast to noncritical software systems, where one wants overall performance at the highest level, but can tolerate occasional "glitches" where performance is slower than average.

Multicore and cache/memory contention

CPU throughput has roughly doubled every 18 months since 1985, consistent with Moore's Law. However, that trend began slowing in about 2005 because of three key factors. The main reason is that memory speed has not kept up with CPU performance, increasing only about 10 percent per year during this same timeframe. Larger caches help alleviate this problem, but memory subsystems remain significant performance bottlenecks.

Theoretically, greater parallelism should increase peak performance by enabling the CPU to process multiple instructions concurrently. However, techniques like pipelining, branch prediction, and speculative execution have begun to "hit a wall," making it increasingly difficult to exploit that parallelism.

Thermal factors have also slowed the advance of CPU throughput. As operating

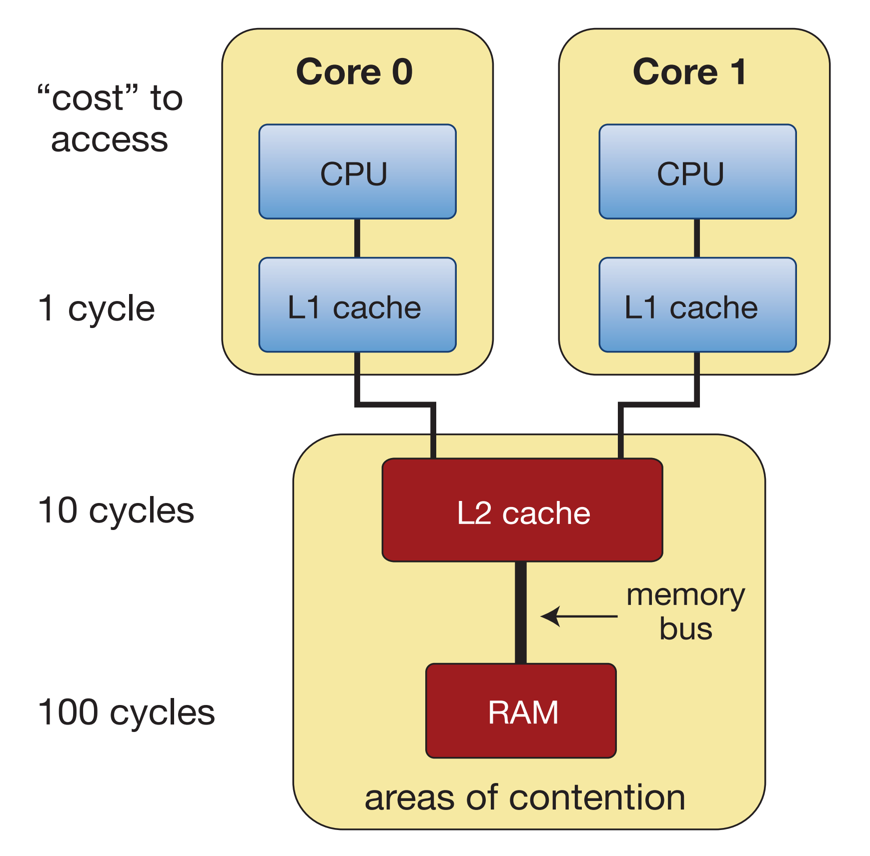

Figure 1 | A simple dual-core processor, each core with its own CPU and L1 cache, both cores sharing an L2 cache and a RAM subsystem

frequencies increase, power consumption and heat generation increase proportionally. Dissipating this heat presents difficult challenges in many environments, particularly for passively cooled embedded systems.

Recently, multicore processors have evolved to meet many of these challenges. To boost memory throughput, for example, each CPU core is equipped with its own L1 cache. Tighter physical packaging also boosts performance by shortening signal runs between cores, which makes data transfers proportionally faster and more reliable. Meanwhile, multiple cores enable processors to execute more instructions per clock cycle. This enables each core to run at a lower frequency, thereby consuming less power and generating less heat.

Despite these advances, multicore processors still present challenges for developers of safety-critical software: primarily, increased contention for shared resources such as L2 cache and the memory subsystem. Figure 1 shows a simple dual-core processor, each core with its own CPU and L1 cache, both cores sharing an L2 cache and a RAM subsystem.

The values listed on the left side represent the "cost" that each CPU incurs when accessing a given resource. For example, say it costs one cycle for the CPU to access its local L1 cache. If that access misses and the CPU has to go to the L2 cache, it costs 10 cycles. If the L2 cache misses and the CPU has to go to RAM, the cost is 100 cycles. If the cache is "dirty" and "write-backs" are needed, performance is even worse. Note that these numbers aren't intended to be exact, and will vary from processor to processor, but the relative orders of magnitude are typical. The important point is that the further out the CPU has to reach to access data, the more time the data transfer takes.

Contention arises when multithreaded processes on a CPU simultaneously compete for that core's L1 cache, and when multiple cores simultaneously compete for the shared L2 cache and memory subsystem. Even with a single-core processor, the CPU can easily overwhelm the memory subsystem. In a multicore system, where multiple cores must contend for shared memory resources, the memory access bottleneck is much worse.

Slack scheduling and cache partitioning

One way that developers can mitigate memory contention and harness the power of multiple cores while still meeting worst-case execution requirements is to utilize a real-time operating system that is optimized for safety-critical applications. DDC-I's Deos, for example, provides cache partitioning and slack scheduling facilities that alleviate memory access bottlenecks, enhance determinism, and increase CPU utilization for safety-critical applications spanning one or more cores.

Cache partitioning reduces memory contention and worst-case execution time by enabling designers to dedicate a portion of the cache to each core. With this physical partitioning, the total amount of cache available to each core is reduced. However, overall contention is reduced, as multiple cores no longer share the same resource.

Slack scheduling, meanwhile, takes advantage of the fact that the average thread execution time is typically much shorter than the worst-case execution time. For those threads where the actual execution time is less than worst-case budgeted time, the RTOS reclaims the unused time and reallocates it to other threads, thereby boosting overall system performance.

Hyperthreading (HT)

HT allows increased parallelization of computations by duplicating parts of a processor that store a certain application state without duplicating the processor's main processing engine (CPU). In this way, an HT processor appears as two logical processors to the RTOS. HT technology can also be used in a multicore setting where each core has two logical cores.

The advantage of HT processors is increased parallelization of application code, and improved reaction and response times. Some HT processors, for example, have shown performance improvements of up to 30 percent as compared to non-HT processors. Unfortunately, realizing this performance is difficult with safety-critical software, as


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HT increases contention for the cache and memory subsystem, and makes the system more difficult to bound. As such, HT must be disabled in many safety-critical applications.

Dynamic Frequency Scaling (DFS)

DFS (also known as *CPU throttling*) allows the frequency of a processor's clock to be adjusted in real time, either to conserve power or reduce the amount of heat generated by the chip. Though primarily used in battery-powered mobile devices, DFS can also be used in passively cooled avionics systems that must meet stringent heat profiles using only ambient air. DFS is generally used in conjunction with Dynamic Voltage Scaling (DVS), as the frequency is proportional to operating voltage, and power consumption increases as the square of voltage.

DFS and DVS can save power and reduce heat, but in a safety-critical environment, they are problematic because they also reduce the number of instructions a processor can issue in a given amount of time (including slowing down memory bus access). Consequently, performance might be reduced in an unpredictable fashion that is difficult to bound. DFS and DVS can be disabled if power consumption is not a gating factor. Alternatively, designers who want to utilize DFS and DVS can do so by measuring worst-case performance while running the processor at the lower frequency/voltage, and then budgeting accordingly.

Direct Memory Access (DMA)

DMA boosts performance by allowing devices to move large amounts of data (including map displays and terrain databases) to and from system memory without involving the CPU, thereby freeing the CPU to do other work. For safety-critical software, the main disadvantage of DMA is that it operates outside the control of the CPU and the Memory Management Unit (MMU). Thus, a flaw in the DMA controller can break space partitioning. One way to mitigate this problem is to use an RTOS with special DMA controller software that meets the highest level of design assurance.

With the help of an RTOS like Deos, designers of safety-critical systems can reap the performance benefits of advanced processors with multiple cores, high-speed DMA, and DFS without compromising worst-case execution time. Not all advanced processor features, however, are well suited to safety-critical applications. Some such as hyperthreading, while ideal for boosting average performance, simply lack the determinism required for safety-critical applications and must be disabled. **MES**

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U.S. Air Force photo by Tech. Sgt. Wolfram M. Stumpf

COM Express enables application-specific data acquisition systems

By Earle Foster

Military system designers often struggle with finding COTS technologies that can meet critical application requirements. Custom designs almost always offer the best opportunity to create an optimized design, but time to market and design costs can be prohibitive. A hybrid architecture using a Computer on Module (COM) for the core processing functionality with a custom carrier board for application-specific I/O can offer the best of both worlds. This approach eliminates the time and risk associated with a custom processor design while the less-complex carrier board provides the advantages of a purpose-built design.

When considering the architecture for a new military system, designers are faced with an important decision: use readily available COTS products or create or commission a custom design. Design costs and development time can be reduced significantly using standard products, and this approach has found recent favor as a way to lower development costs. However, finding readily available products to meet all application requirements, especially for I/O, can be problematic. Another major concern with COTS solutions is system longevity and design control during the 10+ year life cycle of most military systems. Costs for unexpected changes and product obsolescence can easily exceed the original savings realized from integrating a system using off-the-shelf parts.

On the other hand, a custom design can often meet the technical specifications and allow for tight design control, but might not provide the flexibility to adapt and respond to future application demands. Additionally, without a redesign, a custom system will not be able to take advantage of processor performance improvements and expanding memory options, thus limiting support for application program requirements or future operating systems. Effectively, the design will be frozen.

The good news is that this dilemma can be addressed in new product designs for applications requiring long-term availability and a large amount of I/O in a relatively small amount of space. The answer is a marriage of COTS and custom design using a COM Express module with a custom I/O carrier board. Using this architecture provides the freedom to exactly match the system I/O and mechanical requirements while providing an easy upgrade path for the core processing functions that are most likely to change, thereby extending the useful life cycle of the system.

Computers on Module speed designs, add versatility

Historically, designing custom single board computers that included application-specific I/O was a common solution for high-volume or extremely user-specific applications. Today, modern processors and advanced chipsets require designers with extensive experience and state-of-the-art equipment to implement. The

> "When considering the architecture for a new military system, designers are faced with an important decision: use readily available COTS products or create or commission a custom design."

Computer on Module concept eliminates the "hard part" of custom board design by combining the processing, memory, video, Ethernet, and USB functionality in a small, highly integrated module. These modules are not meant to operate stand-alone, but instead bring the processor bus and high-speed I/O out to an interface connector. The Computer on Module installs on a carrier board that provides application-specific I/O and external connectors.

COM Express, a widely supported implementation of Computer on Module design, is based around the latest high-speed serial bus technology and incorporates PCI Express, USB 2.0, Serial ATA, LVDS, and Serial DVO interfaces. The 2.5 GHz PCI Express 2.0 bus combined with today's fast, low-power processors provide the bandwidth needed for a wide variety of applications including high-speed data acquisition and image processing.

COM Express modules are small and intended for rugged environments, simplifying integration into the mechanical form factor defined by the carrier board. Users can select from processor choices ranging from powerful Intel Core 2 Duo to low-power, low-heat Atom designs. Extended temperature range (-40 °C to +85 °C) models are available from many vendors.

Custom carrier boards for application-specific I/O

Meeting technical specifications with off-the-shelf products might not be possible or might result in unacceptable performance, size, environmental, or cost constraints. A custom carrier board can be "custom tailored" to meet all of the required system functionality outside of the core features supplied by the COM Express module. The carrier board can be designed to the mechanical footprint that best fits the application, and the bus signals necessary to interface the I/O are brought down from the COM Express board via the mating connectors. Since low-voltage differential signaling is used for the bus signals, COM Express offers designers a number of advantages over traditional parallel bus designs including improved noise immunity and fewer traces for easier signal routing.

Common I/O carrier board features include serial, analog, and digital I/O, all of which can be designed to exactly meet the I/O count, voltage ranges, and connector types for the signals to be interfaced. This flexibility is especially useful when connecting to legacy COTS or proprietary equipment that cannot easily be changed.

A company might do custom carrier design in-house if the necessary skillset exists and if they choose to invest the resources. A third-party carrier board provider can also offload the design and manufacture.

Optimized design meets challenging requirements

For a design such as the one mentioned earlier, a large number of I/O points, internal battery backup, and fanless operation over an extended temperature range could be implemented, all in a 1U enclosure. On first read, these specifications might seem unlikely to fit in the 17" (W) x 10.5" (D) x 1.75" (H) size required for the system in the target environment:

- 1.2 GHz fanless Core 2 Duo processor
- Up to 8 GB RAM
- 64 GB SATA solid-state hard drive
- Analog video
- 2 GbE, 4 RS-232/422/485, and 4 USB 2.0 ports
- 120 TTL digital inputs; 96 open collector outputs
- 32 single-ended, 12-bit analog inputs
- Powered from 24 or 48 VDC with 5-minute internal battery backup
- -30 °C to +60 °C operating temperature range

However, using a COM Express module that meets all of the core processing, memory, video, and disk interface requirements for this application can ensure success. The COM Express module also supplies the required USB functionality and one of the Ethernet ports. The remaining I/O and power circuitry – along with the connectors for the COM Express functions – are implemented on the custom carrier design.

For maximum flexibility, an FPGA is used on the carrier board to interface the processor buses to the I/O circuitry. Certain low-level functions to service the I/O are built into the FPGA using the device's 17 Kb lookup tables and 700 Kb embedded block RAM to offload those tasks from the host processor. For example, the 32 analog inputs are continuously polled by the FPGA, and the values are retained in a table for easy access when needed by the application program. Future I/O requirements are also simplified because the FPGA can be easily modified to accommodate the changes. The architecture for the COM Express and custom carrier board is shown in Figure 1.

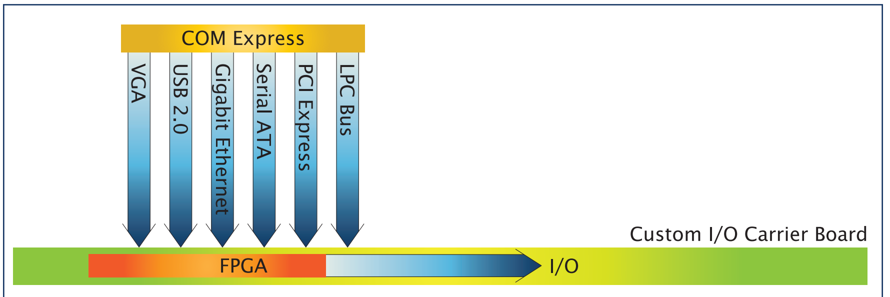

Figure 1 | The COM Express module provides the core processing functions and mounts to an application-specific carrier board that adds the I/O, power, and all connectors.

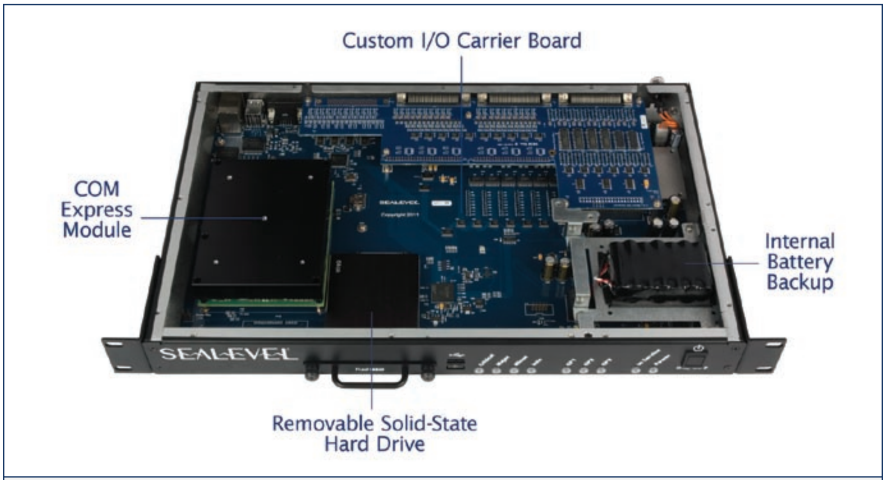

Figure 2 | An example system shows a 19" 1U rack-mount computer with a COM Express module and custom carrier board.

Yet another advantage of a custom carrier board is demonstrated by the absence of cabling from the system. Implementing COTS technologies usually requires some type of cabling to locate the I/O connectors in the enclosure. The cable connections create potential failure points, especially in high-vibration, high-shock environments such as military vehicles. A custom carrier board can be designed to the exact mechanical dimensions to allow I/O connectors to be soldered directly to the PCB in such a way to allow external access, improving system ruggedness and MTBF. Figure 2 shows the target system including COM Express module, custom carrier board, and 1U rack-mount enclosure.

Choosing the right approach for the application

The COM Express with custom carrier board architecture does not fit every application. Although using an off-the-shelf COM Express module speeds development time, a full COTS solution is still the fastest way to configure a system. But for many applications, the design flexibility, reliability improvements, and design control advantages make COM Express and a custom carrier board an excellent choice. **MES**

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Streaming real-time video with CPUs/GPUs

By Dr. David G. Johnson

U.S. Air Force photo by Staff Sgt. Robert Barney

The distribution of sensor data to multiple console displays can be achieved using standard Ethernet networking and off-the-shelf 3D gaming CPU/GPU hardware to support software-based decompression and display composition. This reduces the dependency on proprietary hardware technologies for video processing and display systems.

Modern computing platforms have evolved substantially to meet the needs of 3D gaming markets. As a result, they now offer a high-performance computing solution that is ideally suited to the demands of streaming real-time video and radar data from sensors to displays.

Adopting industry-standard processing and graphics architectures reduces initial system costs, and future technology enhancements are simplified by a reduced dependence on specialist proprietary hardware. Flexible software running across the heterogeneous CPU and GPU hardware is also key. This software is readily moved between different vendors' processing hardware and can accommodate upgrades in processing and display capabilities from the road maps of industry-standard processing and display technologies (see Sidebar 1). To understand this shifting paradigm, video decompression and display, along with software and middleware interfacing, are discussed.

Video decompression and display

The continued evolution of Graphics Processor Units (GPUs) such as those used in 3D gaming markets has enabled a modern display client to handle sensor decompression and display in software. Using standard client display hardware, configured through software to fulfill different operational needs, means more commonality, fewer variants, and reduced system costs. Full H.264 decoding of multiple channels – along with radar decompression, scan conversion, and multi-window display – can all be achieved with industry-standard hardware using standard CPU-plus-GPU technologies. The flexibility to use the GPU for multiple applications significantly simplifies system architectures because a common display architecture can be used for radar, video, and combined display positions.

With the compressed sensor data distributed using multicast protocols, the network loading is unaffected by the addition of extra display clients. Low-cost display positions, based on PCs or SBCs, can implement complex, multi-console, real-time displays of video and radar, and software can readily be reconfigured between different operational roles.

Modern graphics processors, such as those provided by NVIDIA and AMD (incorporating ATI), provide sophisticated processing and display capabilities, which have now evolved to blur the distinction between the CPU and the GPU. Additionally, software is now evolving to permit the programmer to write code that will be executed on the CPU or the GPU under the choice of operating environment. This allows intensive operations on data sets to exploit the multiple processors on the GPU, with the CPU handling the complex sequential code, input/output, and system administration.

Even though GPUs have the potential for huge throughput when calculations can be parallelized, many problems, even compute-intensive ones, are hard to express in a way that the GPU can exploit. A multicore CPU running at 3 GHz is no slouch, so it is often more efficient just to have the CPU process the data than to figure out how to employ the GPU and then transfer the data in and out for processing. Moving the data in and out of the GPU and synchronizing that transfer with processing on the CPU might negate

VIDEO PROCESSING FOR SENSOR DATA

Cameras and radars generate sensor data for navigation, command and control, and security requirements. This data can be compressed and distributed over Ethernet networks to client displays using industry-standard protocols. For camera video, compression based on the H.264 standard offers a good level of compression. (Though the exact level is data-dependent, typical figures of 50:1 are achieved.) H.264, the compression method used in Blu-ray disks, also provides good image quality, with typical implementations providing control of the compression process to allow an optimal adjustment of compression, information loss, and latency. Radar video, which is distributed as a compressed signal, uses different compression techniques, but similar choices of compressed data rates versus resource allocation need to be considered to ensure timely delivery of the data onto display consoles.

The latest generation of video capture products for cameras has incorporated compression into the acquisition process. In commercial security markets, cameras generating H.264 video as a network output are commonplace. For military applications, where more flexibility is needed to handle non-standard video types, or environmental factors demand a rugged technology, mezzanine cards are available to combine capture with compression. For example, on the XMC form factor, Tech Source's Condor VC 100x offers dual-channel video capture and H.264 compression. These capture and compression products provide H.264 coded video directly through a software driver, with the compressed video accessed by an application or server software for distribution or recording. Video coding process control allows the desired compromise among image quality, latency, and network bandwidth to be achieved.

Sidebar 1 | Choices of compressed data rates versus resource allocation need to be considered to ensure timely data delivery onto display consoles.

any processing gain that the parallel processing can provide. In many cases, the overhead of transferring the data and synchronizing the handover of results back to the CPU is prohibitive, and modeling and quantifying this prove very difficult.

In the case of decompressing H.264 video, the GPU provides an ideal processing platform. The compressed and hence relatively low data rate (for example, 20 Mbps for an HD video signal) input data is transferred from the CPU to the GPU. After compression, the data can remain in GPU memory, ready for transfer to the display window. In this way, the otherwise expensive operations (in terms of both memory transfer and need to synchronize back the CPU) can be avoided. The CPU is responsible for scheduling the transfer of video data from off-screen memory into a display window, optionally combining the video data with overlays to add symbology into the video window. This process allows the client display application to create graphical layers that appear as overlays to the video (crosshairs, target information, geographical features, and so on) and have the final display be composed of multiple, independently updating layers – all in real time. Until recently, this sort of multilayer, real-time video system required highly specialized hardware products; however, 3D gaming technology now enables this CPU-plus-GPU compression and display. The capability to implement this in industry-standard hardware is a significant development. The data paths are shown in the diagram of Figure 1.

In a practical implementation of a combined video and radar distribution system, a server captures data with cameras and radar sensors. This data is compressed by the acquisition servers and distributed using multicast network packets to any number of consoles. Since the raw camera and radar data are presented on the network, each console can select any combination of the available data. Additional consoles do not affect the network bandwidth, which is a function only of the number of distributed sensors. A network switch is responsible for interfacing the clients to the servers. A client console can be dedicated to the display of radar or video or show both on two heads of a single display position. In the example shown, a client display shows three windows of radar video on the primary head and two real-time video windows on the second head. For the camera display, the H.264 data is decompressed inside the GPU and then scaled to fit the output window. For the radar display, the compressed radar video is decompressed using the CPU and then scan converted and displayed with graphics in each of three PPI windows at up to 1,920 x 1,200 resolution. This entire client processing occurs on a mid-range hardware configuration with less than a 10 percent CPU load. Additional clients on the network maintain their own independent display presentation of radar and video.

The software designed for radar and video ensures that extremely cost-effective and interchangeable hardware can be used across a range of display positions for security, command and control, and fire control applications. The emphasis on software and the elimination of proprietary hardware ensure that future upgrades of the equipment can employ mainstream computing and graphics components. Evolution of these components will enhance the performance, resolution, and data rates that can be handled with the same software architecture.

Interfacing through software/middleware

With an industry-standard hardware-processing platform to provide the CPU and GPU resources, the software that implements the scenario is a combination of application and middleware. The middleware/software provides the components that connect the application layer to the drivers of the graphics and capture hardware, handling network distribution, quality of service, buffering, priorities, and display compositing. Cambridge Pixel has developed a set of server and API modules in its SPx integrated radar processing and display software family that provides the programming API for sensor-to-display capture, compression, distribution, processing, and display of radar and video sensor data. The middleware permits capture and compression from a wide range of sensor types, with hardware cards from third-party manufacturers such as the Tech Source's Condor VC 100x XMC card, standard network cameras, and RGB devices using frame grabbers provided by Matrox. This ability to interface to a wide range of third-party sensors and

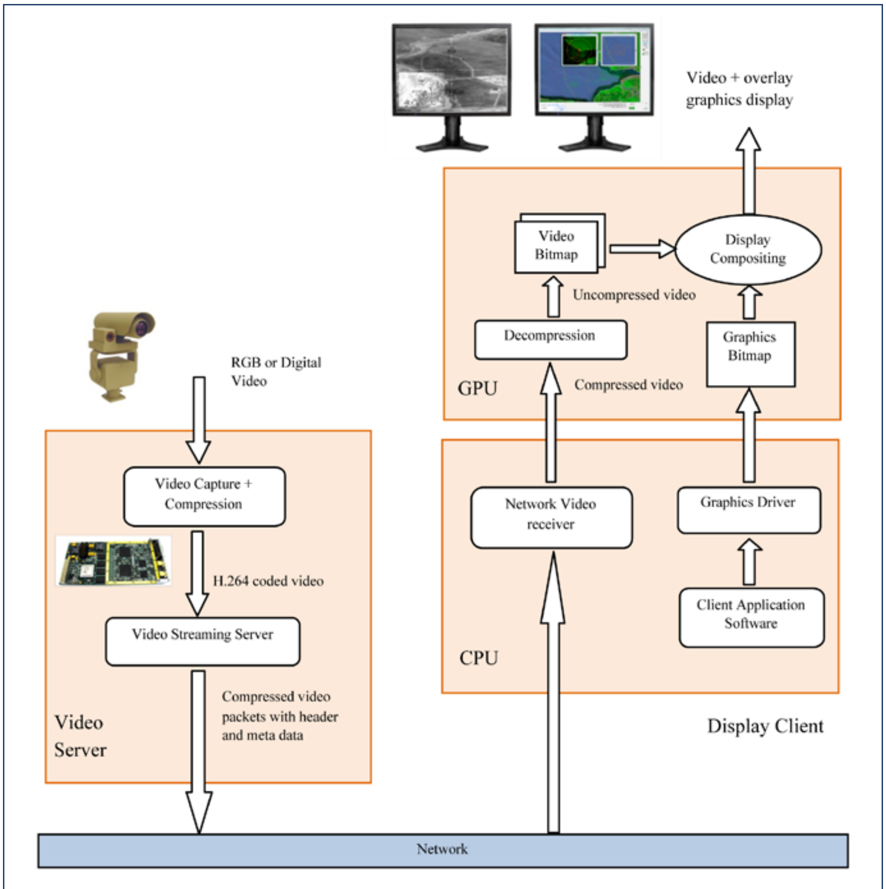

Figure 1 | Camera video captured and compressed with server-side hardware can be decompressed and displayed with standard GPU-plus-CPU architectures, with optional annotation provided by the client display compositing.

hardware provides significant flexibility and cost benefits. Distribution of video can be handled with the standard SPx AV Server application, or a custom server can be built using the integrated radar processing and display software library. On the client side, the software provides the interface software between the application and the hardware, permitting the GPU to be exploited for video compression and display processing. Where radar is displayed, the integrated radar processing and display software handles the radar scan conversion and display mixing to support high-resolution (up to 1,920 x 1,200) console displays.

A future-proof system architecture

3D gaming GPUs provide a general-purpose processor that is closely coupled to the display processing, so that once video has been decompressed, it can be transferred to the display window within the confines of the GPU. A modest CPU and GPU combination can handle simultaneous multiradar and video display, along with application graphics, to provide a versatile multiscreen, multiwindow, and multilayer display capability. The replacement of proprietary hardware by high-performance, low-cost commercial processing and graphics devices, coupled with software that can exploit the capabilities of these devices, promises significant savings during initial deployment and lifetime maintenance. The market will develop further as graphics move towards general-purpose processing (NVIDIA's road map) and processors integrate graphics (Intel's and AMD's road maps). **MES**

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U.S. Navy photo by Mass Communication Specialist Seaman Apprentice Cameron Bramham

VPX standards keep pace with faster fabrics

By Bob Sullivan and Ivan Straznicky

High-speed fabrics driven by the commercial market are also revolutionizing the military embedded market, by way of the VITA 46, 65, and 68 open standards – which aim to keep VPX on track to deliver the ever-increasing need for speed.

VME has been the dominant bus architecture for the embedded market since its inception in 1981, and for the defense and aerospace portion of that market since the late 1980s. From 1981 to 2003, performance has increased eightfold from 40 MBps to 320 MBps. The performance increases came through architectural improvements, but fundamentally, clock speed remained the same. Today, with VPX and its ability to support serial fabrics such as PCI Express (PCIe), Serial RapidIO, Gigabit and 10 Gigabit Ethernet (GbE), and InfiniBand, there is a continual push to ensure that the backplane has the speed and bandwidth required to support the next, fastest variant of these fabrics.

Additionally, fabric speeds are increasing at a fast pace, driven by the commercial market. And the change is happening at a faster rate than was seen in the past. Ethernet, PCIe, and Serial RapidIO are all migrating to faster speeds, in part driven by the processing infrastructure being developed to support cloud computing and the so-called "Internet of Things." As even the most mundane devices become connected to the Internet, the amount of data the Internet backbone needs to handle will continue to grow rapidly. While the military market is too small to be a market driver for serial fabrics, it is positioned to benefit from the resulting performance improvements.

The increase in fabric speeds is impressive. The first VPX boards used Serial RapidIO at 3.125 Gbaud for transmit/receive pair. Today, VPX boards and backplanes are shipping with 5 or 6.25 Gbaud speeds. Figure 1 is an example of a standard Curtiss-Wright 6.25 Gbaud OpenVPX backplane; this one is 16 slots. In two

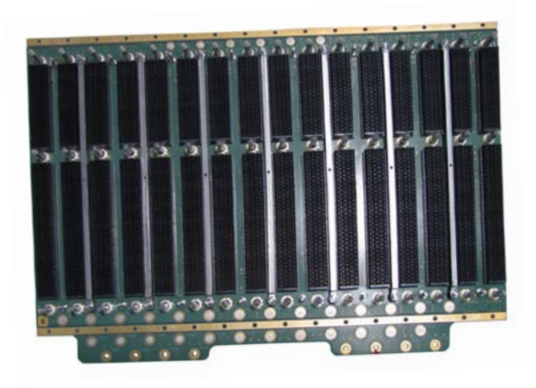

Figure 1 | 6.25 Gig OpenVPX backplane

to three years, it is anticipated that VPX boards will ship with 10 Gbaud speeds. In less than a decade, there will have been a 3x rate of speed improvement on the backplane serial interconnects.

To keep pace with this rate of change, open standards are evolving. We have seen PCIe go from Gen 1 to Gen 2 (5 Gbaud) and soon to Gen 3 (8 Gbaud). We've seen Serial RapidIO go from Gen 1 (3.25 Gbaud) to Gen 2 (5 and 6.25 Gbaud). The next variant of Serial RapidIO, Gen 10GxN (10 Gbaud) has been recently announced, with finalization expected toward the end of this year or the beginning of next year. On the Ethernet front, we've gone from 1 GbE to 10 GbE, which is now gaining prominence in our industry. 40 GbE is already starting to emerge in applications in the commercial space and, not surprisingly, military customers and vendors are starting to look at it, too. 40 GbE uses 10 Gbaud signaling, so it features the same physical SERDES signaling being used by 10GxN Serial RapidIO. Looking further out, 100 GbE is going to arrive in the next year and a half in the commercial space and will emerge some time after that in the military market. One version of 100 GbE uses 10 Gbaud signaling and another version uses 25 Gbaud signaling.

What does this all mean for VPX and OpenVPX (VITA 65)? There is plenty to be optimistic about, and a closer look at the VITA 65 and VITA 68 standards reveals just that.

Fitting in OpenVPX

The genius of OpenVPX is that it is not tied to a particular fabric technology or connector set. It supports multiple fabrics and speeds through the use of profiles. As newer fabrics come along and gain momentum in the marketplace, they can be added to the current list of fabrics already supported.

The same holds true for connectors. OpenVPX calls out VITA 46, which specifies the TE Connectivity MULTIGIG RT connector. However, there are already efforts underway to allow for the use of alternate VPX connectors, such as VITA 60 (Amphenol) and VITA 63 (Hypertronics). If a newer connector is required to take VPX beyond 10 Gbaud, then this could also be referenced in VITA 65. The challenge will be if this connector is not footprint compatible with existing VPX connectors. Today, the TE Connectivity, Amphenol, and

Hypertronics connectors are footprint interchangeable, but not intermateable. That is, they use the same PCB footprint so a PCB can support all three connectors, but designers must use the same manufacturer on both the backplane and the module. It's conceivable that a future pin-compatible VPX connector will be able to achieve 20 to 25 Gbaud per differential pair.

VITA 68 boosts channel compliance

The VITA 68 (VPX Compliance Channel) working group is dedicated to channel compliance or signal integrity. This working group is developing a new draft standard to define channel compliance for high-speed serial pipes over a VPX backplane. Initial simulations have shown that many protocols can operate at speeds up to 10 Gbaud using current VPX connectors. To support that effort, the VITA 68 working group has established a limited liability corporation with contributions from VITA member companies, including integrators, vendors, and connector manufacturers.

Initial plans include simulation and testing of the backplane channel at 1, 2.5, 3.125, 5, 6.25, and 10 Gbaud rates with channel parameters based on IEEE 10GBASE-KR, plus simulation of complete end-to-end channels including module Tx channels, backplane channels, and module Rx channels for several fabrics: Gen 1/2 PCIe for 2.5 and 5 Gbaud, Gen 1/2 Serial RapidIO for 5 and 6.25 Gbaud, and Ethernet for 1 and 10 Gbaud per differential pair. Future plans include simulation of Gen 3 PCIe for 8 Gbaud, Gen 3 Serial RapidIO for 10 Gbaud SDR, DDR, and QDR InfiniBand variants for 2.5, 5, and 10 Gbaud. Figure 2 shows Curtiss-Wright's simulated 10 GBaud Insertion Loss to Crosstalk Ratio (ICR) for 10GBASE-KR, 10 GigE across a VPX backplane. This is one of several 10GBASE-KR signal integrity criteria being leveraged in VITA 68.

VITA 68 will specify several signal integrity parameters for different speed grades of backplane channels, using VPX connectors. This will allow a compliant backplane design to interoperate with compliant modules using various fabric types and different fabric speeds up to the rated speed grade of the backplane. The result of these simulations will inform users what to expect in terms of speed using the standard VPX connectors and connector 3D footprints. The simulations will tell which protocols will work best and how fast they will go over our current VPX backplane technology. And the simulations will show what to expect as speed is increased over the connectors and backplane to support the new fabric variants. Today, the lower-speed Gen 1 variants, up to about 3.125 Gbaud, work well. And no problems are foreseen in running Gen 2 Serial RapidIO and Gen 2 PCIe today if modules and backplanes are properly designed. But VITA 68 will ensure signal integrity interoperability as baud rates increase, and the simulations will lend understanding of what to expect as technology advances beyond Gen 2 rates to support upcoming Gen 3's 8 to 10 Gbaud next-generation variants.

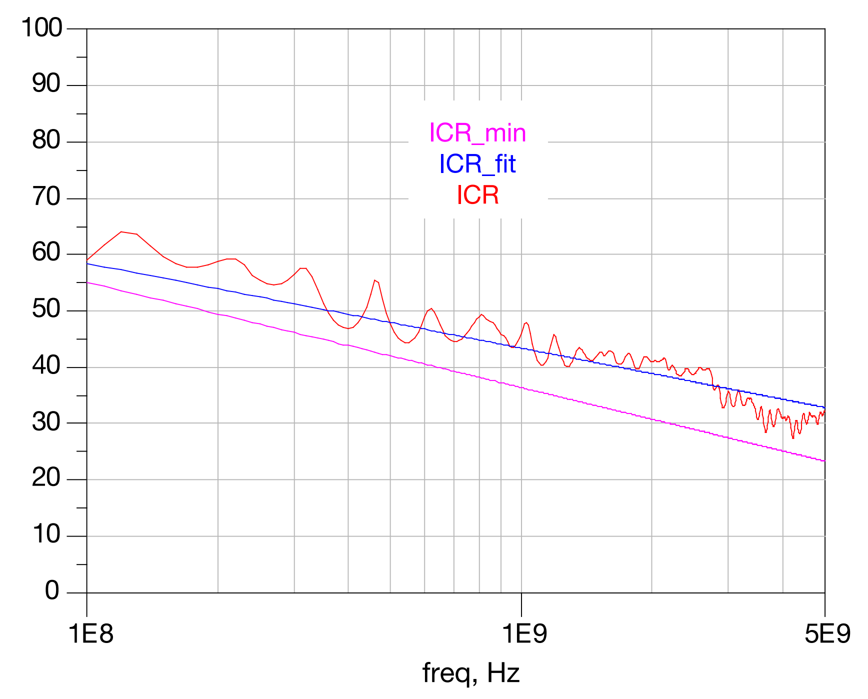

Figure 2 | 10GBASE-KR VPX Insertion Loss to Crosstalk Ratio (ICR)

VITA 65 and 68 foster VPX signal speed

At this point in the development of the VPX standard and its ecosystem, it remains to be seen where the industry will end up in regard to connector types and fabric speeds. But, it is a safe bet that at some point, the industry will use optical connectors. When VPX was first defined, the original expectation of achievable bandwidth via the MULTIGIG RT connectors was 5 or 6 Gbaud. However, with careful design, layout, and routing, it appears that speeds up to 10 Gbaud are attainable with our current connector set.

There was real foresight in the way that the VSO structured VPX and OpenVPX, enabling the addition of new protocols to VITA 65 as needed, once they've been successfully validated. That, along with the new channel compliance specification, promises to get us to 10 Gbaud signaling in the next several years. **MES**

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Expanding options in VPX connectivity

By Gregory Powers

VPX embedded systems require robust interconnections to achieve and maintain signal integrity. Commercial technology is being ruggedized and adapted for use in power (VITA 62), optical (VITA 66), and RF (VITA 67) applications to supplement the qualified digital backplane connectors and complete the high-performance architecture's interconnect technology set.

Manufacturers of embedded systems for military and aerospace uses face the daunting challenge of maintaining pace with the rapidly evolving world of electronic systems. There is an ongoing migration toward serial switched architectures that support high-speed protocols, such as 10 Gbps Ethernet, to realize advantages such as eliminating differential skew in parallel data paths. While commercial silicon continues driving bandwidth and processing power, embedded computing platforms in the high-reliability world of military/aerospace applications require rugged technologies capable of withstanding vibration, thermal extremes, and other application rigors.

Modern embedded computing systems depend enormously on board-level interconnects to support mission- and life-critical applications. VITA is a primary source for standardized embedded architecture development in aerospace and defense. VITA has guided the progress from the original VMEbus to the latest standards, such as VITA 41 (VXS) and VITA 46 (VPX) systems. VXS provides a transition between traditional VMEbus parallel architectures and newer serial switched architectures. VXS uses both the traditional VME connector and a selection of modules from the newer MULTIGIG RT connector family. Unlike VXS, the serial VPX does not straddle both the parallel and serial worlds.

One drawback to VPX was interoperability issues. First, VPX allows a wide range of configuration options, many of which are never used. Second, the standard VPX connector is designed primarily for digital signals. This left designers fashioning *ad hoc* technologies for power, optical, and RF connectivity, which only made interoperability issues worse.

To assure interoperability on an architectural level, VITA 65 (OpenVPX) has been established as the governing standard and defines profiles for various configurations at the chassis, backplane, slot, and module levels. The ultimate goal is to create compatibility between products from different vendors, enabling open architecture and also two-level maintenance and system upgrades, allowing users to swap out Line Replaceable Modules (LRMs) in the field. To remedy the deficiencies in the interconnect technologies, a new series of standards has evolved, including VITA 62 (power), 66 (optical), and 67 (RF).

Adapting COTS connectivity for the militarized zone

Commercial connector technology is at the forefront of supporting multigigabit data rates. Designing a high-speed connector is a challenge in electrical engineering. (*High speed* is a slippery term in relation to connectors: Essentially, the concept of *high speed* comes into play when electrical modeling treats the signal path through the connector as a transmission line, with the effects of impedance, capacitance, and inductance all critically affecting signal integrity. In some respects, the size of any impedance discontinuity compared to the signal rise time determines the difference between a "regular" connector and a high-speed connector.) High-speed connectors typically represent the largest impedance discontinuity in the signal path. Their design requires a delicate balance of conductor and dielectric to prevent reflections, crosstalk, and other forms of signal degradation. High-speed commercial connectors can meet demanding electrical requirements, but struggle to meet the mechanical ruggedness of military/aerospace requirements.

Conversely, traditional military/aerospace connectors are rugged, but don't offer the speed and density required. The latest rugged connector designs blend the best attributes of high-speed commercial connectors with lessons learned from military/aerospace applications, offering the optimal combination of gigabit data rates, dense packaging, and mechanical robustness. Even though commercial backplane connectors are not directly usable in military/aerospace applications, it is much easier to take the proven signal-transmission technologies and incorporate them into a more robust package than it is to build a new connector from the ground up. The goal, then, is to take the best of COTS technology and ruggedize it.

This goal was realized in establishing the VITA 46 digital interconnect for VPX and represents a well-executed process of ruggedization and validation. Table 1 compares a number of environmental performance tests of the source commercial connector and the ruggedized VPX version to illustrate the extended validation testing performed. Note that the VPX connector must pass additional tests that the commercial version does not.

Test	Commercial	VITA
Vibration	Sinusoidal 10 g_{peak} 10-500-10 Hz	Random 11.95 g_{rms} 50 to 2000 Hz
Mechanical Shock	30 *g* 1/2 sine pulse	50 *g* 1/2 sine pulse
Bench Handling	N/A	4 drops, 4" or 45°
Durability	200 mating cycles, min.	500 mating cycles, min.
Corrosion	Mixed Flowing Gas	Salt Fog & SO_2
Dust	Mixed dust: 9 gram/ft^3 at 1,000 ft/min 60 minutes	Talcum: 9 gram/ft^3 at 350 cfm 90 minutes (twice)
Sand	N/A	140-mesh silica: 9 gram/ft^3 at 350 cfm 90 minutes (twice)

Table 1 | Ruggedized VITA 46 connector performance versus its commercial counterpart

The connector's plug-in module wafer design in place of pin contacts is well established in commercial applications. Wafers – available for differential, single-ended, and power needs – can be easily modified to support specific customer needs for characteristic impedance, propagation delay, and other electrical parameters. The pinless backplane half of the connector assures protection of the motherboard, thereby protecting the system, vehicle, and mission. Signal integrity has been elevated in parallel with the mechanical integrity. As a ruggedized version of a commercial design, the VPX connector supports speeds up to 10 Gbps, well above that need to support VPX's 6.25 Gbps. The design is highly modular to support both 3U and 6U configurations.

VITA 62: High-density power

While power can be brought through the VPX connector, a higher-capacity route is offered by VITA 62 (Power Supply Modules), which refines VITA 46 power requirements to support OpenVPX system-level requirements and to address such issues as in-rush current at power-up, output control, and synchronization. The connectors defined in VITA 62 are focused on the power-handling task. The dedicated power contacts, derived from commercial designs, deliver up to 40 percent more power in the same space over earlier generations of contacts. With both 20 A and 50 A contacts, the design is hot pluggable, tolerates mating misalignment, and has lower mating forces.

VITA 66: Enlightened optical connectivity

VITA 66 [Fiber Optic Interconnect (Formerly 46.12)] further expands the VPX ecosystem by defining optical modules that demonstrate the advantages of using proven, existing technology and adapting it to new applications. Providing separate modules for optics (or RF) assists design and manufacturing by allowing Line Replaceable Units (LRUs) and LRMs to be disconnected at the backplane, which greatly speeds assembly, maintenance, and upgrades. Older approaches worked similarly, but the new modular approach fits the VPX form factor, is scalable, and creates an industry-standard methodology in place of *ad hoc* approaches.

VITA 66 gives users the choice of MT array connectors, ARINC 801 termini, or Expanded Beam (EB) contacts using a common module form factor (Figure 1). Each of these has an aerospace pedigree and offers different benefits in terms of density, ruggedness, reparability, and other characteristics. For example, the MT ferrule offers the highest density of fibers – up to 48 in a 3U system and 240 in a 6U system. The ARINC 801 contact, based in the established 2.5 mm ceramic ferrule, offers the best optical performance with low insertion loss and low reflectivity. The expanded-beam connector is the most forgiving of dirt, vibration, and frequent mating and unmating. Any of the optical connectors are contained in a robust machined housing that includes guides and keying. Modules can be used in positions P2/J2 through P6/J6.

VITA 67: High-density RF to 40 GHz

VITA 67 (Coaxial Interconnect on VPX) covers RF connectivity and is based on blindmate SMPM contacts, which allow high performance to 40 GHz in a high-density configuration. Conforming to the same envelope as the VITA 66 fiber optic modules, the RF modules support four or eight positions, are also scalable, and allow very rapid assembly, repair, and reconfiguration of the open architecture VPX systems.

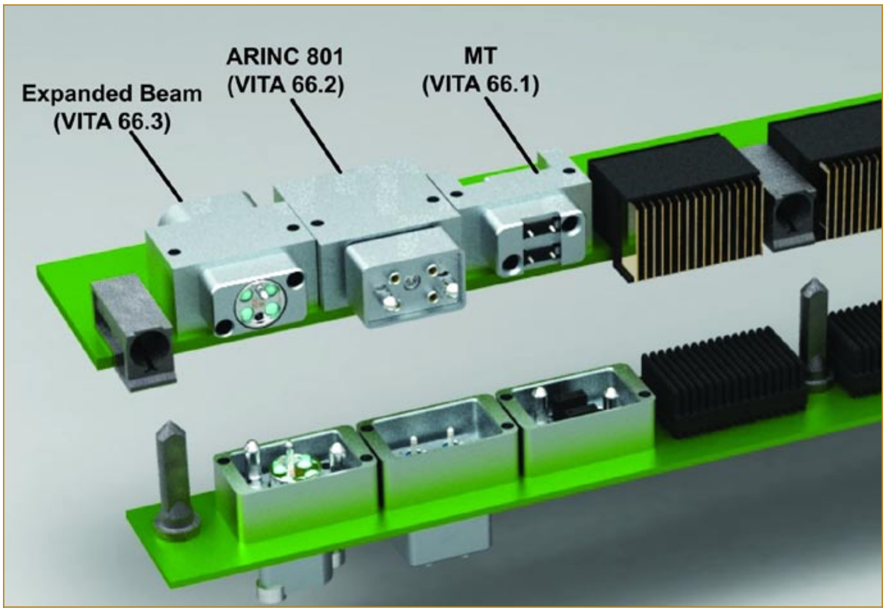

Figure 1 I VPX system with VITA 46 and VITA 66 modules

Ruggedized commercial products meet military needs

Adapting and evolving commercial interconnection technology has proven to be the preferred way to meet the ever-increasing needs of military embedded computing. Commercial technology often leads in achieving new levels of speed and density, needing only to be sufficiently ruggedized to meet the stricter requirements of high-reliability applications. While such ruggedization of commercial technology might not be a trivial matter, it often provides a lower risk and faster path to market than starting from scratch. Rather than proving a technology works at all, it only needs to be demonstrated that the technology – already widely used – works in a more rigorous environment. **MES**

Gregory Powers *serves as Market Development Manager for the Electronic Systems and Space segments within the Global Aerospace, Defense & Marine business unit of TE Connectivity. He received a BSME from Syracuse University, has completed numerous graduate-level studies, and holds two patents relative to optical datacom devices. He can be contacted at gregory.powers@te.com.*

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The U.S. Army's ability to "see first, shoot second" rolls on with UGVs

An interview with Robert Moses, President of iRobot's Government and Industrial Robots division

Editor's note: With its DARPA-initiated PackBot robot making its debut in caves in Afghanistan in the 9/11/01 aftermath, iRobot's Unmanned Ground Vehicles (UGVs) keep rolling while delivering the ability to see first, shoot second. These days, iRobot/U.S. Army contracts for the company's 320 SUGV robots for BCTM [Brigade Combat Team Modernization], in addition to other U.S. Army orders, are also rolling in. But is it really possible to control the PackBot and 320 SUGV robots with only an off-the-shelf Best Buy variety Xbox controller? Yes indeed, as our interview with Robert Moses, President of iRobot's Government and Industrial Robots division, reveals. Edited excerpts follow.

We received a press release saying that the U.S. Army is to purchase two more LRIP model 320 SUGV brigade sets from iRobot, and that iRobot is additionally developing the 320 SUGV follow-on variant of the same name for the Army's BCTM [Brigade Combat Team Modernization] to be delivered next year. Tell us more.

MOSES: The SUGV is a Small Unmanned Ground Vehicle. It weighs about 30 lbs. It was developed under the former FCS [Future Combat Systems] program. We were one of the original 21 partners under that contract, which was awarded in 2004, with our responsibilities being design and development work. We are one of the few companies actually taking things from that program and supplying them to today's Army.

We have finished Increment 1 of that program. Underneath the original FCS contract, iRobot was responsible for providing the chassis, and the controller and EO/IR [Electro Optical Infrared sensor] head were going to be developed by other vendors. The radio was going to be the JTRS radio. We've gone ahead and put a commercial controller and a commercial sensor suite with EO/IR on the robot – and that is what we are under contract for with the LRIP effort. It was important for us to get a system out to the Army, so we put a complete system solution together.

Your press release says iRobot and Boeing teamed to develop the SUGV. What is Boeing doing, please?

MOSES: Boeing is a prime contractor under the BCTM contract.

Relative to the Army's plans to procure two additional LRIP brigade sets of model 320 SUGV, is model 320 the Increment 1 model?

MOSES: Yes, the Increment 1 model is the same robot as 320 SUGV. Increment 2 is called the *XM1216* (experimental model 1216). At iRobot, we call it the *320 SUGV* (Figure 1).

So is that the designation for the Increment 2 or the Increment 1 version?

MOSES: It is for both.

There is also a model called *310 SUGV*, and we have a separate mini-EOD contract for that. That robot is riding on the same chassis [as 320 SUGV], but it has an arm on it and does not have the same sensor suite. We are selling this 310 SUGV to the military as well.

iRobot makes Roombas and many other sorts of consumer devices, but these SUGVs are obviously very serious devices. Which types of technology are involved?

MOSES: Going back to SUGV's roots, you'll find the PackBot product, which is a man-transportable robotic system. In all, we have delivered about 4,000 robots to the military and various customers around the world. Our largest customer is the U.S. government. We started this [PackBot] program in the 2002 timeframe. The main mission for PackBot is Explosive Ordinance Disposal [EOD] – to combat IEDs in theater. That product weighs about 65 pounds.

And you said earlier that SUGV weighs 30 lbs. What's the difference in SUGV's mission versus a PackBot?

MOSES: As I mentioned, the PackBot is primarily for EOD missions, and the 320 SUGV performs reconnaissance, building clearance, and other similar types of missions. Being able to send a robot in *first* to see what's on the other side of the door is extremely important. And the ability to

Figure 1 I 320 SUGV robot, photo courtesy of iRobot

shoot *second* is very important. It's all about what we call *remote presence*.

What were the origins of PackBot then?

MOSES: PackBot came out of a DARPA program and was first used on the battlefield after 9/11 when we were looking for the enemy in caves in Afghanistan. Before PackBot was being used, we were sending soldiers into caves with lights and a rope tied around their waists. The Rapid Equipping Force was evolving around that time. They said, "Hey listen, we're going to take these robots in here."

Later, in 2003, we sent one of our engineers to [Afghanistan], which was beneficial because we have a bunch of engineers designing robots who need to understand how the customer is going to use the robot. The colonel at that time said, "You know this is really a pretty sophisticated robot, but it's kind of heavy." And the engineers responded, "Sir, given there's a computer inside, you have to have that mass to protect the computer." The colonel responded, "That's interesting, but it's kind of heavy." The engineers responded, "Sir, it also needs these flippers so it will be able to climb stairs." So the colonel said, "Well that's interesting, but it's kind of heavy. Why don't you go ahead and carry it up two flights of stairs today." And then after doing so, someone said, "We have to get the weight down. This thing's too heavy." So having that interface with the customer and understanding that feedback we get from them is incredibly valuable.

How or by whom are the PackBots operated?

MOSES: These robots are tele-operated. We're trying to take some of the workload off the soldier, so we're also making our robots more autonomous. There are three things that we're doing right now to increase autonomy. One is that if the robot tips over as you're going down-range, the robot automatically self-rights itself. You don't have to send somebody down there to do that.

Another thing is that if the robot's going down-range and it loses communications – the robot will automatically stop and retro-traverse back to the place where it last had communications and will re-establish communications. And the last thing we're doing is putting on a cruise control, if you will, to send it down a vector for several hundred yards so soldiers don't actually have to drive it the whole way.

How is this autonomy engineered?

MOSES: With software: It's because of a software package that we call *Aware 2*. The SUGV will eventually get that capability, and right now we have it available for the PackBot. The majority of our deployed units are PackBots. Of the 4,000 robots we have delivered, about 3,600 are PackBots and about 400 are SUGVs.

> OK, so the guts of this radio, tell us about the computer that's in it. What kind of embedded computer and system? Any open standards?

MOSES: For proprietary reasons, I [can't provide] those specifics.

> What about the operating system that's used – is it Linux-based or VxWorks, or …?

MOSES: It is Linux based, and we developed our own proprietary software to write on top of that.

> How does this compare then to what the SUGV can do?

MOSES: With regard to SUGV, many missions are conducted at night, so you need the IR sensor and thermal imaging. And in Iraq, soldiers were driving to work. They're performing road clearance missions, so they're in the back of a Humvee. If they see something that looks suspicious, they stop and then they send the robot out. In Afghanistan, they're walking to work – so SUGV is more suited for dismounted operations.

> What does a PackBot cost, roughly? And what does the SUGV cost, roughly?

MOSES: The cost of a PackBot averages about $100,000, but it depends on the configuration. The 320 SUGV is more expensive than a PackBot because it's early in the learning curve. Because of the cost of miniaturization and the more sophisticated sensor suite, it's more expensive.

> But the PackBot has an arm, which also has more mechanical parts in it, more moving things, and so on. So certainly more costs are associated with materials.

MOSES: Thermal cameras are expensive, too. The other thing we're doing is making our robots easier to use. With the original military operators, it was thought that they were going to be using these robots with body armor gear and big gloves on. However, what's happening now is they're not wearing this gear when operating these robots. Originally, we had a large suitcase-type operator control unit with large pucks that were used to manipulate the robot. We investigated the best ways to operate these robots if they're not using the gloves or getting dressed up in bomb suits. So we went to a laptop configuration and Xbox game-style controller with SUGV and PackBot.

> Literally an Xbox controller?

MOSES: Yes. It's one that you could pick up at Best Buy or any other store like that. The idea is to make it [as easy as possible]. The users are all young people who are gamers.

> Who are familiar with video games at least.

MOSES: Yeah, they've got a thousand hours training on these controllers already. They're very familiar with this. So that's really decreased the training time significantly.

Tell us about any future plans that you can – for this program, for robots that iRobot is going to develop, or just any future technologies that are needed.

MOSES: The next robot that we're working on right now is called *FirstLook*, which is a 5 lb robot with core sensors on it. It's capable of being dropped from 15 feet, and it is a pure reconnaissance robot. I said the SUGV is made for dismounted operations – and it is. But, if you're going to be out in the bush for a week, you'd probably like a lighter robot.

It's less capable than SUGV or PackBot, but if you want something to do some reconnaissance work – you just throw it over the wall, and it can see what's there, by itself. It has four cameras on it. It also has mesh networking capabilities so you can use it as a communications range extender for your robots if you want to. So, FirstLook is what we have going on for the small side. On the large side, we've got the Warrior product that will be out this year in the fourth quarter, and that is a 350 lb robot.

Does it have a lot more capability?

MOSES: Warrior is a lot heavier, a lot stronger. It can lift more. We sent two Warriors along with two PackBots over to Japan to help with the post-earthquake and tsunami efforts at the Fukushima nuclear power plant. The Warriors have been clearing debris there. Again it's all about remote presence in dangerous environments.

Any technology that you wish for, to make a lot of what you do easier, better, cheaper, faster, whatever?

MOSES: Well, autonomy, manipulation, mobility … those are the three areas that we work on. We partner with others – we're not going to build a battery or build a radio. We do work with others to get that type of capability. And also cameras – we're not getting into that business.

So do you need better batteries, higher-bandwidth radios …?

MOSES: Well there's always a demand for those, be it with robots, tanks, or aircraft. The big ones are weight, communications, and power.

How about pricing?

MOSES: The biggest way to drive down cost is through higher-quantity orders that you can count on and that allow you to get your supply chain going. That's the main way to go. **MES**

***Robert Moses** is President of iRobot's Government and Industrial Robots division. Prior to joining iRobot in 2003, Moses served as a career naval officer. As director of contracts for the Naval Air Systems Command, he supervised more than 800 employees and administered contracts worth more than $20 billion annually. Moses holds a Bachelor's Degree in Business Administration from the University of Mississippi and a Master's Degree in Acquisition and Contract Administration from the Naval Postgraduate School.*

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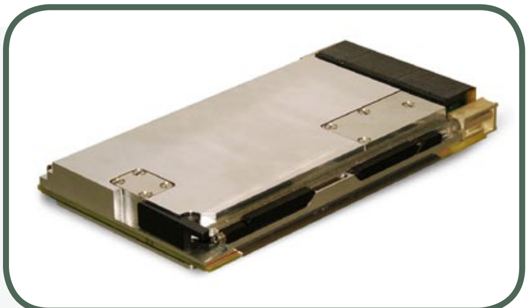
35 W DC/DC converters bring on the rugged

Power is an uber-popular watercooler topic at any company engineering military electronic applications or systems, being a critical consideration in defense designs. Accordingly, XP Power has incarnated its MTC35 COTS DC/DC converters, specially designed to ease the power and rugged woes that can occur in avionics and military vehicle applications. Case in point: The 35 W converters handle an input range of 10 to 40 VDC and accommodate transients ranging "to 50 VDC for up to 100 ms," the company reports. Moreover, the encapsulated, board mounted, and robust modules are vended in single-output formats with outputs of +3.3, +5, +12, +15, and +28 VDC; however, single-output modules can be modified with an external trim pin, affording a -20% to +10% adjustment capability.

And these DC/DC converters are rugged galore. In conjunction with the company's EMI filter modules, the MTC35 series meets MIL-STD-704A and MIL-STD-1275A/B/C/D for transients and surges. Additionally, MIL-STD-810F (rugged environmentals) and MIL-STD-461 E/F (emissions) are met. And the DC/DC converters' design features baseplate cooling and operation from -40 °C to +100 °C, though the converter can be started at -55 °C. Protection is rendered via signal and control pins, which shut down the converter when needed and give thermal warnings, in addition to inhibiting output and synchronizing external source frequencies ranging from 400-500 KHz. Regarding output, any drops up to 0.5 VDC activate remote sense compensation.

XP Power • www.xppower.com • www.www.mil-embedded.com/p53537

Simultaneous UAV video streaming maximized



As UAVs rapidly gain traction as a viable means of intelligence gathering and transmission, being able to capture and process multiple video sources simultaneously is imperative. Thus, GE Intelligent Platforms' GFG500 3U OpenVPX-REDI GbE video processor caught our eye. Designed for tucking into UAV and ground vehicle systems, the GFG500 can provide 30 Hz processing of ten 1,392 x 1,024 GigE Vision video streams from GbE-based video sources simultaneously. And that's not all. The GbE video processor is powered by a 700 MHz Tilera TILEPro64 processor packed with 64 general-purpose processor cores configured on an 8 x 8 grid to render high-performance networking and image processing. The processor also brings four banks of 512 MB DDR2 800 SDRAM to the table.

Meanwhile, it doesn't stop there; other notables of the GFG500 include two 4-lane PCIe interfaces, in addition to 2x XAUI full-duplex 10 GbE ports. Linux OS support is also included, as are direct camera control proffered by GigE Vision Ethernet, in addition to a programmable user interface. The interface allows users to configure myriad provided video-processing options such as video compression and sampling, as well as Bayer decoding. And GFG500 comes in conduction- and convection-cooled variants. So basically, this video processor is a real keeper.

GE Intelligent Platforms • www.ge-ip.com • www.mil-embedded.com/p53536

Server helps apps travel through the rough spots

The fact is that military airborne, land-based, and shipboard applications are housed in systems traversing harsh environments that are just not for the faint of heart. And Crystal Group Inc.'s SS16 Sealed Server can surely withstand the heat (and other extremes) of such environments. Compliant with a veritable laundry list of MIL-STDs, let's start there: The server meets MIL-STD-810F for shock, vibe, temperature, and altitude, in addition to MIL-STD-704E, -1275D, and -461. Additionally, vertical fin orientation proffers the best thermal performance for the server, which features top or base mounting, and the CPU heat sink and motherboard both have several attachment points to heighten shock and vibe tolerance and stabilize the PWB. The temperature range of -40 °C to +55 °C is provided, and higher-temperature environment applications can benefit from the cold-plate mounting also available. Cooling includes external convection or internal conduction.

As for any EMI/EMC issues, the company has ensured that the SS16 is filtered for conducted emissions and conducted susceptibility. Noise-free operation is built in via grounding paths. Meanwhile, the 23 lb., IP67-rated server maintains a hermetic seal courtesy of its solid machined aluminum construction. Its outer shell is protected with a powder coat and MIL-C-5541E finish, plus hermetic mil circular connectors. But with all this talk about the rugged, it would be remiss to not mention what's inside the box: an Intel Core i7 620M processor at 2.66 GHz suited with up to 8 GB RAM. There are also six removable HDDs. Need we say more?

Crystal Group, Inc. • www.crystalrugged.com • www.mil-embedded.com/p53139

ARM inside SWaP-C savvy flight control computer

Well known for sitting inside smartphones, GPS, and many other mobile devices, the ARM processor has found a home inside Curtiss-Wright Controls Electronic Systems' Versatile Flight Control Computer (VFCC). Not only is the inclusion of the ARM processor intriguing, but we also have to strongly concur with the first part of the VFCC's nomenclature: "versatile." Accordingly, the computer is suited to mission computing, flight control, engine control, vibration management, and actuator control missions, among others, in unmanned and manned avionics, in addition to rotorcraft, for example. Boasting low Size, Weight, Power, and Cost (SWaP-C), the computer measures in at 11.5" x 9.3" x 2.1", weighs less than 4.4 lbs, and has power dissipation of fewer than 21 W. Input power slides into the picture at 28 VDC with 50 millisecond holdup. Additionally, the "natural convection-cooled" VFCC's operating temperature is -40 °C to +71 °C.

But getting back to the brain behind the brawn, the VFCC specifically includes two ARM Cortex-A8 processor clusters speeding along at 600 MHz. Also nested in the computer are three Xilinx Spartan-6 FPGAs and a duo of Texas Instruments TMS320C64x+ DSP processors, plus 1 GB nonvolatile RAM. Since the computer is for flight applications, a DO-178B Level A certifiable RTOS is included, and the FPGAs are DO-254 Level A certifiable. System-level Built-In Test (BIT) and interfaces such as ARINC 429 and 825, RS-422/485, USB 2.0, synchronization discretes, excitation outputs, 10 mA servo valve drivers, and discrete inputs/outputs are included.

Curtiss-Wright Controls Electronic Systems • www.cwcelectronicsystems.com • www.mil-embedded.com/p53535

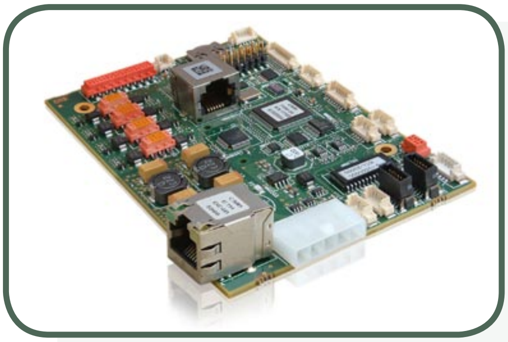
Cisco's industrial Ethernet switch goes mil rugged

Cisco Systems routers and switches certainly provide value in many industrial or benign computing scenarios. And while Cisco's IE-3000 Ethernet switch was viable in the applications for which it was originally crafted – like the utility substation or factory floor – it needed more ruggedization for the harsh environments encountered in the military. To the rescue is Parvus Corporation's DuraNET 3000, a ruggedized iteration of the Cisco IE-3000 Ethernet switch. Designed with C4ISR situational awareness and extreme military environments in mind, DuraNET 3000 is suited for shipboard, airborne, and vehicle use. And this ruggedized version of the Cisco switch provides the same pluses as its foundation Cisco tech: Best-in-Class Layer 2 LAN IOS. And Layer 3 IP Services IOS Software Support is provided as an alternative.

IOS management is extensive and includes voice, video, and data features to further security and high availability. The too-long-to-write-here list of IOS management specifics includes CLI over Serial, advanced routing protocols, Cisco Device Manager over Web Browser, Enhanced Interior Gateway Routing Protocol (EIGRP), multicast routing, Layer 3 IP Services Support Inter-VLAN Routing, Cisco Network Assistant, and many more.

Meanwhile, ruggedization is built-in for withstanding shock, thermal, and vibration per MIL-STD-810, and the aluminum chassis is sealed to prevent EMI, dust, or water infiltration. Temperatures of -40 °C to + 71 °C (fanless operation, sans any moving parts) are no problem for DuraNET 3000, which offers reliable network connectivity via circular MIL-DTL-38999 connectors. Not only that … interfaces include an RS-232 console and 2x GbE uplink ports plus 8x, 16x, or 24x Fast Ethernet ports.

Parvus Corporation • www.parvus.com • www.mil-embedded.com/p53149



Chassis Monitoring Board keeps an eye on the system

What good is it to be on a ship if the entire ship is sinking, figuratively speaking? The same idea applies to VME and VPX systems managed and monitored exclusively by system-implemented firmware and chipsets: Odds are such a system management scheme won't continue working if the system itself crashes. Enter Kontron's Chassis Monitoring Board (CMB), providing management and monitoring of parameters including power supply, airflow, and temperature of installed boards. Deployed in a satellite navigation system program utilizing a VME chassis, CMB has interfaces including GPIOs and I^2C and offers high MTBF through compliance with MIL-HDBK217F-2. It is additionally suited to demanding air rotary wing applications (20,485 h at +55 °C) and ground benign conditions (603,005 h at +25 °C).

Its power requirements are less than 1 W (yes, you read that right), and it can control and monitor as many as eight temperature sensors, eight power modules, and eight fans at once. It also renders out-of-band management and monitoring for as many as eight VPX or VME boards. This enables power efficiency, as a system can be allowed – via CMB's variable computing capacity – to change to maximum computing capacity if the system is in activity mode. Conversely, minimal power consumption can be activated when the system works in surveillance mode. And, a compromised or malfunctioning interface can be inactivated with CMB. The CMB also gathers, then forwards installed-board information including boot stage, health status, and inventory information. CMB has an integrated microcontroller to execute "a multithreaded monitoring application on the Freescale MQX real-time OS," the company reports. Boot time is faster than 1 second when a multithread approach is taken with the monitoring software.

Kontron • www.kontron.com • www.mil-embedded.com/p53534

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