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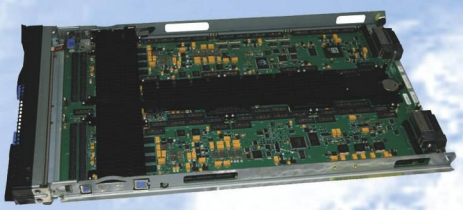

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WIND RIVER

New Mil-Embedded website and cover design, plus the debut of Embedded Tech Trends

By John McHale, Editorial Director

When I joined *Military Embedded Systems* magazine last summer, I was fortunate to inherit a publication that was already well known and well respected. However, the magazine's website needed a big upgrade to make it relevant in today's digital media world. While we were at it, we also decided to freshen up the look of the print product too.

We've had the most fun online. If you have visited our website – www.mil-embedded.com – during the month of February, you've already had a taste of our new look. Our editorial team, along with the OpenSystems Media in-house web designers, completely modernized Mil-Embedded.com to deliver more fresh content than ever before, with a clean design that uses a keyword architecture to make navigation more intuitive. Mil-Embedded.com also will have new content in the form of blogs, news articles, and more. Unlike our previous website, the redesigned site can be viewed as easily on an iPad or iPhone as it would be on a PC or Mac.

The topics on our navigation bar – embedded hardware, embedded software, signal processing, unmanned systems, and safety certification & security – enable website visitors to easily find all the articles, blogs, news, and white papers on those topics just by clicking on the appropriate menu button. The topics are also tied into OpenSystems Media's (OSM's) popular TechChannels such as DSP, VPX, FPGAs, and Safety & Security. Navigation also improved for our videos and white papers, as well as the links to the OSM online events.

Our print design changes were more subtle, enhancing the magazine's visuals and style while maintaining its familiar flow and content.

The new print style starts with this edition's cover, which has two very cool shots highlighting features inside – one of the Lockheed Martin MONAX 4G wireless technology and below it, a shot of the Air Force AN/FPS-117 long-range surveillance radar in a remote northern location. We've also brightened up the colors inside and freshened up sections such as Managing Editor Sharon Hess's *Daily Briefing: News Snippets* column, which is now called *Defense Tech Wire*.

We're very excited about our new look online and in print and hope you are too. Please tell us what you think and keep an eye out for new digital features later this year.

> *"We're very excited about our new look online and in print. ... [And] we weren't the only ones kicking off 2012 with a redesigned product ... VITA revamped their media networking event – originally called* Bus & Board."

Bus & Board returns

We weren't the only ones kicking off 2012 with a redesigned product. The folks over at VITA revamped their media networking event – originally called *Bus & Board* – with a new name and location: The Embedded Tech Trends (ETT) conference was hosted by VITA in January in Cocoa Beach, FL. ETT 2012 was a good start to recreating the positive networking environment that made Bus & Board (B & B) a go-to event for those in the single board computer industry.

The new conference was built around media meetings just as B & B was, but this year it had a more laid-back, informal atmosphere than its previous incarnation for editors to meet with key companies. Of course, this could be because there were fewer sponsors attendees – which is expected in a rebuilding year. However, I also attribute the collegial atmosphere to companies wanting to network and discuss market trends and publication directions more than just promoting their latest press release or product announcement, which can be accomplished over email. Face-to-face meetings should have a little more depth.

The conference content was steady, with updates on various VITA initiatives such as small form factors and optical computing. One complaint I heard was that the conference seemed heavily tilted toward the defense market, with not as much emphasis on the medical, transportation, or industrial markets. One way to address that at the next ETT would be to recruit focused market presentations from system integrators in the defense, medical, and industrial fields: Essentially, get the integrators to tell the audience what challenges they're facing that can be solved by a standards body such as VITA. Another way would be for ETT to re-engage with the PICMG standards body to broaden the reach of the conference, as many of the sponsoring companies also produce CompactPCI and other PICMG standard-based products.

Overall the conference was a success and a strong retooling of the former model. Jerry Gipper, Marketing Director for VITA, did an excellent job as host and created a bit of momentum going into next year's event, which heads back to Long Beach, CA. ETT 2013 will be held in January 2013 on the Queen Mary in the Grand Ballroom. The Queen Mary is anchored in Long Beach, and is also a full-service hotel.

It will be the first conference I've attended on a cruise ship. Should be fun.

John McHale
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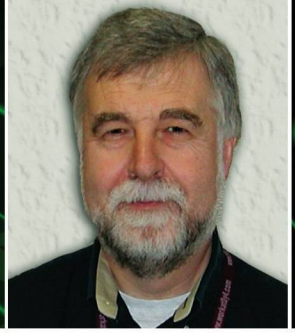
High-definition sensors drive video compression

By Duncan Young



Multispectral electro-optical sensing plays a pivotal role in the detection of threats and movements of insurgents, terrorists, and other destabilizing forces operating with limited technology capability. Video is gathered from surveillance platforms, such as Unmanned Aerial Vehicles (UAVs), helicopters, or ground vehicles, which must then be analyzed and disseminated throughout the battlefield command structure as quickly as possible. Ethernet is the medium of choice for streaming video, but with its potentially limited bandwidth, real-time video compression is essential for the new breed of high-definition sensors or where many channels of video are to be carried.

Communications

Surveillance platforms carry diverse types of sensor such as HDTV, regular TV, infrared, low light, and custom. Payloads also vary as each sensor platform does not have the space, endurance, electrical power, or cooling to support all sensors concurrently. Whichever kind of platform is deployed, wireless data links convey images to where they are needed for each specific mission. Typically, mobile sensor platforms will use either SATCOMs or digital data links to stream video. SATCOM is most often supported by large air and ground vehicles, whereas smaller platforms rely on air-to-ground digital radio channels with limited bandwidth.

Compression standards

The most commonly used compression standards are JPEG 2000 and H.264/MPEG-4. JPEG 2000 was developed for the compression of still images, but is also used for streaming video by transmitting consecutive images at video frame rates. As a result, JPEG 2000 recovers any potential transmission data losses on the next frame, whereas some H.264 image integrity can be lost in the same circumstances. But this is recovered over a small number of subsequent frames, plus complete images are transmitted periodically. H.264 has become the standard for Internet applications and HDTV, offering low latency and twice the compression rates of MPEG-2. Typically H.264 can achieve up to 100 times compression, whereas JPEG 2000 achieves 30.

Video distribution

In addition to surveillance vehicles, streaming video over Ethernet using H.264 can replace many cumbersome and inflexible video distribution systems, wherever multiple video sources are to be distributed, switched, and shared between many display positions. Typical applications can be found in naval combat systems, ground forces' surveillance vehicles, helicopters, and security installations plus many areas of training, simulation, and recording.

Implementation choices

H.264 compression is very processor intensive, specifically for HDTV or where low latency is needed, whereas decompression is much less rigorous. As H.264 is now such a common standard, there are many technology choices for its implementation. Software, IP cores, ASICs, and Digital Media Systems-on-Chip (DMSoCs) are all available. However, these alone do not offer the flexibility needed to deal with multiple channels of differing formats and evolving requirements of multispectral, multisensor platforms. Typically, a flexible and efficient design solution would be to use an FPGA for video capture and reformatting and DMSoCs for the intensive Discrete Fourier Transform (DFT) processing required by H.264. This architecture is used by the rugged DAQ8580 multichannel video compression subsystem from GE Intelligent Platforms supporting two HDTV channels or four regular channels with Ethernet output (Figure 1).

Figure 1 | DAQ8580 multichannel video compression subsystem from GE Intelligent Platforms

Military applications for video over Ethernet are necessarily more demanding than the many devices, appliances, and terminals in everyday use. As well as extremes of environment, sensor platforms will continue to mix state-of-the-art sensors with legacy equipment, highlighting the need for more flexibility and performance. Users will demand better and faster threat detection capability, perhaps achieved by combining image preprocessing, target detection, tracking, and compression functions into future video processing subsystems.

Final farewell – or farewell finally

This is my final column for *Military Embedded Systems*, as I have reluctantly decided to bid farewell to paper, pencil, laptop, and cell phone in exchange for a new life of self-indulgent leisure. I have been privileged to have played my part in the development and rapid growth of the rugged embedded computing industry during the past 45 years. I wish all my ex-colleagues and many friends the very best for a long and bright future.

Editor's note: *Though we're sad to see Duncan move on, the* Field Intelligence *column will continue in this magazine. Find out who the new author is in our next edition.*

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

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DSP goes all digital to boost real-time sensor data analysis

By Steve Edwards

DSP systems for military signal-processing applications have taken a major leap forward. In the past couple of years, the speed and performance of digital electronics have made it possible to reduce the need for analog front ends in signal-processing applications. This is specifically true in radar systems where high-speed A/D converters can be used to interface directly to the RF front end. DSP systems designers can now build COTS-based High-Performance Embedded Computing (HPEC) all-digital radar systems because digital devices can be directly interfaced to the antenna, capturing sensor data directly without an intermediary RF stage. Instead, the analog sensor signal is delivered directly into the system's transmit/receive element.

Reducing analog increases capabilities

The functionality provided by large analog systems, such as filters, can now be implemented directly into a high gate count FPGA, essentially replacing a significant amount of analog equipment with embedded digital processing elements. And as the space dedicated to RF front-end processing becomes available, the size of the digital subsystem can increase, boosting the capabilities that can be applied to any specific mission. While radar leads the charge in moving to *all digital,* other sensor-processing applications will start moving in this direction over time as A/D technology continues to improve.

Compared to mixed legacy analog/digital systems, all-digital architectures are easier to design and program. For system integrators, the signal-processing design challenge has evolved from a hardware integration task into a software programming exercise, as open standard VPX and FMC digital components replace sensitive, complex, hard-to-ruggedize analog components.

Digital boosts real-time sensor-data analysis

The move to digitization enables COTS vendors to build better DSP technologies. With the RF section removed, more DSP boards can be integrated into a given chassis. The resulting HPEC system can support the more intensive algorithm processing demanded by applications such as multifunction radars, sensor fusion, and multitarget tracking. While older embedded DSP systems were often limited in target and location identification capabilities, today's all-digital DSP systems, without impacting Size, Weight, and Power (SWaP), can identify the target, locate it, image it, and then distribute and downlink its digitized image. Formerly, processed sensor data was downlinked to remote signal analysts who might require days to identify targets and trends of interest. With onboard embedded HPEC systems, sensor-data analysis becomes near real time as the target is imaged, drastically reducing the time needed to turn sensor data into actionable intelligence.

> *"Fortunately, COTS components are becoming more 'Lego-like,' leveraging the latest commercial chip technology ... to address these all-digital radar systems."*

Older single-function, self-contained DSP systems send their data directly to an analyst, as mentioned. Now customers desire systems that can talk to other systems, too. The all-digital HPEC systems that COTS vendors such as Curtiss-Wright Controls Defense Solutions (CWCDS) can now enable comprise multifunction systems that are able to support functionality that formerly needed multiple different analog systems. Vendors are providing the frameworks to exploit sensor data, with Modular Open Systems Approach (MOSA) and Radar Open Systems Architecture (ROSA) middleware that enables HPEC systems to interact with different communication systems or different pieces of equipment beyond the radar.

Writing application software for digital DSP systems can become challenging as missions complexity increases and functions get added. Fortunately, COTS components are becoming more "Lego-like," leveraging the latest commercial chip technology from laptop vendors and the wireless industry to address these all-digital radar systems. Furthermore, there are far fewer analog engineers than digital engineers, and digital software is more cost effective to develop. Also, unlike analog technology, the key limiter for performance improvements in HPEC system digital electronics is the amount of space available on an FPGA and the CPU's speed and bandwidth, which historically double every 18 months. Digital COTS components enable integrators to mix and match the high-speed, high-performance, open-standards boards they need to uniquely match the system design and SWaP envelope to their mission demands.

Benefits of all-digital DSP

Two of the greatest costs associated with airborne DSP missions are fuel that limits the flight duration, and expensive satellite uplink/downlink access. All-digital HPEC systems will help system designers better match their specific fuel/data communications envelope while optimizing system functionality to match their SWaP envelope. As the processing capability per watt of these new systems continues to double over time, their mission capability will grow commensurately. As capabilities expand, legacy systems will be increasingly upgraded and converted to all-digital designs.

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

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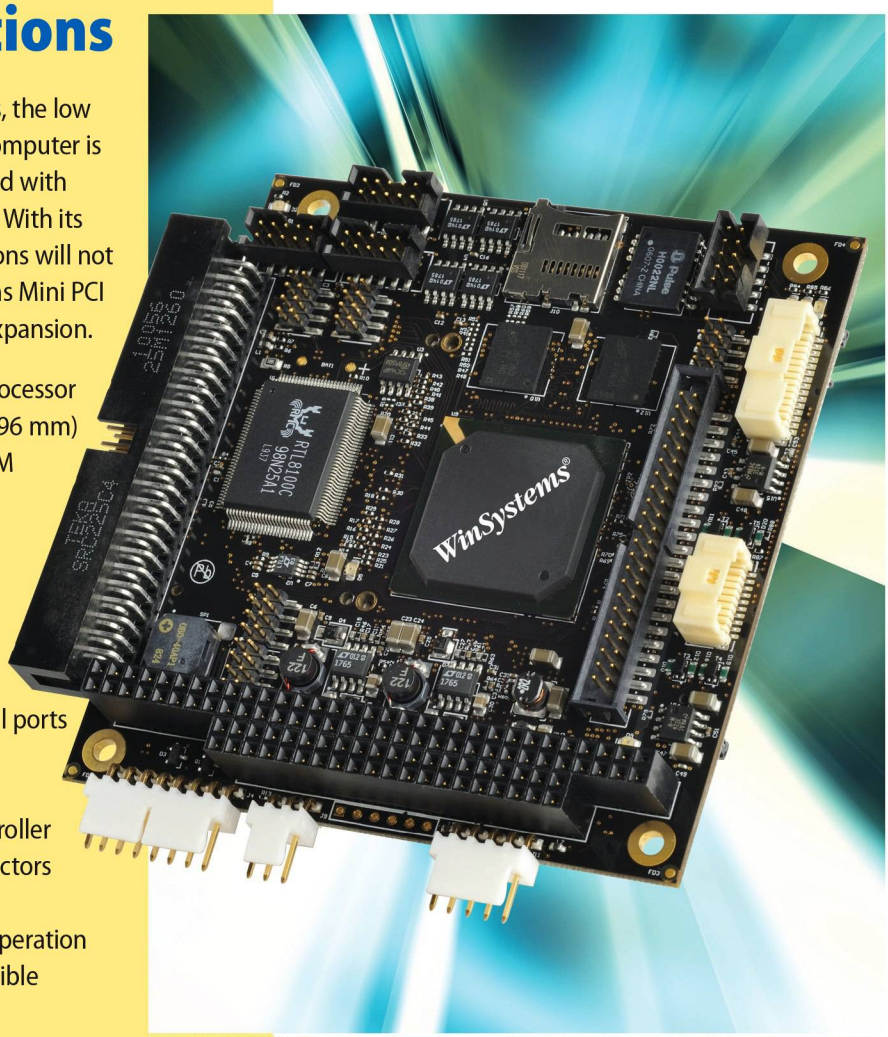

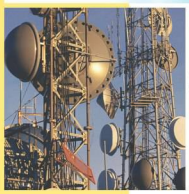

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DEFENSE TECH WIRE

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By Sharon Hess, Managing Editor

NEWS | TRENDS | DoD SPENDS

LCS in U.S. Navy spotlight

Though calling U.S. Navy/LCS contracts "ubiquitous" might be a bit of an overstatement, it's clear that the Littoral Combat Ship (LCS) is garnering lots of attention anyway. The evidence: three recent Navy contract options activated on the same day. One contract modification was exercised on a previous Lockheed Martin/U.S. Navy contract, specific to the LCS 3 aka the USS Fort Worth (Figure 1). The option specifies that Lockheed executes "deferred design changes that have been identified during the construction period." The upgrades and changes are supportive of various LCS phases, including those dubbed the sailaway and follow-on post-delivery test and trials, according to the DoD website. The same day, the Navy exercised two more LCS-related contract modifications, to Lockheed Martin and Austal USA. The options appear identical except for the amounts paid (Lockheed at $11 million and Austal at nearly $8 million). The two "twin" options mods call for each company to "assess engineering, baseline, and configuration management services in support of the basic construction, post-delivery, test and trials phases of the LCS class," again, according to the DoD website. The work is anticipated for completion by next December.

Figure 1 | The Littoral Combat Ship (LCS) is grabbing lots of attention from the U.S. Navy, which recently exercised a triad of related contract modifications. Pictured: LCS 3, U.S. Navy photo courtesy of Marinette Marine Corporation

Air vehicle analysis gets a lift from Navy/SAIC

A recent $11 million contract modification option exercised by the U.S. Navy has Science Applications International Corp. rendering engineering and technical services to benefit the Manned Flight Simulator/Air Combat Environment Test and Evaluation and Air Vehicle Engineering facilities. Services under the contract option will support usage and design of air vehicle technology to facilitate analysis of air vehicle controllability and flying capabilities, in addition to prototype simulation building and simulation software development. Contract fulfillment is anticipated next December.

Busy holiday season for mergers and acquisitions

The holidays brought not only "visions of sugarplums [that] danced in their heads" and choruses of "happy new year!"; it additionally yielded an ongoing roster of mergers and acquisitions: Defense industry subsystem supplier **Mercury Computer Systems** acquired intelligence and defense systems purveyor **KOR Electronics (KOR)** in addition to subsidiary **Paragon Dynamics, Inc.** for an undisclosed sum of cash in December. Earlier in December, defense industry Software-Defined Radio provider **Thales** agreed to acquire government/commercial tactical satellite communications vendor **Tampa Microwave** for an undisclosed amount. Then safety- and security-critical software provider **AdaCore** helped ring in the new year by merging with Automated Software Quality (ASQ) provider **SofCheck, Inc.** (The monetary renumeration is again, unannounced.) And last but not least is the unexpected *intracompany* merger that *seems* like a two-company merger: **Curtiss-Wright Controls, Inc.** has announced the creation of its new **Curtiss-Wright Controls Defense Solutions (CWCDS)** organization, which now streamlines and unifies into one its formerly disparate module-focused Embedded Computing division and its (obviously) systems-focused Electronic Systems division.

Warfighter comms benefit from Boeing/USAF option

Warfighters will continue to get a boon in information exchange capabilities (Figure 2), thanks to a U.S. Air Force-exercised Boeing Satellite Systems contract option for nearly $300 million. The option calls for a Wideband Global SATCOM (WGS) Block II follow-on, specifically for Boeing to manufacture and then deploy the WGS-8 satellite. (The satellite's WGS-1 through WGS-7 iterations were already or are presently being spawned, with WGS-4, -5, and -6 expected to launch this year or next.) Suited for battle management, C4ISR, and combat support information broadcast, WGS is touted to trounce its DSCS III satellite predecessor: WGS, which supports the Ka-band spectrum (1 GHz) and X-band (500 MHz), is capable of instantaneously routing/filtering 4.875 GHz of bandwidth and handles 2.1 to 3.6 Gbps (or more) data transmission; meanwhile, a DSCS III satellite crawls along with up to 0.25 Gbps as its peak capability.

Figure 2 | The USAF recently exercised a nearly $300 million contract option for a Boeing Satellite Systems-produced Wideband Global SATCOM (WGS) Block II follow-on: WGS-8. Stock photo

USAF/Raytheon double header

Raytheon and the USAF put pen to paper twice in one day, for two very different contracts. The first contract stipulates that Raytheon Missile Systems in Tucson, AZ produces the laser Maverick missile for a $15 million pricetag (missile quantities not specified on the DoD website). The second contract specifies that Raytheon BBN Technologies Corp. in Cambridge, MA develops an "architecture and revolutionary technologies for analyzing, identifying, and slicing binary executable components" (Figure 3). The contract deliverables comprise prototype system hardware and software in addition to technical documents. Contract completion is slated for June 2015.

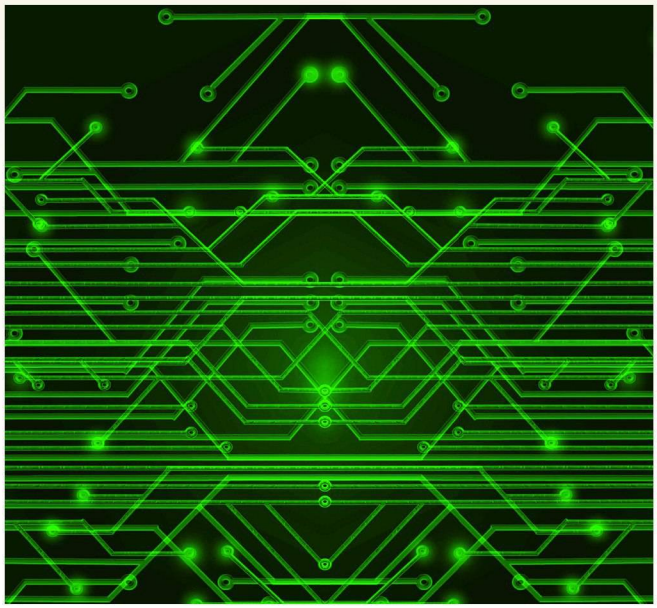

Figure 3 | Two Raytheon/USAF contracts were recently signed, one for laser Maverick missile production and the other for binary executable component management technologies.

'Combat System of the Future' in development

The U.S. Navy is working on the "Combat System of the Future," per a recent $11 million contract option exercised and extended to Advanced Systems/Supportability Engineering Technologies & Tools in Manassas, VA. The option is for Phase III of a Small Business Innovative Research "topic" and services are slated to be provided when needed. Efforts under the contract option apply and extend earlier efforts in areas such as technology evolution, data fusion, operator cognition, manning requirements, automation, processing, and combat system development relative to Navy air and surface platforms and submarines. Contract fulfillment is anticipated this August. The contracting activity is the Naval Sea Systems Command in Washington, D.C.

For consideration in Defense Tech Wire, submit your press releases at http://submit.opensystemsmedia.com. Submission does not guarantee inclusion.

Figure 4 | A U.S. Navy/Navistar Defense LLC delivery order stipulates that Navistar Defense provides contractor logistics support for the Mine Resistant Ambush Protected recovery vehicles' (MRVs') Contract Data Requirements List (CDRL). MRAP photo courtesy of U.S. Army

Navy contract provides relief for MRAPs

Though the weight of MRAPs has decreased exponentially (compare the original 60,000 lb MRAPs with the newer 25,000 lb versions such as the M-ATV), MRAPs are, in essence, still the "monster trucks" of the battlefield – and thus not easy to move (Figure 4). Therefore, the U.S. Navy recently issued a $9.5 million delivery order under a contract modification to Navistar Defense, LLC for Mine Resistant Ambush Protected recovery vehicles (MRVs) to provide contractor logistics support for MRV's Contract Data Requirements List (CDRL). The goal is to provide coalition forces on the Operation Enduring Freedom battlefield with assistance when MRAPs are disabled. The contract is anticipated for completion in February 2014.

MUE gets a boost from USAF/Rockwell Collins

The USAF recently contracted with Rockwell Collins, Inc. for $20 million for Modernized User Equipment (MUE) program completion. The contract stipulates that Rockwell Collins invokes some MUE receiver card changes "identified during functional qualification testing, in order for the receiver cards to comply with contract requirements," according to the DoD website. The contract also provides for efforts to add capability to military GPS receivers delivered (Figure 5), raises the receivers' performance design margin, and integrates updated documents for MUE interface control. Contract fulfillment is slated for February 2013.

Figure 5 | A $20 million USAF/Rockwell Collins contract has the latter providing the former with Modernized User Equipment (MUE) program completion efforts. Pictured: A Defense Advanced GPS Receiver, U.S. Air Force photo by Staff Sgt. David Carbajal

Innovations for the warfighter: Small, COTS-based, portable, and platform agnostic

By John McHale, Editorial Director

Requirements for platform-independent, portable, cost-effective solutions that leverage commercial technology will drive innovation among designers of future military electronic systems.

MONAX photo courtesy of Lockheed Martin

During the next 5 to 10 years, the U.S. military will be forced to accomplish its missions with fewer resources as the U.S. Department of Defense (DoD) initiates major funding cuts. Major platforms will be cut or scaled back and new research and development dollars will also be hard to come by.

Designers of new military systems will need to not only be innovative in improving performance but in managing design costs.

Across the industry, system integrators and suppliers are already anticipating these needs by creating systems that are built with as much COTS technology as possible to save costs and shorten design cycles. They are also designing smaller, portable systems and components that can be used across multiple platforms, as that also saves money.

Let's look at three examples of where the defense industry leveraged COTS technology in portable systems with small components that can work in air, land, and sea platforms: the Multi-Function Training Aid (MFTA) portable simulation system from Lockheed Martin Global Training and Logistics, the postage-stamp sized MicroGRAM GPS receiver from Rockwell Collins, and the MONAX 4G tactical cellular system from Lockheed Martin.

Portable simulators for any platform

In the world of training and simulation, engineers at Lockheed Martin have developed a portable simulator that can travel anywhere; be assembled in hours; be adapted for aircraft, ground vehicles, and naval vessels; and is completely designed with COTS technology.

"We can take the Multi-Function Training Aid (MFTA) to pilots wherever they are located to use as a refresher or [for] training on a new version of an aircraft software [Figure 1]," says Chester Kennedy, Vice President of Engineering at Lockheed Martin Global Training and Logistics in Orlando. The MFTA takes only an hour or two to assemble on location, as opposed to trying to get a full-motion simulator out to different locations, he adds.

"It does not replace the need for a full-motion simulator nor real flight time in an airplane," Kennedy says. "However, we were able to take a tremendous

percentage of the learning objectives and enable them for training in a more affordable way by simply being able to take the MFTA to different environments."

U.S. Air Force Special Operations and C-130 aircrews are using it today to train their pilots. The fixed-wing aircraft community was the early adopter of the MFTA, but the system's application potential is much broader than just aviation, Kennedy says.

"We can bring it out for a variety of airplanes, ground vehicle, and surface Navy applications," Kennedy says. For the Navy demonstrations, the system has ship controls instead of avionics, he adds.

Back view of the Multi-Function Training Aid (MFTA) from Lockheed Martin

Figure 1 | The portable Multi-Function Training Aid (MFTA) from Lockheed Martin leverages commercial gaming technology and can train pilots wherever they are located.

In a reduced funding atmosphere as the DoD is forced to accomplish its mission with fewer resources, there may be more demand for affordable solutions such as the MFTA, Kennedy says.

Largely because the system is a COTS solution, "We were able to turn around the MFTA from the first prototype request to delivery in six months," Kennedy says. "The customer didn't have a hard requirement, just a general need to fill gaps in the training pipeline."

"For the C-130 configuration, we took the mission computer out of the C-130 cockpit and right into the MFTA," Kennedy says. "However, the core software runs on a PC that you could buy at Best Buy."

Not every system will use the mission computer of the flight platform, but every MFTA will have the simulation software running the system, which is the real game changer, Kennedy continues.

"The heart of the MFTA is the Flight Sim software we acquired as intellectual property from Microsoft," Kennedy says. "It is the COTS kernel at the core of this solution. We put a lot of work at taking the gaming technology and bringing it a new level in realism and simulation to create the enhanced Prepar3D gaming kernel."

Prepar3D gives "us affordability and the agility" to enable different platforms in the simulator through software without having to build an entirely new, expensive simulator for each application, he continues.

Simulating with a gaming environment fills a gap in the training path by enabling pilots to train while deployed instead of having to take the more expensive route of going off-station to a location that has a full-motion simulator, Kennedy explains. All the functionality and switches do exactly what they would do in an actual aircraft or vehicle, he adds.

"We've brought in capabilities that are much more important to a military customer than a gamer-built system would," Kennedy says. "We built off the foundation Microsoft had that goes back to their flight simulator product. We then sell it commercially and, in an interesting twist on this, anyone can buy it – including our competitors.

"We decided to offer Prepar3D as a COTS product to encourage others to innovate on top of it," he continues.

The user community can go out and look at it online and enhance it in a variety of ways such as by adding graphic plug-ins for a region of the country, modeling different parts of the globe in high fidelity, and adding weather modules or "aircraft instruments in any kind of airplane you can imagine," Kennedy says.

"It is a very different business model from what Lockheed Martin has done in the past," he continues. "However, it allows

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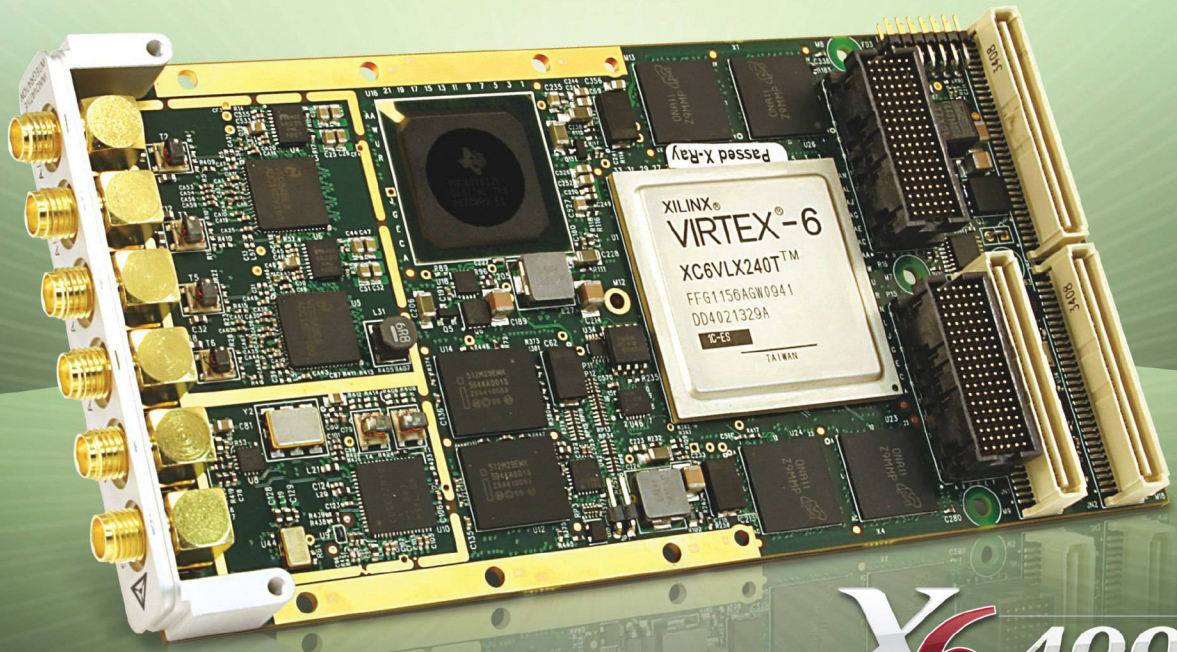

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Much like an iPad, it is all about the applications or apps that users create in the open development environment, Kennedy says. "I love my iPad, but wouldn't love it if it weren't for the apps or if the apps only came from Apple. It's the beauty of seeing one app developed, then seeing how I or others can extend it."

Visit www.prepar3d.com to buy the software and download development kits to create add-ons to the system such as instruments, buildings, and so on.

One GPS for you and your UAV

In the spirit of platform agnosticism, engineers at Rockwell Collins located in Cedar Rapids, IA, funded their own development of a miniature Global Positioning System (GPS) smaller than a postage stamp that can fit underneath a small Unmanned Aerial Vehicle (UAV) or be attached to a soldier's radio.

The MicroGRAM GPS receiver (Figure 2) is a 90 percent reduction in size and an 85 percent reduction in weight from its predecessor, the Miniature Precision Lightweight GPS Receiver Engine SAASM (MPE-S Type I), says Trevor Overton, Program Manager for Surface Embedded and the MicroGRAM at Rockwell Collins. The MicroGRAM has already been provided to AeroVironment for a small UAV application, he adds.

"This technology falls into the DoD's philosophy of combining capabilities into platforms," Overton continues. "In this case, putting GPS into radios, combining navigation and communications into one device. "

In addition to unmanned systems, "We've been talking to several different user communities about potential applications for the MicroGRAM such as rifle mounts, mortar computers, laser range finder devices, as well as the large community of reconnaissance and unmanned aircraft." Its weight, small size, and low power also make it useful for a large number of radios.

Figure 2 | The MicroGRAM GPS receiver from Rockwell Collins can be used on a small UAV, a tactical radio, and even a rifle site.

A radio manufacturer is currently interested in the MicroGRAM concept and is getting ready to test it out, Overton notes. However, "We do not have the MicroGRAM on the Rifleman radio," which is part of the Joint Tactical Radio System (JTRS) program. "We are trying to get on that platform, though," he adds.

Inside the DoD, there was a real need for a small, secure GPS receiver, Overton says. The alternative was to purchase a commercial GPS receiver for the task, but the main problem with commercial devices is that they are not secure, as they do not have Selective Availability Anti-Spoofing Module (SAASM) capability, Overton continues.

The result was the MicroGRAM GPS receiver, which not only has SAASM capability, but it is secure at the die level as well, he says. The chip inside the receiver meets NSA anti-tamper requirements for any probing that might occur by an enemy agent, Overton adds.

Its design combines the functionality of six ASICs into one, which eliminates die-to-die communication signaling by using only one single die, which cuts down on tampering risk, Overton says.

At the moment, ASICs also are better than FPGAs as FPGAs are not quite as small as they need to be for this application and they still consume more power than is optimal, Overton says.

Smaller and smaller designs are the overriding theme throughout the DoD, Overton says. Requirements are demanding smaller, lighter electronics that consume less power while adding more capability, he adds.

The MicroGRAM is engineered to be low power – as low as four tenths of a watt, Overton says.

"We are definitely looking at even greater size reduction in the future," Overton says. Size reduction is a never-ending struggle in the embedded community.

Secure smartphones and a tactical app store

Future military outposts will have their own private network with its own app store, enabling U.S. and allied personnel to access a tactical app store with iPads or commercial smartphones, depending on their security clearance level.

Engineers at Lockheed Martin are designing a portable system that integrates the capabilities of these commercial products into a secure solution for warfighters called *MONAX* (Figure 3).

MONAX is basically a 4G tactical cellular system, but one that functions within a private, secure network, explains David Weber, Business Development

Manager at Lockheed Martin in Philadelphia. Essentially, the network can be set up in places where there are no cell towers and, within hours, a private, secure cellular network is operational.

The system consists of a portable MONAX Lynx sleeve that connects off-the-shelf touch-screen smartphones to a MONAX XG Base Station infrastructure located on the ground or on airborne platforms, says a Lockheed Martin MONAX brochure. The MONAX interface uses a secure RF Link with exportable encryption.

"MONAX is device agnostic," Weber says. Warfighters can use an iPad or commercially available smartphone like an Android for voice, video, and data transmission, but to connect to the MONAX network will require having the proper security protocols, he adds.

For example, U.S. Marines and NATO personnel can all bring their own unique smartphones and still access the network if they have the proper clearance, Weber continues. Once connected, their device will access a VPN tunnel that is encrypted, he adds.

Just as iPad users go to an app store for personal and business uses, MONAX users will also have access to a secure, tactical app store that is available 24 hours a day, 7 days a week, Weber says. The apps, which could be tactical maps or other mission-specific information, are developed for or rehosted on a smartphone, then approved for and made available to warfighters in the app store, he adds.

"MONAX uses a layered approach to security, but another reason it is secure is that we use nonstandard commercial frequencies," Weber says.

The solution has a mobile device management feature, which enables users to set secure access policies, Weber says. For example, if the Marines want NATO allies to only have access to a certain level, they can set policy and push it out to the phones, he continues. MONAX also can be set to give different security access based on rank, with a general having access that lance corporals would not, Weber adds.

The MONAX network is capable of interfacing with tactical radios like devices within the Joint Tactical Radio System (JTRS), Weber says. Radio users would just have to enter the VPN tunnel, he adds.

MONAX was just made available for sale this year and is not being used in the theater yet, but is being evaluated in different exercises, Weber says. The Marines have tried it out already and found it very user intuitive, he adds. **MES**

Figure 3 | MONAX is a secure 4G wireless network that enables warfighters to use commercial smartphone and tablet technology to manage their missions.

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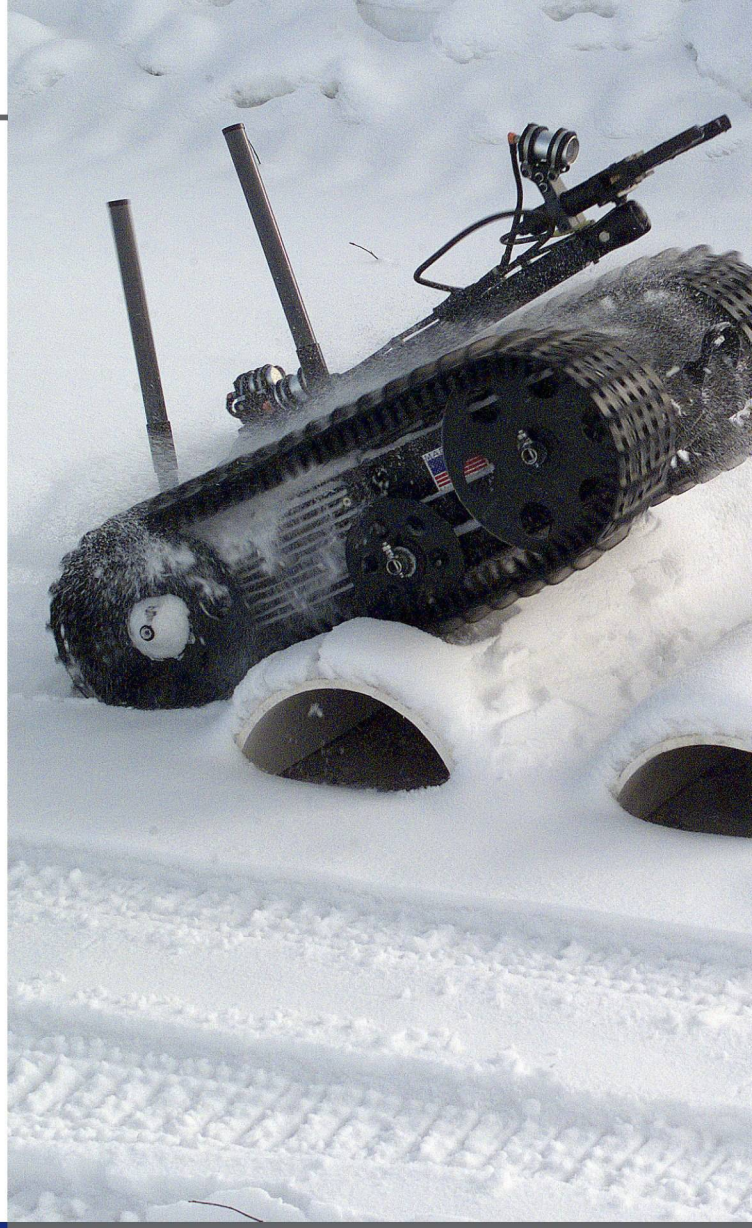
Robots in the military: Brave, autonomous, and dispensable warriors

By Jim Davis

The airspace in today's military conflicts is filled with Unmanned Aerial Vehicles of all sizes – from the hand-launched vehicles of the Special Forces to the jet-powered Predator drones flown by airmen thousands of miles away from the conflict area. On the ground are autonomous and wirelessly controlled robotic vehicles for everything from high-risk patrols to explosive ordnance detonation and disarming. These robotic vehicles support a variety of military missions ranging from covert intelligence gathering to direct support to ground forces and overt military strikes. And this is just scratching the surface of what is moving autonomously on the battlefield. System-on-Chip (SoC) advances finetune mixed-signal designs, enabling reduced power consumption and expense.



U.S. Army photo by Yuma Proving Ground Public Affairs Office

The use of robots in war dates back as early as World War II with the German Goliath remote-controlled explosive vehicles and the Soviet's wirelessly controlled, unmanned Teletanks. Today, the military robotic force also saves lives. As designers and engineers of robotic systems and components might or might not even know, they are playing a large part in enabling these and future systems. Developing these systems, however, is not a trivial task. Robotic systems, in their most basic form, simulate or otherwise artificially sense their environment and, through programmed logic, respond and interact with their surroundings. As far as complex embedded systems go, they are the ultimate mix of analog sensing, driving and digital logic, processing, and communications. While mixed-signal design is not a new concept, state-of-the-art advances in the fundamental components that make up these designs – including Systems-on-Chip (SoCs) – provide ways to implement robotic subsystems easier with lower power requirements and at greatly reduced cost.

Sensing technology for robotics

Interactions with the real world are inherently analog. A robotic system's ability to not only accurately sense its surroundings but to do so with high resolution provides the system a stream of data inputs to more effectively enable correct decision making and response. For example, to enable a robotic sentry to effectively protect a perimeter, the system must be able to monitor and detect movement – be it through sight, sound, or touch. Through the use of a combination of high-precision thermal, IR, ultrasonic, and/or optic analog sensors, the raw input of what the robot can see can be streamed into a programmable movement detection algorithm to measure the change between snapshots and processed for the decision-making process – effectively an analog-to-digital conversion. The response itself is also an analog process (that is, a robot interacting with its environment requires movement, motors, and motor control), effectively a digital-to-analog conversion.

The brain of the robotic system lies within the digital domain. Based on the converted analog signals, the preprogrammed logical steps of responding to those signals are carried out by the robotic brain and/or externally communicated commands to the robot. For example, in a robotic sentry, after the detection algorithm feeds an alert to this brain, a series of preprogrammed logical functions is executed to steadily increase

the robot's overall alertness state. This is done by executing intimidation actions to thwart the intruder into retreating via floodlights, verbal warnings, and so on.

Historically, designs engineered for systems like a robotic sentry required sensors, costly analog discrete ADCs, amplifiers, highly accurate voltage references, DACs, PWMs, and multiple processors and microcontrollers. These are the components that make up the individual sense-detect-decide-respond-report subsystem – just one of many functions for which a robotic sentry would be responsible. The challenge in implementing just this one function is the selection of the right analog discrete components (ADCs, amps, Vrefs, DACs, and so on) designed for or compatible with the selected high-precision sensors. It can also be difficult to choose the digital components, processors, and even potentially the custom logic gates to build the alarm-level state machine to enable the appropriate decision and response. Not only is this a complicated and challenging task, but should any part of this require redefinition – perhaps swapping a sensor, adding additional sensors, adding additional response mechanisms, and so on – the same complicated task must be repeated all over again. Finally, the

large number of discrete components also quickly adds up in total subsystem BOM cost and increases power requirements, doubly impacting the system because of the number of components.

Mixed-signal SoCs are key

Considering the aforementioned challenges in building a robotic system, the good news is that mixed-signal programmable SoC architectures and software tools can ease robotic design burdens. Through the integration of an analog, digital, logic, and processing core into a single mixed-signal device, designers can realize system cost savings while greatly improving the power budget. Systems-level programmability in both the analog and digital domains in these types of devices also eases the often difficult and time-consuming analog design process; these devices also provide the ability to rapidly prototype, test and, without even having to relayout designs, change and incrementally update the design along the way. For example, with systems-level programmability, tools designed at this level of design present developers with a method for defining the signal chain in a mixed-signal device and the ability to modify any part of that same signal flow as the design progresses. In this way, it becomes possible to define the signal path and configure the components at the system level via the ADC itself, using parameters such as desired resolution, sample rates, voltage reference sources,

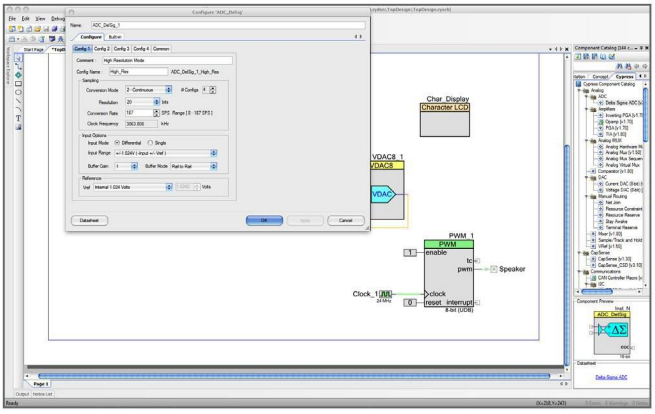


Figure 1 | Mixed-signal programmable SoC software generates an ADC based on parameters such as desired resolution, sample rate, and voltage reference source.

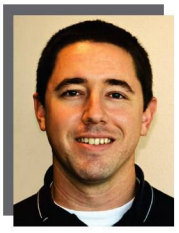
and so on. All this can be done without having to consult an analog component data book when using, for example, Cypress's PSoC architecture and software tool, PSoC Creator (Figure 1).

The PSoC Creator dialog shown in Figure 1 generates an ADC based on parameters such as desired resolution, sample rate, and voltage reference source. If there are significant changes in system requirements, developers can accommodate them

without any hardware modifications by adjusting these parameters and rebuilding the system application.

Mixed-signal SoC tech helps robots save the day

The military robot is a brave and autonomous warrior, and unlike its human counterpart on the battlefield, can be a dispensable asset that protects those it serves. Through the use of state-of-the-art, programmable mixed-signal SoC architectures and software, engineers can further evolve these robotic warriors with greater ease within power/cost budgets, freeing designers to apply more time and effort on the things that matter most: the robot's core mission. **MES**



Jim Davis is Product Marketing Manager for Programmable System-on-Chip (PSoC) products at Cypress Semiconductor. He joined Cypress in 2008 and prior to that served eight years in the U.S. Air Force as a Communications Officer. He has a Bachelor's degree in Computer Science from the U.S. Air Force Academy and a Master's degree in Software Engineering from the University of Maryland. He can be contacted at jfmd@cypress.com.

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Radar signal processing upgrades use embedded COTS hardware

By John McHale, Editorial Director

Military radar designers are turning more and more toward Commercial Off-the-Shelf (COTS) signal processing solutions to modernize existing radar systems.

Engineers at Lockheed Martin used GPP and FPGAs for an upgrade of 29 U.S. Air Force AN/FPS-117 long-range surveillance radars.

The capabilities of modern radio detection and ranging systems, better known as radar systems, are light-years ahead of where they were when radar was invented in the World War II era.

There are so many different slices and flavors of radar now, and the technology available today versus 5 or 10 years ago is night and day in terms of performance, says Rodger Hosking, Vice President of Pentek in Upper Saddle River, NJ. Radar system requirements coming out of the DoD put a tremendous demand on signal processing solutions that not only deliver compute performance, but that must be rugged and low power, he adds.

A major source for the ruggedization demands are Unmanned Aerial Vehicles (UAVs) that perform Intelligence, Surveillance, and Reconnaissance (ISR), Hosking says. The UAVS, which continue to increase in number, need rugged, light radar payloads with unique small form factor configurations that can operate in hazardous environments, he adds. Military customers also are interested in generating stealthy radar pulses that are difficult for an enemy to defeat, Hosking says.

The military wants higher and higher performance to be able to track multiple targets simultaneously and track every signal coming in, says Anne Mascarin, Solutions Marketing Manager at Mercury Computer Systems.

Turning to COTS

Because of performance requirements and the expectation of reduced funding, system integrators are looking to outsource radar signal processing tasks to COTS suppliers, says Jane Donaldson, President of Annapolis Microsystems in Annapolis, MD. Integrators are essentially wanting to do more with less, she says.

Where in the past they would use internal resources to develop signal processing boards, they will be forced to outsource because of lack of funding and possibly workforce reductions as well, she explains. Military system integrators also will want to use open architecture designs based on commercial standards as they are more cost-effective in the long run and easier to upgrade, Donaldson says.

The open standards tie so much to the spiral upgrade strategy the DoD uses, where there must be open standards or the spiral upgrade will not work, says Tom Roberts, Solutions Marketing Manager at Mercury Computer Systems.

System integrators want an open architecture at the board and chassis levels so they can actually plan out lower-cost technology insertions, says Eran Strod, Systems Architect at Curtiss-Wright Controls Defense Solutions in Ashburn, VA.

Advantage of GPPs and FPGAs

Two key enabling signal processing technologies for radar are the performance capabilities of General Purpose Processors (GPPs) such as Intel's Core i7 family and the growing capability of FPGAs.

COTS GPPs are still the main processing tool for radar systems, and that probably will not change any time soon as Intel is continuing to make inroads into this space with high-performance processors such as the Core i7, says Doug Patterson, VP of Business Development for Aitech in Chatsworth, CA. The extra processing power is essential for new radar applications such as some K-band multimode radars that do not emit signals an enemy could detect, he adds. For more information on Aitech signal processing systems, visit www.aitech.com.

FPGAs and GPPs are not virtually exclusive either; new radar designs are making use of both components to meet substantial processing demands of modern radar systems.

There is a need to have the FPGA and GPP work together, Pentek's Hosking says. The FPGA is good for doing parallel operations very quickly, but is not good at sophisticated analytical type tasks, which is where a GPP comes in, he adds. For more on Pentek's FPGA signal processing products, visit www.pentek.com.

"We see virtually every radar program using a mix of general purpose processors and FPGAs in radar systems," Roberts says.

FPGAs are phenomenally good at dealing with the problem of power, as they are only tuned to do what you want them to do, Jeff Milrod, President and CEO of BittWare in Concord, NH, says. They also are better at doing data independent processing where you do the same thing every time, he adds.

FPGAs are good at taking data and filtering it and sending it out to other processors that do a better job of interrogating data, Curtiss-Wright's Strod says.

Many FPGAs also have digital signal processors built into them as cores, which enables designers to pack more processing capability into an even smaller footprint, says Ian Stalker, Product Manager at Curtiss-Wright Controls Defense Solutions. For more on Curtiss-Wright's signal processing and FPGA solutions, visit www.cwcembedded.com.

The major drawback with FPGAs is the difficulty in programming them with VHDL. It is harder, more expensive, and more time consuming than programming in C or C++, Donaldson says. Also, there are fewer VHDL programmers than C programmers, she adds. With the DoD cutting back funding, military radar designers will want to find more cost-effective alternatives to VHDL for programming FPGAs, Donaldson continues. "Annapolis offers a product called CoreFire, which enables engineers to program FPGA boards very quickly and get them completed much faster."

BittWare also has a new solution aimed at cutting down on FPGA development time (see sidebar on page 35).

The Annapolis CoreFire is a data flow-based tool that eases FPGA design by allowing developers to automatically generate intermodule control fabrics and use a drag-and-drop graphical interface. The tool also has hardware-in-the-loop debugging and can easily port completed applications to new technology chips and boards, according to the Annapolis website at www.annapmicro.com.

FPGAs key in Air Force long-range surveillance radar upgrade

Engineers at Lockheed Martin in Syracuse, NY combined GPP and FPGAs and programmed their FPGA board with the Annapolis CoreFire tool for an upgrade of 29 U.S. Air Force AN/FPS-117 long-range surveillance radars – 15 in Alaska, 11 in Canada, and one a piece in Hawaii, Puerto Rico, and Utah. The radar system makes up the Air Force's Atmospheric Early Warning System.

The upgrade program, dubbed the Essential Parts Replacement Program (EPRP), has Lockheed Martin engineers replacing and updating all the radars' data and signal processors to state-of-the-art commercial technology to help extend their operational lives through 2025, Chris Atherton, Technical Director for Long Range Radar at Lockheed Martin, says. The radar site's secondary surveillance radar, which is used for air traffic control purposes, will also be modernized.

This is not a capability upgrade for the Air Force, but more an effort to "sustain existing missions in a better, faster, cheaper manner," Atherton says. The mission of this radar system has not substantially changed even with the upgrade, he continues. It is an air defense early warning radar system covering the periphery of Alaska and northern Canada with its main customers being the Federal Aviation Administration (FAA) and the North American Aerospace Defense Command (NORAD), Atherton adds.

"We have an open architecture approach to L-Band radars that enables technology refresh long-term for sustaining a fleet of more than 175 radar systems," he says. At the design level, the goal is to not only decrease failures but to decrease the Mean-Time Between Failures (MBTF) too, he adds.

The older system was not an open architecture, by any means. "We literally made our own computers that used a digital data processor, a memory board, and our own operating system to handle the demands for radar signal processing.

Patriot radar upgrades with OpenVPX

Patriot radar upgrades with OpenVPX

COTS capability and performance in a rugged package was what Raytheon Integrated Defense Systems officials wanted for the upgrade of the Patriot Air and Missile Defense System's radar for Taiwan and Saudi Arabia (Sidebar Figure 1).

The Patriot upgrade required an open architecture that took advantage of commercial processor technology for improved performance and was rugged enough to be deployed in extreme environments, says Tom Roberts, Solutions Marketing Manager at Mercury Computer Systems in Chelmsford, MA.

The upgrade used Mercury's Missile Defense Phased-Array Radar Application Ready Subsystem, which is packaged in a conduction-cooled, 6U OpenVPX chassis with a multiplane backplane.

"The Patriot upgrade is an upgrade from RACE++ and VME to Serial RapidIO and OpenVPX, but the Power Architecture technology was retained, while moving to a newer generation of Freescale Power Architecture processors," Roberts says. "We did help the customer move their application software to the new generation subsystem, thereby helping move the project forward on schedule."

Mercury OpenVPX products used in the solution include the Ensemble 6000 Series OpenVPX HCD6220 processing modules and SFM6100 switch modules. Each module has an OpenVPX multiplane architecture, which provides separate control, data, expansion, and system management planes to carry traffic and segregate it.

"OpenVPX has many advantages," and the way it "lends itself to rugged, conduction-cooled solutions was very important to the Patriot program," Roberts says. "Because customers can preserve their software investment, upgrading to an OpenVPX solution [also] is a cost-effective way to get a performance boost. Our customers can then add to their application, using the performance boost to support functions like more powerful radar capabilities.

"We often help our customers port their software to new architectures," Roberts continues. "One thing that is a huge benefit is that Mercury kept the calls to our algorithm library (SAL) consistent between RACE++ and newer Serial RapidIO architectures. This means that our customers' application software that calls SAL to perform a function, perhaps like an FFT, does not have to change."

For more information, visit www.mc.com.

Sidebar Figure 1 | The Patriot Air and Missile Defense System's radar for Taiwan and Saudi Arabia uses OpenVPX technology from Mercury Computer Systems.

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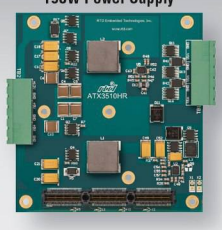

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If it's embedded, it's Kontron.

BittWare's floating point coprocessor eases FPGA programming

BittWare's floating point coprocessor eases FPGA programming

Engineers at Bittware working to find a way to improve the efficiency of FPGAs in floating point signal processing applications came up with a coprocessor solution called Anemone acceleration technology.

FPGAs are difficult and time consuming to program, and the Anemone coprocessor mitigates that challenge by offloading C-language processing tasks from an FPGA, says Jeff Milrod, President and CEO of BittWare in Concord, NH. "We've come up with a new paradigm with the Anemone processor, which gives us all of the advantages of an FPGA solution" while eliminating some of its limitations.

"We wanted something to attach to the FPGA that is a C engine," to ease development, Milrod says. "Twenty percent of the FPGA is too hard [to] implement. Why do you need a team of 10 guys to beat a compiler into submission when you can just architect around it." Offloading the C development will also cut down on the FPGA's power consumption, he notes.

"The better mousetrap doesn't always win, but we've done something with the coprocessor that is very practical," Milrod continues. "It's still early, but so far it has been very well received everywhere we go. We've started to release the solutions and it may be just my wishful thinking and vision, but I believe it's gonna work."

Anemone is an implementation of the Epiphany architecture from Adapteva in Lexington, MA, Milrod says. It is a startup company and BittWare is one of its investors, he adds. "We also got buy-in from Altera for the product, which was very important."

BittWare's first product with the Anemone chips will be an FMC (VITA 57) mezzanine card that utilizes Altera Stratix FPGAs. A military version will be introduced late this year, Milrod says. The AA-FMC hosts four Anemone104 chips providing a total sustained performance of as fast as 128 GFLOPS. Inside each Anemone chip are 16 small RISC processors designed for floating-point operations. What is unique is that the processors are interconnected and tied directly into an FPGA, Milrod says.

The Anemone104 (AN104)'s 16 eCores run at rates as fast as 1 GHz, providing a total sustained performance of 32 GFLOPS while consuming only 2 W of total power. "Each core is super simple to program; you just have to figure out how to leverage all 16 of these cores," Milrod says. The chip is tied to the ground with no external interfaces and can only talk to the FPGA, he adds.

For more information on Anemone, visit www.bittware.com.

With this upgrade, "We replaced five cabinets measuring 6 feet by 3 feet by 3 feet that were completely filled with homemade electronics" with 15 COTS cards with "substantial commercial processing capability," Atherton says. "We used COTS technology wherever possible, as it was the easiest and least expensive way of supporting the system over the next 15 years. The processing is done via an Oracle Sun Netra 5220 server – which has an UltraSPARC T2 processor – and a 10 Gigabit Ethernet interface is used to move the radar data, Atherton says. The Oracle devices have plenty of horsepower and are very efficient parallel machines, he continues. The operating system is Solaris, Atherton adds.

"We also used a Wildfire FPGA board from Annapolis Microsystems that uses their CoreFire FPGA development tool" to program the boards to do the digitization and digital filtering inside the radar system, Atherton continues. "They've taken what was a row of cabinets of electronics and fit it all onto a 6U VME board.

Thanks to CoreFire, "We were able to use the same software folks [who] worked on the GPP on the FPGA, instead of having to employ a VHDL specialist," Atherton says. "This also gives us advantages for when we migrate to the next generations of their board." **MES**

Mitigating undesired input beat frequencies in parallel DC-DC converter arrays

By Kai Johnstad

When an array of switching DC-DC converters is connected in parallel for higher power output, differences in operating frequencies result in undesired beat frequencies at the common input bus. The result is an unwanted increase in AC ripple currents circulating in the input sections of the converters. By using simple input filtering, the AC input ripple current can be significantly curtailed. DC-DC converters with higher fundamental switching frequencies (>1 MHz) permit the use of smaller filtering components, suiting systems where overall space and weight are at a premium.

U.S. Navy photo by Mass Communication Specialist Seaman Tyler Caswell

While a single DC-DC converter is often a preferable solution, there are many instances when two or more converters are needed to meet a military system's power capacity requirements. In such applications, an array of two or more DC-DC converters may be connected in parallel to generate the requisite power – and in other cases where an application needs to be robust, fault-tolerant or N+1 redundant power supplies are used to meet the capacity requirements.

In critical military applications where power supply failure can be catastrophic, fault-tolerant power supplies use N+1 similar converters to provide a very high level of reliability. Through redundancy, fault-tolerant systems ensure that there is at least one more module than the minimum required to carry the load in case of converter failure.

If the DC-DC converters in an array are operating off the same feed, they are typically collocated to gain the benefit of shared thermal and shielding features, while saving real estate. Although these converters may be of the same type, switching frequency mismatches will occur unless the DC-DC converters selected permit synchronization.

Because of slight variations or mismatches in nonsynchronous DC-DC converters operating in parallel off the same input bus voltage, there are small differences in operating frequencies of these converters. This difference in converter operating frequencies results in undesired beat frequencies in the input current to the array. As a result, the AC ripple current circulating in the input section of the converters is increased. While converters offering a synchronization method do avoid beat frequencies as there are no operating frequency mismatches, the choice of selecting converters off-the-shelf is restricted, which can lead to lower overall system efficiency and power density. By implementing simple input filters, the input ripple currents of an array of unsynchronized converters

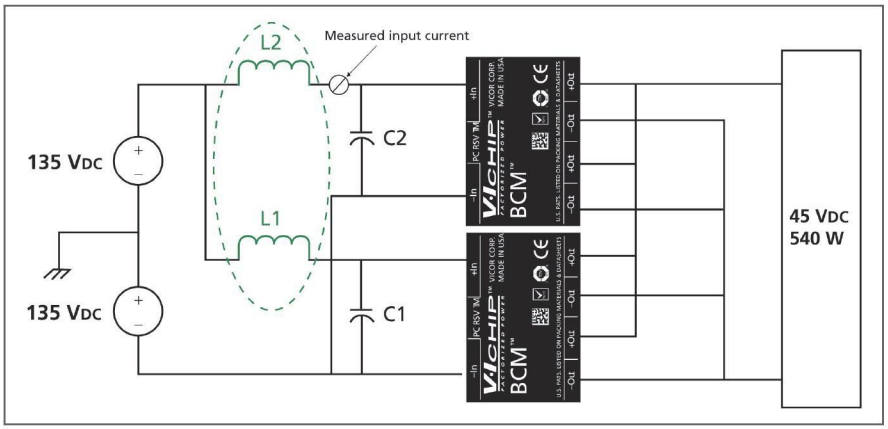

Figure 1 | An array of two high-input voltage 270 W DC-DC converters in parallel with subsequent input filter inductors, L1 and L2, shown in green.

can be easily suppressed significantly, along with beat frequency components, allowing unsynchronized converters to be considered.

Beat frequencies in parallel arrays of DC-DC converters

To demonstrate this problem and the impact of input filtering, let us take a look at military power systems such as RF transmitters or microwave radio links, which require substantial power. For example, a system requiring 2.1 kW output power from a MIL-STD-704E supply connects eight 270 W bus converters in parallel to form a high-power DC-DC array. For simplicity, a scaled-down version – an array of two high-input voltage 270 W sine amplitude bus converters in parallel, providing a total output power of 540 W – will be used for measurement (Figure 1).

Even though sine amplitude bus converters switch at fixed multi-MHz frequencies, part-to-part variations in members of this family result in each converter in the array operating at a slightly different switching frequency. The interaction between the switching noise of each DC-DC converter in the array creates the undesired beat frequencies, at multiples of the differences between the operating frequencies of the converters.

The impact of the undesired beat frequency is most notable in the ripple current circulating amongst the DC-DC converters of the array. The ripple currents of the switching frequencies add up to generate an amplitude modulation of the overall ripple current envelope of the converters. For instance, in the parallel DC-DC converter array described earlier and test setup depicted in Figure 1, a pair of interconnected bus converters with nominal switching frequency of 1.7 MHz might have actual switching frequencies of f1=1700 kHz, and f2=1702.7 kHz. The 2.7 kHz difference between the two means that the total input current will have a much lower frequency component to the apparent ripple.

During periods of time when the ripple amplitudes are highest, the copper losses in the interconnects wiring between the two converters in question are higher than they need to be: The circulating AC ripple current is not being used by the DC-DCs, but it is still flowing through conductors with finite resistance. High additive ripple currents can stress input bypassing capacitors as well, and system noise can be increased, depending on the board layout. In some cases these circulating currents can constructively interfere with sufficient amplitude to lead to an unpredictable behavior of the converters themselves, for example, erroneous detection of an overcurrent condition inside a module.

To practically demonstrate the problem of increased input ripple current and generation of low beat frequency components, a pair of high-voltage 270 W BCM bus converters is connected as a simple parallel array, as shown in

Figure 2. For the initial measurement, the input inductors L1 and L2 are not included and there is no input filtering beyond the input bypass capacitors C1 and C2. Because of asynchronous switching of two modules in the array, the AC input ripple current frequencies are also different. With a common input and no inductive filtering, the AC ripple currents mix and generate ripple with modulated amplitude based on the lower beat frequency as discussed previously.

This array was built from two bus converters operating at 270 V_{IN} and 45 V_{OUT}. The nominal fundamental operating frequency for this converter model is 1.7 MHz, and again to start with, the filtering inductors shown in Figure 1 were not in the circuit. The input ripple current to one of the modules, shown in Figure 1, was measured. The time domain plot of the resulting performance is shown in Figure 2(a). For the bus converter array used in this measurement, the total input current was about 2.1 ADC for full-load operation.

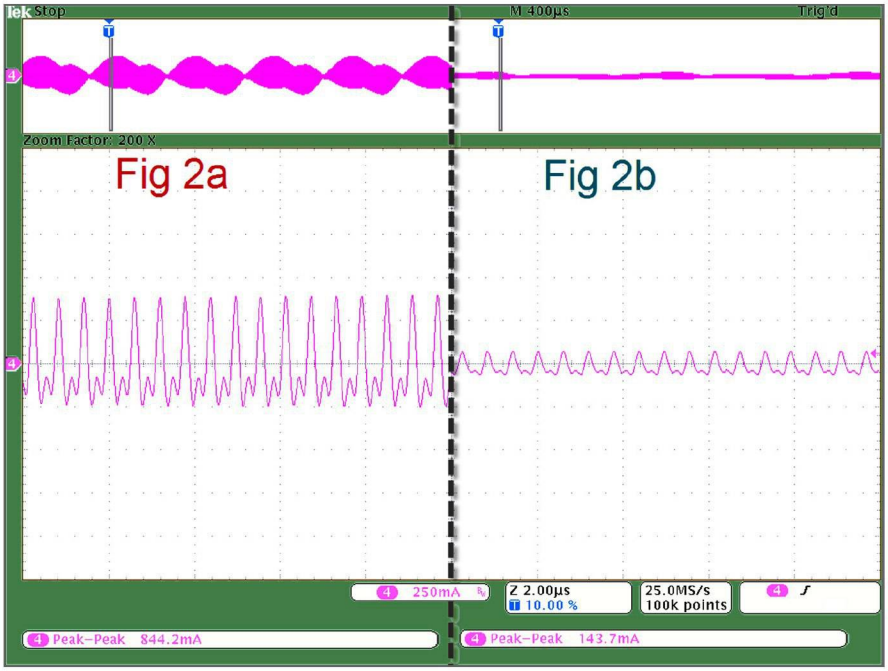

Figure 2 | The time domain scope plot (2a) shows that ripple current without the filter inductors is high (844 mA peak-to-peak). Plot (2b) shows ripple current is substantially curtailed (143 mA peak-to-peak) with filter inductors.

Suppressing the beats

With fairly simple input filtering, the unwanted AC ripple currents circulating between unsynchronized converters in an array can be easily controlled. The input inductors, labeled L1 and L2 in Figure 1 are incorporated to serve as additional input filters. In this experimental setup, the inductors were 0.4 µH, and were placed in series with the +In leg of each bus converter in the array. The input inductors increase the impedance between the input stage of one converter and the other converters in the array at the switching frequency. In this case, the impedance of the inductors is roughly 4 Ω at the 1.7 MHz fundamental switching frequency of the bus converters. This impedance reduces the high frequency AC circulating currents in the system.

The resulting performance after the input inductors were added is shown in Figure 2(b).

The overall ripple amplitude is significantly reduced, with a corresponding reduction in the lower frequency modulation of the ripple current envelope. As a result, with input filter inductors, the amplitude of the input ripple current drops from 844 mA peak-to-peak to below 143 mA peak-to-peak.

Hence, it was observed that the circulating AC ripple current at the input of an array of nonsynchronized DC-DC converters can be substantially higher if no filtering is employed at the common input bus of this array of parallel converters. In fact, the AC ripple current can be substantial compared to the DC input current. However, by using simple input filtering, the AC input ripple can be significantly curtailed. Because V•IChip converters used in this example operate at higher fundamental switching frequencies (>1 MHz), smaller filtering components with lower losses were employed, compared to those required for lower switching frequency converters. This can be advantageous for systems where overall space, weight, and efficiency are at a premium.

Input filtering tames AC input ripple current

From the results depicted in Figure 2, it is obvious that input filtering plays an important role in significantly curbing the influence of beat frequencies in an array of switching DC-DC converters connected in parallel. Using simple input filter inductors, it is seen that the amplitude of the AC input ripple current in one of the bus converter modules – in an array of two high-input voltage 270 W DC-DC bus converters – was reduced by more than 80 percent. **MES**

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Power electronics designs trending smaller and more efficient

By John McHale, Editorial Director

Designers of power electronics components for the military market say business is steady, but they continue to be challenged to increase efficiencies while simultaneously shrinking component size. Meanwhile, in the space arena there is a move toward digital devices.

U.S. Air Force photo by Senior Airman Julianne Showalter

Procurement strategies in the defense world are embracing more open architectures and a greater use of COTS designs in new electronic systems and legacy upgrades. New Department of Defense (DoD) program requirements are also pushing for lower Size, Weight, Power, and Cost or SWaP-C.

Designing low-power systems is trickier than ever as military systems integrate high-energy commercial processors and components.

"Managing power is not a glamorous endeavor, but is essential as military electronics designers continue to add capability to platforms not originally designed to handle the energy that modern electronics expend," says Bud Jewett, Director of Business Development and Company Relationships at Crane Aerospace & Electronics in Lynnwood, WA. "Every design is unique with unique requirements for packaging, size, and weight.

"Military customers are looking for smaller, lighter, more efficient power devices with a lower total cost of ownership," Jewett continues.

There is a push from DoD customers for higher efficiency as well as a requirement for wider input voltage ranges and smaller sizes, says Kai Johnstad, Product Marketing Manager for Vicor in Andover, MA. "The usual things," he adds.

On the application side, the big push is toward unmanned systems, Johnstad continues. In the unmanned market, the demand for smaller power supplies is quite strong as platforms such as small Unmanned Aerial Vehicles (UAVs) continue to shrink, requiring unique size requirements for electronic components, he adds.

"More efficient power supplies also are going to be necessary for high energy producing applications such as high-powered jammers for long-range communications and directed energy weapons," Jewett says.

Custom versus COTS

"Many of the capability upgrades for existing military systems require unique size and weight considerations, which creates opportunities for designers of custom power solutions such as Crane," Jewett says. "The various form factor and weight requirements are not conducive to an off-the-shelf, one-size-fits-all solution."

Regarding custom versus COTS, a lot of those decisions depend on the expertise and comfort level of the customer, says Vicor's Johnstad. The primes have more expertise in design and will typically purchase modules they can design into their systems.

Weight can be just as important as form factor, because many platforms have weight thresholds that cannot be exceeded, Jewett says. Meeting these

Figure 1 | The Vicor MIL-COTS VI BRICK filter is a compact DC front-end module that can function as either a stand-alone device or be integrated with the company's 28 V MIL-COTS PRM.

requirements is challenging because military designs often do not factor in the power conversion considerations until later in the design process, he adds.

In an ideal world, the power design of a system would be laid out first, but that does not happen. Therefore, more customization is needed. If it is done at the last minute, designs become limited as to how much power can be saved.

Whether or not a customer needs a more complicated custom design or a COTS solution really depends on the expertise of the in-house system integrator, Johnstad says.

Many times, customization consists of ruggedizing brick-based designs, Johnstad says.

For more on custom designs by Crane and Vicor, visit at www.craneae.com and www.vicorpower.com.

A COTS product offered by Vicor is the MIL-COTS VI BRICK filter as a compact DC front-end module, either as stand-alone or integrated with the 28 V MIL-COTS PRM, which provides EMI filtering and transient protection, according to a Vicor release (Figure 1). The device meets conducted emission/conducted susceptibility per MIL-STD-461E and input transient surges per MIL-STD-704 or MIL-STD-1275.

Also on the COTS side, engineers at VPT Inc. released a new DC-DC converter for use in commercial avionics, military avionics, and other high-reliability power systems. The DVAB Series eliminates cross-regulation errors and has tightly controlled line and load regulation errors enabled by the use of two independent control loops, according to a company release.

VPT's avionics "customers demand long-term reliability with extremely tight performance metrics," says Michael J. Bosmann, Senior VP of VPT. For more information, visit www.vpt-inc.com.

Emerson Network Power's rugged small digital control devices are also getting design wins in commercial avionics and in-flight entertainment systems, says Shreek Raivadera, Marketing Communications manager at Emerson Network Power in Leicester, U.K. The IFE systems generate a phenomenal amount of power, he adds.

Emerson mostly focuses on the commercial market, but is looking to expand in the military and sees these devices as ideal for military applications such as radar and sonar as well as ground-based Command, Control, Communications, Computers, Intelligence Surveillance, and Reconnaissance (C4ISR) applications, Raivadera continues. The products have yet to go through an official mil-standard testing process, but internal testing shows they can handle the extreme requirements, Raivadera says. For more information, visit www.emersonnetworkpower.com.

Power electronics for space

Smaller size and lower weight requirements are also driving designs of power integrated circuits for space. Designers in this market segment also are seeing greater demand for digitization and standardization across different platforms.

The most common trends in the military space market are standardization, TOR compliance, improved performance, and increased demand for digital devices, says Fred Farris, Vice President of Sales and Marketing for International Rectifier's (IR's) HiRel Products in El Segundo, CA.

"Customers are interested in standardizing across platforms and payloads to reduce development time and cost, and this standardization is being flowed down to components and power supplies they purchase," Farris says.

Regarding TOR compliance, Farris says, "Many if not most of the military space programs today are requiring compliance to the TOR – reliability requirements for government space contracts that involve design, development, and test of spacecraft bus, payload, and launch vehicles.

The demand for digital devices also "is expected to climb as the needs for digital and signal processors onboard a spacecraft continue to rise," he continues. "Other performance trends see bus voltages continuing to increase while efficiency demands on power electronics increase as well."

One of International Rectifier's latest digital space power products is the GH Series of radiation-hardened (rad-hard) DC-DC converters (Figure 2). These devices are designed for onboard spacecraft applications with a mission life as long as 15 years. The series is targeted for designs that use new digital signal processors and FPGA technologies that require a supply voltage as low as 1.0 V. Other features include 18 V to 40 V input range, a Total Ionization Dose (TID) of more than 100 kilorads, and a weight of less than 110 g, according to an IR release. For more information, visit www.irf.com.

Vehicle power distribution

Vehicle power distribution

Military designers are getting smarter about how they manage power distribution in ground vehicles instead of just adding systems and components haphazardly, thinking only of improving capability.

Planning a power management approach is essential to improving efficiency, says Steve Goldman, Marketing Manager for Power Products and Motion Control Products at Data Device Corp. (DDC) in Bohemia, NY. Many times, users will add on capability to a system or vehicle before really thinking about how they efficiently manage power, he adds.

"This was basically the hard lesson learned in Iraq," Goldman continues. "Many ground vehicles systems were created *ad hoc* to defeat Improvised Explosive Devices (IEDs) and other situations. However, the users would just add on and stick gear into the vehicle without really considering how to manage the power."

Now military ground vehicle designers are planning better when it comes to power distribution from turret drives to C4ISR systems.

Power requirements go to different levels in vehicle – generally primary and secondary, Goldman says. "C4ISR is driven off [a] secondary power distribution system."

"The distinction between primary and secondary distribution can be somewhat vehicle dependent, but very high-power electrical loads, such as turret drives, would be part of the primary system," Goldman explains. "A weapon station may be powered off the primary or secondary distribution system."

DDC supplies products for both levels, he says. The company recently won a contract with Thales UK to provide solid-state controllers for secondary distribution for a C4ISR system.

"Solid-state power controllers improve reliability and reduce size, weight, and power in vehicle power systems," Goldman says. "Weight reduction is crucial as many systems have a fuel threshold and weight additions can be a drag on fuel consumption."

Thales UK is using the DDC 16-Channel Programmable Solid-State Power Controllers (SSPCs – see Sidebar Figure 1) for the UK Ministry of Defense's new Foxhound Light Protected Patrol Vehicle (LPPV). The module's programmability and multichannel capabilities were keys to the win as its role in supporting General Vehicle Architecture (GVA) conformance, according to a DDC release.

The RP-20161XXFC1 module replaces conventional circuit breakers, switches, and relays; increases system reliability; and reduces size, weight, and power. The device also enables automated load shedding and load prioritization. For more information, visit www.ddc-web.com.

In future designs, DDC engineers see opportunities related to the Army Victory program.

"Victory focuses on data networking and processing resources within military ground vehicles," Goldman says. "Gigabit Ethernet is the network fabric used, plus there are various network adapters for bridging GbE to other buses such as CAN, 1553, etc. With regard to power management, Victory will need to include a modular and scalable power distribution system to support the scalable vehicle processing and other mission electronics. That is the area where our SSPC products fit."

Sidebar Figure 1 | Thales UK is using the DDC 16-Channel Programmable Solid-State Power Controllers (SSPCs) for the UK Ministry of Defense's new Foxhound Light Protected Patrol Vehicle (LPPV).

Figure 2 | The GH Series of radiation-hardened (rad-hard) DC-DC converters from International Rectifier is designed for onboard spacecraft applications with a mission life as long as 15 years.

Figure 3 | The The VPX55-3 from North Atlantic Industries is a high power density 3U VPX power supply with a +28 Vdc input and six outputs (per VPX) at a total output power of 300 W.

VPX power solutions in demand

Board designers continue to see more requirements for ruggedization of power components and are also seeing more demand for VPX-related power supplies.

Over the past several years, there has been a demand for 3U CompactPCI power supplies, says Lou Garofolo, Product Manager at the Power Supply division of North Atlantic Industries in Bohemia, NY. North Atlantic has addressed this demand with their 55LQ and 55MQ product lines. "Most recently, we have seen the trend toward higher-density VPX power supplies that are designed per VITA standards – such as form factor, pinouts, and signaling. We are addressing this through our line of 3U and 6U VPX products with either DC or AC inputs."

"In the military, conduction-cooled power supply market, our customers are typically looking for fully integrated power solutions that include built-in EMI filtering and input transient protection, which require output power ride-through during severe input power transients that take place on military platforms," Garofolo says. "Today's smaller, lighter systems require high-efficiency power supplies in the highest power density possible."

Another trend Garofolo says he sees is for "intelligent power supplies, which can either report status through discrete signals or through detailed reporting via communication buses such as I^2C. Common requirements are for monitoring and/or reporting of input status, output voltage, output current, and temperature monitoring/shutdown. Along with intelligence, there are very often requirements for features such as inhibit/enable, current share, and holdup time.

North Atlantic's VPX product is the VPX55-3 (Figure 3), a high power density 3U VPX power supply with a +28 Vdc input and 6 outputs (per VPX) at a total output power of 300 W. The conduction-cooled device meets MIL-STD 461 EMI requirements when used with additional system filtering. For more information, visit www.naii.com. **MES**

Steady power electronics

Market for power electronics is steady

Designers of power electronics systems for military applications say the market is somewhat flat, but that opportunities will be available even if the Department of Defense follows through on major cuts to the budget.

"As for the looming possibility of large DoD budget cuts, since that won't impact any immediate programs, I think the market is taking a wait-and-see attitude, expecting that a compromise can be reached before any cuts of the proportions that have been proposed would be implemented," says Fred Farris, Vice President of Sales and Marketing for International Rectifier's (IR's) HiRel products.

"We see the market for military power supplies – in avionics; Intelligence, Surveillance, and Reconnaissance (ISR); and electronic warfare – as being flat, whereas other markets are declining," says Bud Jewett, Director of Business Development and Company Relationships at Crane Aerospace & Electronics. "Even if there are cuts, there will be opportunities when it comes to capability upgrades of existing systems for areas such as networking, surveillance, and reconnaissance."

There is a sense of nervousness and uncertainty, as no one knows what will happen regarding potential draconian cuts in defense spending, says Kai Johnstad, Product Marketing Manager at Vicor in Andover, MA. The U.S. and European budget situations are similar, as many European countries are cutting their defense budgets, he adds.

Even if some programs get cut, there could be opportunities for COTS suppliers of power electronics as there will be a push to upgrade existing systems such as the Bradley Fighting Vehicle.

In the space market, there is a similar apprehension regarding the immediate future.

"Certainly the overall market outlook has grown increasingly gloomy across many sectors," Farris says. "Our traditional markets are becoming more careful about placing orders out ahead of programs, which can be challenging as many piece parts continue to require long lead times to acquire them and test them to the new standards being required.

"Unlike 2008, where we only saw our commercial sectors business drop off, this time we are seeing more of a universal slowdown in demand, especially on new programs," Farris continues. "However, because the cancellation of newer programs typically means the extension of older programs, we aren't seeing the same level of drop-off that you might expect were you to look exclusively at what is being cut from budgets today."

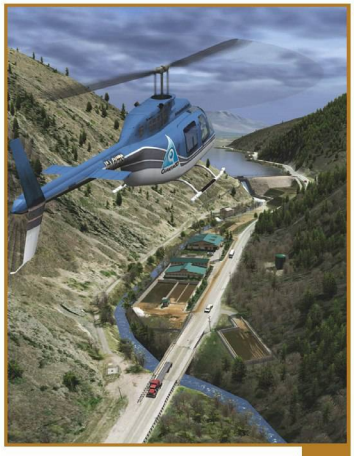
System streamlines the signal recording/playback paradigm

When it comes to military systems, a streamlined approach that delivers maximum functionality is the optimum approach – which is exactly why the RTR 2726 multiband playback and recording system from Pentek caught our eye. Specifically, the multiband system records and plays back high-bandwidth RF and IF [Intermediate Frequency] signals, while eliminating the requirement for spectrum analyzers or oscilloscopes. Of course, digital down- and up-converters are a mainstay in this system, and the record and playback channels' rates are impressive: 16-bit 200 MHz ADCs and 16-bit 800 MHZ DACs, respectively. Data streaming is sustained at 1,600 MBps traveling to and from storage: 4 TB housed in a RAID configuration and comprising eight hot-swappable SSDs.

Additionally, the signal playback/capture at 700 MHz-capable RTR 2726 – geared for rugged environments including ships, vehicles, and aircraft – offers data-file recording parameters, time stamping, and optional GPS. Tipping the scales at 30 lbs and measuring 16.9" (W) x 9.5" (D) x 13.4" (H), inside the box is the Windows 7 Professional operating system, in addition to a quad-core Intel Xeon processor. And one of the handiest features: A panel folds down in the front of this boxed system, which panel encases a 17" LCD monitor, touchpad, and full keyboard; or, conveniently, the box system can be operated and closed remotely, courtesy of a native Ethernet port.

Pentek | www.mil-embedded.com/p366555 | www.pentek.com

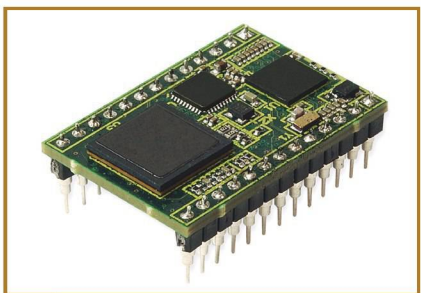
Mil simulation platform increases its flexibility



With increased platform flexibility on the military-embedded priority list these days, we were impressed by Quantum3D's recent move to take its Mantis Real-Time Scene Management simulation software into multi-platform style. Previously, Mantis required implementation on Quantum3D's Independence IDX image generators; however, the Mantis platform's flexibility has been expanded to desktop PCs and lets customers use the PC hardware they deem most suitable for their simulation applications. Meanwhile, Mantis will continue to offer the simulation application savvy it always has for ground vehicle or tank simulations, sensor simulation, rotary-wing flight simulation, mission rehearsal, and so on.

Useful in UAV trainers, cockpit/instrument education, and much more, Mantis renders high-resolution imagery depicting weather conditions (rain, dust, haze, fog, position of the sun), sensors, lighting, special effects (sparks, smoke, dust, vapor trails, noise, explosions, and more), and line-of-sight intersection and height-above-terrain tests. Configuration is a breeze because of Mantis' open standards base including Windows, an object-oriented architecture, C++, OpenGL API, TerraPage terrains and OpenFlight models, and CIGI host interface.

Quantum3D, Inc. | www.mil-embedded.com/p366556 | www.quantum3d.com



Mini stabilizer eases the UAV video shakes

Two things often come to mind when the topic of image/video stabilization arises: 1) the on-target yet ever-moving video streams taken by UAVs dotting the skies; and 2) 6U VME. If you've ever seen UAV footage, you know the picture can vibrate constantly. (Hey, it's not like UAVs never encounter turbulence or other environmental conditions that might cause them to shake a bit.) And then there's image stabilizer size: Though 6U VME has been a mainstay in the world of video tracking, smaller wares such as GE Intelligent Platforms' MIP3ES miniature image stabilizer are much more Size, Weight, and Power (SWaP) savvy. Indeed, measuring a mere 24 mm x 34 mm (pretty small, considering there are 25.4 mm in an inch), the microprocessor-sized stabilizer consumes only about 1.5 W while delivering real-time, high-performance video stabilization in COTS style.

Working as a stand-alone unit, the MIP3ES offers designers board-locale flexibility. Fully ruggedized, it also features composite video output and input, in addition to an RS-232 TTL serial port. The company says setup for the stabilizer – ideal for man-portable devices, video gimbals, and, as mentioned, UAVs – is easy. We'll have to take their word for it for now.

GE Intelligent Platforms | www.mil-embedded.com/p366557 | www.ge-ip.com

Signal generators aim to eliminate field tests

With the DoD tightening its belt and expecting suppliers to absorb many development costs these days, products like Rohde & Schwarz's R&S SMU200A signal generator topped with the company's R&S SMU-K77 signal generator "option" really come in handy. The main benefit, the company says, is that through the Dynamic Scenario Simulation the combination of generators performs, military radio comms performance can be validated – minus the costly flight tests in the field. Keeping the simulation indoors, the generator combination helps engineers see whether their comms equipment is up to par in harsh environmental conditions and factors in things like multipath signal propagation and dynamic fading.

The provided simulation ability encompasses the signal behavior of transmissions, and the R&S SMU-K77 simplifies this by giving users a list of predefined comms standards to choose from. Users can also create their own defined data lists and customize the modulation scheme. But it all goes back to root functionality of the generators. The R&S SMU200A can simulate a radio channel and also generate interferers and the desired waveform. It also supports high Doppler speeds. Meanwhile, the R&S SMU-K77 sticks to the task at hand primarily – simulations – of trajectory and vehicles, at-sea ship maneuvers, and tower-to-aircraft mode scenarios.

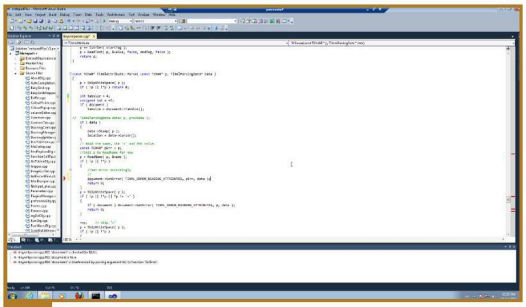
Rohde & Schwarz | www.mil-embedded.com/p366558 | www.rohde-schwarz.us

13U enclosure eases SIGINT, radar processing design

With applications such as SIGINT, radar processing, and image processing at the forefront of military embedded electronics, having those applications designed based upon an open standard such as OpenVPX (VITA 65) is a real boon to helping designers speed up development. Accordingly, the newly formed Curtiss-Wright Controls Defense Solutions (CWCDS) has announced the RME13CC (though it is apparently part of a Hybricon product line, far as we can tell) 13U OpenVPX conduction-cooled development chassis. Comprising 16 6U 1" payload card slots that also support rear transition modules, the chassis is tailored to meet the OpenVPX cooling and power requirements specified for 6U 150W conduction-cooled modules.

Further, the rack-mount enclosures can be powered via configurations providing as much as 3,750 W, suited to 5 V and 12 V payloads. Drilling down a bit, the chassis can be stored at -20 °C to + 70 °C, and altitude is up to 5,000 feet in accordance with VITA 65. Transmission takes place at 6.25 Gbaud, as specified by VITA 65 and VITA 68, and forced-air cooling also occurs, thanks to RME13CC's upper and lower fan trays.

Curtiss-Wright Controls Defense Solutions (CWCDS) | www.mil-embedded.com/p366559 | www.cwcembedded.com



Source code analysis as easy as a spell checker?

Software developers have enough on their plates without having to spend undue time analyzing their code. Sure, there is traditional source code analysis, whether done manually or by using techniques such as static or dynamic analysis, but Klocwork's Insight 9.5 is intriguing because it strays away from the centralized batch-processing analysis *modus operandi* and instead implements on-the-fly, as-it's-created code analysis: So as developers using C/C++ are writing their code, Insight 9.5 goes to work underlining possible code defects, which the company says looks like a spell checker on word processors. However, Insight 9.5 is doing much more than an ordinary spell checker behind the scenes: It's performing build comprehension, dataflow and syntax analysis, and incremental analysis continuously, and errors are flagged within milliseconds.

Besides the on-the-fly analysis, Insight 9.5, the latest version of Klocwork's Insight product, also includes on-the-fly reporting, incarnated thanks to a brand-new implementation based on HTML5. On-the-fly reporting comprises a Web reporting tool, new report templates, and a redesigned report creator. The latter two use drop-and-drag pivot chart capabilities. And finally, there's Insight 9.5's on-the-fly impact analysis, which looks at possible coding issues across multiple projects and systems, to help save developers from dealing with the same issue again and again as they work with different reused code bases.

Klocwork | www.mil-embedded.com/p366560 | www.klocwork.com

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