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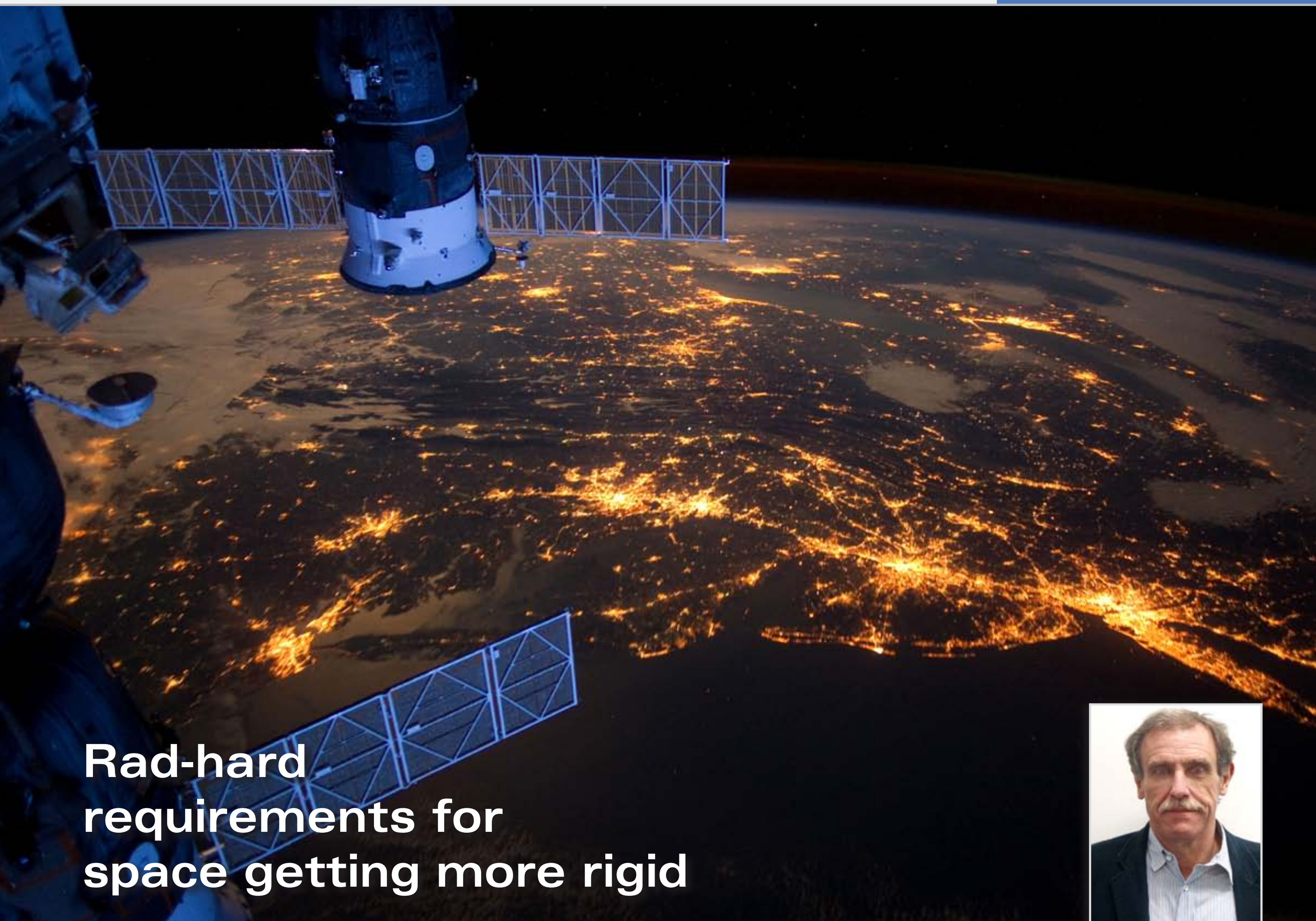

Rad-hard requirements for space getting more rigid

Trends in radiation-hardened electronics testing shape future designs
By Jay Kuehny, Crane Aerospace & Electronics

Export compliance reforms on the way for aircraft & satellite suppliers

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ON THE COVER:

Top photo: An Expedition 30 crew member took this nighttime photograph of a portion of the U.S. Atlantic coast from the International Space Station. Photo courtesy of NASA.

Bottom photo: Five U.S. Air Force C-130 Hercules cargo aircraft line up before taking off during readiness week at Yokota Air Base, Japan, on Feb. 21, 2013. DoD photo by Senior Airman Cody H. Ramirez, U.S. Air Force.

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Government-funded rad-hard fabs fading away

By John McHale, Editorial Director

Back in 2002 tempers were flying in the radiation-hardened (rad-hard) electronics community over government funding of rad-hard semiconductor fabrication (fabs) foundries owned by BAE Systems in Manassas, VA, and Honeywell Microelectronics in Plymouth, MN. While covering the story back then for another publication, I received a few "no comment" responses and had one government source hang up on me. But I also had others who risked the ire of their main customer – the U.S. Department of Defense (DoD) – to speak about what they thought was an unfair practice.

In 2002, competitors to BAE Systems and Honeywell were angry, saying that the government was essentially funding their rivals – at more than $100 million each to keep their fabs alive. The government countered that certain rad-hard technology produced at these fabs was essential to national security as it was used on military satellites and spacecraft. It's no secret that rad-hard fabs have struggled to be profitable because of the low-volume nature of the military space market. Semiconductor fabs can be money pits. Many commercial semiconductor companies have since abandoned their fabs because of exorbitant operating costs. Well, now more than a decade later, market conditions are forcing BAE Systems to do the same.

"BAE Systems' Electronic Systems Sector is initiating the transition to a 'fabless' radiation-hardened electronics business model, [having begun] the transition of wafer production on Nov. 15, 2012," according to the company's official statement. "The demand needed to sustain wafer production in-house at our foundry is not present in the current market. By working with other commercial foundries to produce these products, BAE Systems will be able to save costs for the company and address the demands of future space systems. BAE Systems will continue to operate its space electronics business out of the Manassas facility and no change will take place to the core capabilities there, which include: space computer and subsystem design, ASIC and circuit design, computer/board/box manufacturing, component packing and electrical testing, and radiation testing and failure analysis."

"It's no secret that rad-hard fabs have struggled to be profitable because of the low-volume nature of the military space market."

This does not come as a surprise to many in the rad-hard community, who always thought the government had blinders on when it came to understanding the business side of the equation. However, today, these fabs are not the only game in town for strategic rad-hard technology. Many semiconductor companies are partnering with commercial foundries to produce extreme rad-hard parts through the hardening-by-design process.

"The expensive captive fabrication facilities cannot be maintained nor cost investments justified for radiation-hardened products," says Dan King, President of King Space Research in Albuquerque, NM. "Most vendors already have gone to business models where they have a partnership with commercial manufacturers for front end of line production. The commercial fabrication sector is suffering with the same issues, as fabrication facilities can run in the billions of dollars for the tooling. The government funding forced BAE Systems to follow the government model when BAE Systems was already starting to use hardening-by-design techniques with IBM's foundry. They had to change their business model to redirect resources to apply government funding for an in-house solution and in the end, that fab was not cost-effective investment. BAE Systems is back to the prior model of fab partnership.

"Manassas and Honeywell have significant board/box level processor development capabilities and ASIC compatibilities with commercial partners," King continues. "There really is not a cost-effective ASIC solution for the low quantities required for space. Structured ASIC and various gate array variants are still trying to capture this market, while there is still room for the FPGAs to capture the low-cost niche or vendors with a low-cost FPGA-to-ASIC conversion flow."

Working with high-volume commercial foundries can also improve product quality and reduce risk. "Some military devices are being fabricated on an old semiconductor process at boutique fabs that do not run in volume anymore," says Jim Kemelring, CTO with Triad Semiconductor in Winston-Salem, NC. "If you fabricate through a big fab on a popular process that is running 10,000 wafers a month, you are running on a process that is well in control with devices that yield high and are reliable."

The military rad-hard market – thanks to DoD budget cuts and slow growth – will not be a high-volume market any time soon. However, export reform coming out of the Obama Administration might free space semiconductor companies to do more business internationally. For more on export reform see the Special Report on page 20. For more on rad-hard technology and market trends, see our Mil Tech Trends section starting on page 26. DoD budget coverage can be found on page 10.

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Shrinking DoD budget still has funding for aircraft upgrades

By John McHale, Editorial Director

The President's Fiscal Year 2014 budget request for the Department of Defense is down as expected in procurement and Research, Development, Test, and Evaluation (RDT&E) funding. However, funding still exists for Intelligence, Surveillance, and Reconnaissance (ISR), electronic warfare, and avionics retrofits and modernizations.

The FY 2014 DoD budget request calls for continued funding of the H-1 Helicopter program, which includes the UH-1Y helicopter (pictured) – a replacement for the UH-1N Huey. Photo courtesy of Bell Helicopter.

Slow, stagnant, disappointing, worrisome – all of these adjectives could describe the Obama Administration's Fiscal Year (FY) 2014 budget request for the Department of Defense (DoD). Funding reductions coupled with sequestration woes have put a gloom over the industry. Uncertainty also remains as to when sequestration will end, putting at risk key DoD infrastructures. However, when new programs are canceled or put on hold, it does create opportunities in platform upgrades and modernizations, necessary to keep current aircraft and ground vehicles alive for a few more years.

The FY 2014 for the Department of Defense is $526.6 billion, down about $0.9 billion from the FY 2013 budget request of $527.5 billion. The FY 2014 acquisition funding request for the Department of Defense (DoD) is $167.6 billion, of which $99.3 billion is for procurement-funded and $67.6 billion is for Research, Development, Test, and Evaluation (RDT&E)-funded programs. Of this amount, $69.4 billion is set for Major Defense Acquisition Programs (MDAP). MDAP aircraft funding decreased from $47.6 billion in the FY 2013 to $45.5 billion in FY 2014.

Modernization programs being funded in the FY 2014 budget request include the F-22 Raptor, the F-15 Eagle, the H-1 Helicopter, and the Abrams tank. These upgrades have funding for enhancements to radar, signals intelligence, avionics, and vetronics systems, all of which leverage embedded computing systems. Below are some MDAP aircraft and ground vehicle highlights from this year's budget request.

Fixed wing aircraft

Funding and procurement of the F-35 Joint Strike Fighter (JSF) continues in FY 2014 with a total of 29 aircraft: four Carrier Variants for the Navy, six Short Take-Off Vertical Landing (STOVL) variants for the Marine Corps, and 19 Conventional Take-Off and Landing (CTOL) variants for the Air Force. Total Navy funding for the JSF increased in FY 2014 to $2.778 billion from $2.583 billion in FY 2013. Air Force funding also is slightly up at $3.582 billion for FY 2014 over $3.565 billion in FY 2013.

For FY 2014 the F-22 modernization will add an initial ground attack kill chain capability through emitter-based geolocation of threat systems, ground-looking synthetic aperture radar modes, electronic attack capability, and the initial integration of the Small Diameter Bomb (SDB-1). Total procurement for the F-22 is $285.8 million for FY 2014, essentially flat compared to FY 2013 funding.

Funding of 21 EA-18G Growler electronic attack aircraft is provided for in the FY 2014 request at $2 billion – about twice the 2013 request of $1.027 billion. Five E-2D Advanced Hawkeye (AHE) airborne early warning aircraft are to

be procured in FY 2014 at $1.247 billion, an increase over FY 2013 funding of $984.7 million.

The F-15E Radar Modernization Program (RMP) and F-15C/D radar upgrade programs will continue in FY 2014. RDT&E funding for the F-15E is $244.3 million in FY 2014, an increase of $49.6 million over FY 2013, with procurement for FY 2014 at $354.6 million – more than double the FY 2013 funding of $148.6 million.

Rotorcraft

The H-1 Helicopter Upgrade program consists of new build aircraft and remanufacturing efforts that convert AH-1W Super Cobra and UH-1N Huey helicopters to the AH-1Z and UH-1Y versions respectively. For FY 2014 the DoD is looking to produce 25 aircraft – 15 UH-1Y new build aircraft and 10 new build AH-1Z aircraft. Development funds will provide for follow-on improvements to sensors and weapons integration, avionics, and air vehicle components. The total procurement request for FY 2014 is $821 million.

The Combat Rescue Helicopter (CRH) Program, formerly referred to as the HH-60 Recapitalization, will replace the Air Force HH-60G Pave Hawk. Development funding for FY 2014 supports the second lot of two aircraft for Engineering, Manufacturing, and Development (EMD) activities. RDT&E funding for this program in FY 2014 increases to $395.6 million from $123.2 million in FY 2013.

DoD also is looking to procure 65 UH-60L Black Hawks for $1.163 billion in FY 2014 as part of a continuation of a five-year Multiyear Procurement (MYP) contract for FYs 2012-2016. FY 2014 funding also supports continued development and testing of digital upgrades to the UH-60L. In FY 2013, 59 Black Hawks were acquired.

The remanufacture of 42 AH-64D aircraft to the AH-64E Apache configuration is supported in FY 2014 at $759.4 billion – an increase over FY 2013 funding of $648.8 million.

Eighteen MV-22 Osprey are provided in FY 2014 for the Navy/Marine Corps and 3 CV-22 aircraft for Air Force-U.S. Special Operations Command (SOCOM). The request is based on the second year of a follow-on five-year multiyear procurement contract for FYs 2013 to 2017.

Unmanned aircraft

FY 2014 funds upgrades to system hardware and performance-based logistics support for the RQ-7 Shadow; procures upgrades and provides training and contractor logistics support for the RQ-11 Raven; and procures 25 RQ-21 Small Tactical Unmanned Air System (STUAS) air vehicles. Total FY 2014 procurement for all three is $228.4 million, up from $211.4 million in FY 2013.

The Global Hawk is set for continued funding for its Block 40, ground station, and Multi-Platform Radar Technology Insertion programs. Procurement funding for the high-altitude drone decreases in FY 2014 to $773 million from $1.103 billion in FY 2013.

The development, transformation, and fielding of Reaper aircraft and ground stations is continued in FY 2014 to support the requirement to field and sustain 65 Combat Air Patrols (CAP)/orbits. The FY 2014 request supports the procurement of 12 aircraft and 12 fixed ground control stations at $506.7 billion, less than half of what was spent in FY 2013 at $1.040 billion for 24 aircraft.

For the Predator, Air Force and SOCOM modifications will continue. For Gray Eagle, the Army continues development and integration of the Universal Ground Control Station, a ground based sense-and-avoid system, and a SIGINT capability. The DoD is looking to procure 15 Gray Eagle aircraft and three modular platoon sets of equipment in FY 2014. Total Predator/Gray Eagle funding for FY 2014 is $646.5 billion, down from $784.5 billion in FY 2013.

Ground programs

In an era where the U.S. is scaling back its military footprint abroad, ground vehicle programs will typically see funding cuts. The FY 2014 request calls for a decrease in procurement of the Heavy and Medium Tactical Vehicles – down to $36 million and $226 million respectively in FY 2014 from $58.1 and $377.4 million in FY 2013.

The M1A2 Abrams tank program will have support for modifications and upgrades in FY 2014 funding. It also procures modifications to fielded M1A2 Abrams tanks, such as the Data Distribution Unit the Commander's Remote Operating Weapon Station (CROWS). FY 2014 funding for this upgrade is $279 million, down from $300.8 million in FY 2013.

The Joint Light Tactical Vehicle (JLTV), a joint program currently in development for the Army and Marine Corps to replace the High Mobility Multipurpose Wheeled Vehicle (HMMWV), has its FY 2014 funding provided at $134.6 million, an increase over $116.8 in FY 2013.

The Ground Combat Vehicle (GCV), which is slated to replace Bradley Infantry Fighting Vehicles, will see funding decrease from $639.9 million in 2013 to $592.2 million in FY 2014. The GCV will transition to the EMD phase in late FY 2014. **MES**

CPU bypass: Critical signal processing operation

By Charlotte Adams

A GE Intelligent Platforms perspective on embedded military electronics trends

General-Purpose computing on Graphics Processing Units (GPGPU), using massively parallel GPUs to execute thousands of math instructions simultaneously and repetitively, is a boon to signal processing. But its use in real-time scenarios has been limited by the traditional involvement of the Central Processing Unit (CPU) in Direct Memory Access (DMA) transactions.

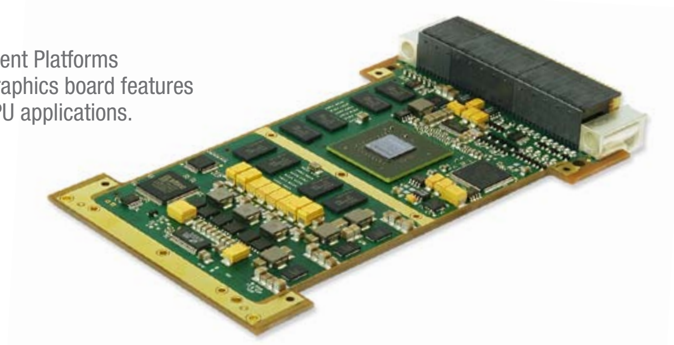

Figure 1 | The GE Intelligent Platforms GRA112 3U VPX rugged graphics board features GPUDirect RDMA for GPGPU applications.

The CPU – the heart and brains of a processing system – also can slow the system down. If the CPU has to be involved each time a data aggregator like an FPGA wants to send data to a GPU, it's obvious that system latency increases, efficiency decreases, and system size and capability are severely limited. How would a wide area surveillance system with hundreds of imagers and multiple GPUs get target data to ground troops on time? Even more challenging, how would an aircraft Electronic Warfare (EW) system squeeze out its jamming signal in time to foil tracking radars in hostile airspace?

What's needed is a "CPU bypass" operation, a method of data transfer – in the context of PCI Express (PCIe) – that limits, or even eliminates, the continuous involvement of the CPU in GPGPU processing. Just as coronary bypass surgery relieves the cardiac stress of clogged arteries, so a new GPU technology relieves clogged CPUs and enables GPGPU computing to serve those sensor processing applications for which it is best suited, even those with zero tolerance for latency.

A better way

Before the CPU bypass technology emerged, getting data from an FPGA into GPU memory was a roundabout process. A PCIe device first sent data into system memory via the CPU's Memory Management Unit (MMU); the GPU then transferred the data from system memory to GPU memory. This indirect path to GPU memory added processing latency, consumed system memory bandwidth, and decreased CPU efficiency.

The new technology, GPUDirect Remote DMA (RDMA), changes this paradigm by extending DMA capability from the PCIe end points to GPU memory. Although the process uses the GPU's MMU, it consumes no GPU cycles.

Asymmetric benefits

GPUDirect RDMA, by reducing CPU involvement in GPGPU processing, radically reduces latency. Delays can drop from 1 millisecond to as low as 50 microseconds, a decrease of 95 percent. At the same time throughput can multiply, as the unclogged CPU can manage more GPUs. The CPU now can handle as many as 16 GPUs versus a practical limit of two GPUs before.

With GPUDirect RDMA, the CPU still sets up the initial data flow from the end point to the GPU. But then the CPU can step aside and perform other operations. In a typical image processing application, for example, the GPU identifies potential moving targets in the image and gives the CPU a list of possibilities. The CPU then applies complex conditional logic to deduce probable targets in the list and initiates a transmission to a ground station.

In an EW application, however, there might not be time for the CPU to perform postprocessing tasks. In fact, the CPU might not get involved at all. The GPU could process a high volume of RF data samples from an FPGA or other sensor data collector, create the jamming signal, and send it back to the FPGA for transmission without consulting the CPU.

The key to GPUDirect RDMA is the addition of a second Base Address Register (BAR) in the PCIe end points that is dedicated to high-speed, high-volume data transfers. The CPU uses the first BAR for chores like checking the status of an end point. The second BAR, however, is larger and faster than the first, and is hooked directly to the GPU. It acts like a window into the GPU, enabling an FPGA or other I/O device to forward sensor data directly to GPU memory without GPU overhead.

One of the first products to exploit GPUDirect RDMA is the GE Intelligent Platforms GRA112, a 3U VPX graphics card with the 384-core NVIDIA Kepler GPU implemented in individually soldered subcomponents to optimize ruggedization, cooling, and processing performance.

Heartsease

For real-time sensor processing applications, the benefits of the CPU bypass operation are huge. Latency plummets, GPU efficiency soars, the CPU is free to pursue other tasks, and applications previously considered to be beyond the ken of GPGPU come distinctly into view.

defense.ge-ip.com

The year of 40 GbE

By Steve Edwards
An industry perspective from Curtiss-Wright Controls Defense Solutions

System architects face many challenges in designing the next generation of ISR systems. They must keep up with the ever increasing amount of sensor data, follow an open systems approach, and make sure that the technology has a future road map. 40 GbE fulfills all of these objectives, making it the logical choice for the next-generation protocol. Ethernet has the most widely supported ecosystem of any protocol, with a clear road map to 100 GbE and beyond. RDMA over 40 GbE means both low latency and low CPU overhead, providing the performance needed for ISR applications.

Optimizing high-performance embedded COTS systems' design for demanding C4ISR and EW applications such as SIGINT, radar, and image processing will likely always be a balancing act between processing performance and I/O limits. In the commercial market, there tends to be a seesaw effect as one of these factors makes a significant leap forward, followed by the other catching up to help ensure that the available processing or data bandwidth can be fully exploited and to ensure that wasteful system bottlenecks don't occur. Later this year, the COTS community will experience another such leap forward as we start to see the first products designed for rugged defense and aerospace applications featuring 40 GbE support entering the market.

Double the I/O bandwidth

40 GbE will effectively double the speed of the in-system I/O on embedded COTS systems. In fact, benchmark data now shows that 40 GbE will deliver between 2x and 2.5x the performance of Serial RapidIO Gen 2, consistent with expectations from the increase in speed from 5 Gbaud to 10 Gbaud signaling. And the military market open standards activities are ensuring that the infrastructure is put in place to support the use of 40 GbE in OpenVPX systems. To make sure that the COTS market can take full advantage of the coming performance boost, the VITA community, through its VITA 65 working group, is currently considering multiple new proposals that define OpenVPX profiles for 40 GbE. Customers are already showing interest. Expect to see 40 GbE supported on products from a number of COTS vendors later this year. In fact, Curtiss-Wright plans to announce a number of new products with support for 40 GbE in the near future.

"40 GbE will effectively double the speed of the in-system I/O on embedded COTS systems. In fact, benchmark data now shows that 40 GbE will deliver between 2x and 2.5x the performance of Serial RapidIO Gen 2, consistent with expectations from the increase in speed from 5 Gbaud to 10 Gbaud signaling. "

Leveraging HPC protocols

To take full advantage of the performance that 40 GbE offers to new COTS system designs, COTS product designers are leveraging work that has been previously done in the commercial High Performance Computing (HPC) market. HPC system designers commonly use Remote Direct Memory Access (RDMA) to provide memory-to-memory transfers; RDMA reduces latency and processor overhead for various network protocols such as InfiniBand, Serial RapidIO, and Ethernet. The Open Fabrics Alliance's Open Fabrics Enterprise Distribution (OFED) open source software provides 40 GbE hardware with RDMA capability. OFED provides a device driver layer that largely abstracts RDMA functions, greatly improving data transfers of other higher-level middleware such as MPI and uDAPL. Using OFED can make system integration for HPEC systems, which typically involves heterogeneous hardware and software elements, both simpler and more effective. OFED supports multiple fabrics such as Ethernet, Serial RapidIO, and InfiniBand.

Native Intel support for 40 GbE

Another benefit that 40 GbE brings to new military COTS systems is its native support by Intel Architecture processors. The latest Intel processors feature PCI Express Gen 3 that hooks directly to a 40 GbE NIC, and these processors have Linux driver support for Serial RapidIO, making implementation of 40 GbE much easier. Ethernet also boasts the advantage of familiarity. While 40 GbE will likely find its biggest use as a system backbone in rugged embedded systems, rather than as an end point like GbE, the fact that most users will already be very familiar with the basics of the protocol will provide customers with a high comfort level.

40 GbE benefits COTS community

The move to 40 GbE highlights how the COTS community benefits from its open standards approach. Through the work of standards bodies such as the VSO, military system designers stay well positioned with the processes and flexibility needed to quickly leverage significant technology advances in the commercial world.

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OS consolidation: The next step in hypervisors

By Raj Johnson and Marianne Loes

There are many reasons why military embedded systems become obsolete. Sometimes it's because vendors stop supplying required hardware or supporting certain operating systems or versions. Other times it's because of changes in the development team, leading to a loss of engineers who know the software's inner workings and how to maintain it.

Many teams turn to hypervisor solutions to extend the life of legacy military embedded systems by hosting them on newer computing platforms. However, these solutions make it difficult for software engineers to continue developing the application moving forward. This is because the environment has now become more complex with a variety of integration and communication issues. The increased complexity is also because more OS platforms are added, each requiring special development tools.

These teams should take the next step and consolidate their applications to a single operating system to simplify development, reduce bill-of-material costs, and utilize the system resources effectively. There are many issues that are resolved when consolidating to a single operating system, which will be addressed later in this discussion. However, we first need to understand more about next-generation hypervisors.

What is a next-generation hypervisor?

Typical hypervisors for embedded military applications allow for running applications on multiple OSs on a single hardware platform. The next-generation hypervisor goes one step further by eliminating the need for multiple operating systems by providing the OS functionalities required by the applications. Next-generation hypervisors are able to accomplish this by reading the application's source code and generating the code needed to compile the application for the new single OS using native tools. Figure 1 illustrates next-generation hypervisors.

Next-generation hypervisors are able to eliminate the middleman by providing OS services that enable hosting the application across multiple operating system platforms. This design ensures that applications are not locked into a particular OS platform. These hypervisors are redefining virtualization from wrapper-based implementations to source-level virtualization, thereby bypassing multiple layers of OS and hypervisor schedulers. They also provide pools of reusable static resources (for example, threads, timers, queues, and so on) that improve performance by eliminating the dynamic creation and deletion of resources.

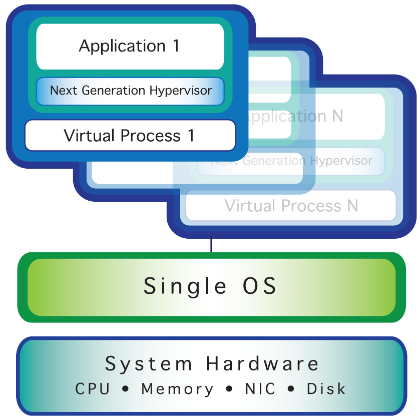

Figure 1 | Next-generation hypervisors

OS consolidation solves issues

There are many reasons for consolidating applications to one OS. These are four of the top reasons:

Simpler development: Consolidating to one OS allows for streamlining the development to include one set of tools, device drivers, and BSPs.

Cost savings: Eliminating the extra OSs will decrease overall development costs. Once a budget includes costs for only one OS and related tools, teams will see immediate savings and a reduction in maintenance requirements.

Integration of applications: Migrating legacy applications to a single platform allows for more efficient communication and a tighter integration of the applications. Applications can communicate with each other through direct data transfer via shared memory rather than using physical or simulated devices. A typical hypervisor solution does not provide such a mechanism.

Better performance: One of the more important reasons to choose a next-generation hypervisor is performance. When all applications are running natively on one OS platform, engineers will have greater source-level control for performance optimization. Consolidating to one OS also means your system needs to set aside fewer OS resources. In addition, CPU resources can be dedicated to a single application utilizing the SMP features offered by the target OS.

OS consolidation wrap-up

Many developers may have concerns when considering consolidating all of their applications to one operating system platform. They might think they are exposing their systems to risk by putting all of their eggs in one basket and locking their code to one particular OS. They may also worry about the work involved in porting various applications to a single OS. However, these issues are easily solved with next-generation hypervisors such as the Cross-OS Hypervisor from MapuSoft Technologies, which provides a way for applications written to various OSs to be consolidated to one OS without manual porting effort. In addition, the applications can easily be moved to different OS platforms in the future.

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DEFENSE TECH WIRE

NEWS | TRENDS | DOD SPENDS | CONTRACTS | TECHNOLOGY UPDATES

By Sharon Hess, Managing Editor

NEWS

BAE Systems awarded two U.S. Army mods

The U.S. Army recently awarded a duo of contract modifications to BAE Systems Land and Armaments LP. First, a modification was awarded to the Sterling Heights, MI business to add six more months to the development phase for ground combat vehicle technology, at a $159.5 million maximum value. Second, a nearly $29 million modification awarded to the York, PA business calls for M88A2 Heavy Equipment Recovery Combat Utility Lift & Evacuation System (HERCULES) vehicles procurement (Figure 1). Work under the second modification is slated for completion in March 2014 in York, PA. The contracting activity for both modifications is the Army Contracting Command in Warren, MI.

Figure 1 | U.S. Army/BAE Systems contract mods provide extended development for ground combat vehicle technology in addition to M88A2 procurement. U.S. Army M88A2 photo by Sgt. 1st Class Kap Kim, 2nd BCT, 1st Cav. Div. Public Affairs

Northrop Grumman to render E-2D Advanced Hawkeye software support

The U.S. Navy recently awarded Northrop Grumman Systems Corp. in Bethpage, NY a $23 million delivery order against a previously issued basic order agreement to provide all aspects of E-2D Advanced Hawkeye (Figure 2) software sustainment support for Full Rate Production Lot 1. The delivery order comprises software management support for the weapons system, aircraft software, and subsystem. Work occurs in Bethpage, NY; Syracuse, NY; Marlborough, MA; Greenlawn, NY; and Woodland Hills, CA. Work is anticipated for completion in October 2014. The contracting activity is the Naval Air Systems Command in Patuxent River, MD.

Figure 2 | Northrop Grumman will provide all aspects of E-2D Advanced Hawkeye software support for Full Rate Production Lot 1 per a $23 million delivery order. Photo courtesy of Northrop Grumman

Raytheon to provide 19 D-RAPCONs to USAF

The USAF recently awarded Raytheon Co. in Marlborough, MA a $50.6 million cost-reimbursement contract to provide 19 of its D-RAPCON systems, described by the company as an "air traffic control system in a box." D-RAPCON comprises both secondary and primary ATC radars that have secure networked data communications, a VHF/UHF ATC voice communications system, an autonomous deployable ATC ops center, and a rapid setup radar antenna integrated. Providing instant, fully mobile air traffic control to disaster sites or the military theater, D-RAPCON renders enroute surveillance/control with an expeditionary terminal approach for civil, coalition, and joint aircraft globally. Work under the contract occurs in Massachusetts and is slated for completion in December 2016. The contracting activity is the Air Force Life Cycle Management Center/HBAK, Hanscom AFB in Massachusetts.

Figure 3 | A $7.8 million U.S. Navy/Insitu, Inc. mod provides ScanEagle maintenance/operations for Operation Enduring Freedom and other OCONUS ops. U.S. Navy photo by Photographer's Mate 2nd Class Daniel J. McLain

ScanEagle UAS contract mod means more operations, maintenance

ScanEagle Unmanned Aerial Systems (UASs) (see Figure 3) will soon benefit from a $7.8 million U.S. Navy contract modification awarded to Insitu, Inc. in Bingen, WA. The modification calls for maintenance and operational services, including mid-wave IR and Electro-Optical/Infrared (EO/IR) imagery for land-based operations real-time data and imagery for Operation Enduring Freedom in addition to other overseas ops. Work is slated to occur in Bingen, WA by March 2014. The contracting activity is the Naval Air Systems Command in Patuxent River, MD. Meanwhile, ScanEagle is designed to render persistent ISR data, comms relay, and/or battlefield damage assessment. A standard ScanEagle payload is an IR camera or an inertial stabilized EO/IR camera.

VIDEO

F-35B Lightning II undergoes first nocturnal test

Lockheed Martin recently released a short video of the first nighttime test of an F-35B Lightning II's Short Takeoff (STO) and Vertical Landing (VL) capabilities. The test's primary goal was to glean data about lighting conditions and the helmet during F-35B nocturnal operations. The test was part of an event series designed to prep the aircraft for number 2 of 3 at-sea test sessions that will occur while the development program is underway. The F-35B is an iteration of Lightning II developed for U.S. Marine Corps use, in addition to utilization by Italy and the U.K.

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MARKET PULSE

WHITE PAPER: Characterisation of Boundary Conditions for an Aircraft Engine Electronic Control Unit

By Dr. Nathalie Kopp, Mentor Graphics Corporation
Jean-Yves Soulier, Mentor Graphics Corporation

In this paper, we present the first part of the thermal analysis performed on an aircraft engine Electronic Control Unit (ECU) installed in the engine environment. The ECU is mounted on the engine in a forced convection environment. Attached to one side of the chassis, there is a cooling circuit providing an additional cooling air coming from a scoop.

A preliminary analysis without cooling air has been necessary to simulate the environment as it is specified by the engine manufacturer: We have determined the ambient airflow rate, which produces the specified ambient heat transfer. Then in a second model, a cooling airflow expressed in lbs/s has been added. The FLOTHERM model has therefore allowed us to study the behaviour of mixed airflows, and to simulate other configurations in terms of geometry or cooling airflow rate. On another hand, we have determined the boundary conditions to be applied on each face or defined areas of the chassis in the detailed ECU model.

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E-CAST

Learn about the Intel Haswell processor:

New Intel Core Processor – Big Performance, Low Power

Presented by: Intel, Advantech, Portwell

The future 4th generation Intel Core processor family (code-named Haswell) pushes the envelope on performance, graphics, security, as well as lower power, creating a platform that can take embedded designs to the next level. In this webinar we will examine the new Haswell features, highlight use cases, and show how developers can use off-the-shelf hardware and software to speed their own designs to market.

June 20, 2013, 11:00 AM EDT

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BLOG

Ada watch: Getting the right programming language for the job

By Greg Gicca, AdaCore

Ada is a strongly typed language that is a natural choice for developing high-reliability programs. Some languages such as C are good at low-level programming but not for solving other challenges. You need to choose the right tool for the job. Instead of using one language or one tool for every problem, you should provide engineers with multiple options for developing high-reliability software – which is where Ada shines.

We can illustrate this via a high-level perspective, without diving into specific language details and individual preferences. The first step is to look at how a strongly typed language can avoid hard-to-detect errors and incorrect program operation.

Advantages of Ada for high-reliability applications

Many of Ada's high-reliability software development features are not unique to Ada and might be found in a variety of other (strongly typed) programming languages. What makes Ada unique is that all of these features are found in a single programming language.

Ada is strongly typed. In a simple sense, this means that variables, constants, or objects must be declared before they are used. However, it also allows the language (compiler) to statically check the validity of the use of such identifiers.

An interesting effect of this design feature is that typos and misspellings can be detected as mistakes and flagged for the developer. Any human-writing endeavor will have errors and as the size of the total writing effort increases, so will the number of mistakes. Since many misspellings look correct to the casual observer (or they wouldn't have happened in the first place), having the language detect these is extremely valuable.

Let's say the programmer intends to calculate a vehicle Location "L" as a real number and is using an integer Index "I" for another purpose. In Ada, if the variable "I" is used instead of "L" it will be flagged as an incorrect type for the operation. In C, the Index "I" will be implicitly converted ("cast") to a real value in the expression, introducing a bug. Simple mistakes like this can remain hidden, be difficult to discover, and have insidious changes in the expected meaning of the software. For example, "Location" was expected to be the vehicle location at this point in the program, but Index "I" is something unrelated.

Ada supports the concept of separation of program specification from implementation. The language supports the definition of a program specification that is visible and callable by outside program units. This defines the name of the unit or subprogram as well as its parameters, their types, and so on. The specification is made visible to callers using the "with" construct. The implementation, or body, may be in a separate file and contain the full algorithmic implementation of the specification. This unit is always semantically invisible to callers. Thus, internal details of the algorithm cannot be altered by a caller.

This is a critical feature of the Ada language in that collections of units may be developed, tested, and verified individually without worry of side effects occurring when they are combined. This allows for building layered or component architectures in a safe and scalable way. Ada has additional functionality in this area, but this basic concept is critical for developing high-reliability applications. Other languages with a "#Include" style feature semantically "include" the source text of the referenced unit into the source of the referencing/calling unit. This makes all internal details visible to the caller and allows for accidental or purposeful side effects to take place. In small programs it may be possible to manually detect manipulation of these internal details. The reader can see that a typo in the caller may accidentally reference and change an internal value within the called unit. (The developer typed an "X" that is not declared locally, but ends up referencing "X" in the unit being included.) Once again, in larger programs simple references like this can remain hidden, be difficult to discover, and have insidious changes in the expected meaning of the software.

By combining these two simple features, the language can also check to see if two identifiers can be used together in an expression. Assuming two variables "A" and "B" declared as:

- A and B are of Integer types
- A is an Integer and B is of a Color type

Plus ("+") is a subprogram with a defined number of parameter inputs, of a certain type, with a specific return value type. Is there an operation "+" for 1 "+" 1 (A+B)? Is there an operation "+" for 1 "+" BLUE (A+B)? In the case of the C language, both of these expressions are likely to be valid, but what do they mean? In the case of Ada, the first expression is valid but the second is not. Again, such errors are caught early in the development life cycle where they are easily and cheaply found and corrected.

I've outlined just a few of the high-level advantages of some very basic features of Ada so that it can be understood at an intuitive level why these make programs easier to develop without errors. The Ada language has many more features that can aid in developing high-reliability programs, and I encourage you to explore and test them for yourselves.

To become a guest blogger for mil-embedded.com, email Editorial Director John McHale at jmchale@opensystemsmedia.com.

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The pulse of innovation

Export compliance reforms on the way for aircraft & satellite suppliers

By John McHale, Editorial Director

U.S. export compliance regulations such as the International Traffic in Arms Regulations (ITAR), set in place to protect national security, have also handcuffed American defense electronics suppliers – preventing them from competing internationally. New reforms coming out of the Obama Administration promise to loosen those controls for non-combat related aircraft and commercial satellite related items.

Five U.S. Air Force C-130 Hercules cargo aircraft line up before taking off during readiness week at Yokota Air Base, Japan, on Feb. 21, 2013. DoD photo by Senior Airman Cody H. Ramirez, U.S. Air Force.

Multimillion dollar fines, criminal charges, lost business – all of these are the side effects of noncompliance with the International Traffic in Arms Regulations (ITAR). Ignorance of the law does not guarantee a pass. The ITAR is tough and rigidly enforced as it is designed to protect advanced U.S. defense technology from getting into the wrong hands.

One problem: The rest of the world is catching up to U.S. electronics expertise. U.S. defense and semiconductor suppliers often find themselves shut out on international contracts – with friendly nations, not ITAR proscribed countries like China – because foreign primes and integrators don't want ITAR headaches and have strong alternative vendors in Europe and Asia. The U.S. government recognizes this and the Departments of State and Commerce are creating new rules and changes to the ITAR and Export Administration Regulations (EAR) to move certain technology not crucial to military programs from State's U.S. Munitions List (USML) to the Commerce Control List (CCL).

"Since the Obama Administration announced its plans for export reform, it has moved along quite nicely and made significant progress," says Kay Georgi, an export compliance attorney and partner at Arent Fox LLP in Washington. "Until the proposed satellite regulations came out on May 24, the latest and most significant development happened on April 16 when State and Commerce published their final rules implementing changes to ITAR and EAR. Essentially what this will do is move a very large set of controlled aircraft and aircraft parts common to State's U.S. Munitions List (USML) Category VIII over to the Commerce Control List (CCL). Those products that move over to Commerce will now be authorized for export to 36 countries – provided that exporters meet all requirements of license exception Strategic Trade Authorization (STA). However, they will not just be able to export to just anyone. Export must be done to the approved countries and must be for the end use of government organizations such as the military, police, search and rescue, etc.

"Parts and components that are staying on the USML are those that are 'specially designed' for combat aircraft such as: the B-1B; B-2; F-15SE; F/A-18 G, H, and F; F-22; F-35 Joint Strike Fighter (JSF); and the F-117 Stealth jet – as well as items that are specifically called out on a positive list contained in the revised USML Category VIII," Georgi continues (see Figure 1 on page 22). "Mission-critical technology that is listed in USML Category VIII on all aircraft – not just military aircraft – will not be allowed to

be moved over to Commerce. However, any parts and components not specifically called out in USML Category VIII will move over to Commerce. Because some companies make parts for both the enumerated combat aircraft and other military aircraft, there is a potential for dual licensing and dual burden, outweighed, however, by the unquestioned advantages of exporting 600 series items under license exception STA. The manufacturers will need to figure their licensing obligations on their own. The 600 series refers to a new sequence of Export Control Classification numbers that contain the number 6 in the third position from the left to indicate the military nature of the controlled items."

Specially designed

"For these rule changes the government has come up with a new definition of 'specially designed' to enable the aircraft regulations as well as ITAR and EAR reforms down the road," Georgi says. "Before 'specially designed' was undefined; with the change it becomes a complicated catch and release system. The first part of the test – the catch – defines the universe of items that could be 'specially designed.' The second part – the release – provides several criteria that, if met, will release the item from being treated as 'specially designed.' The new 'specially designed' definition plays a major role in determining which items that are not specifically enumerated in the USML will nevertheless remain there, because they are 'specially designed' for an item that is called out in the USML. For example, printed circuit board suppliers will need to evaluate whether their printed circuit boards are 'specially designed' for an item remaining in USML Category VIII (or another USML category). But 'specially designed' also will play a part in the numerous Commerce Export Control Classification Numbers (including but not limited to the 600 series) that also use the term 'specially designed.'

"For the most part, however, the new USML will be a positive list, and suppliers will need to spend time with the list and feel comfortable with the new definitions and categories of products," Georgi continues. "Just like before the rule changes, there is still the Commodity Jurisdiction (CJ) process that can be used to confirm that an item, particularly one designed to work in both commercial and military platforms or being sold for both commercial and military platforms, is not subject to State controls and can be licensed as dual use. Companies need to see what will work best for them – self classification, the CJ process, or a mix of the two. Commerce has announced that it will conduct audits of exporters to make sure they are complying with all the conditions for using license exception STA. Inevitably some items will remain under State, and even if all of what a company produces is transferred, there is still a good chance that some portion of the technical data the company receives from its prime contractors will remain under the USML. Thus, even a company now producing 100% Commerce controlled products might still need to ensure internal ITAR compliance to protect ITAR controlled technical data from unauthorized export, for example, to foreign person employees. Thus, there is still a possibility of dual licensing.

"The export reform initiatives are good news, but not completely painless," Georgi says. "The trick for defense suppliers is they will need to study the new rules and regulations and see whether their products and technology qualify for a move to the CCL. They shouldn't wait until Oct.15, 2013 either, which is when the new rules go into effect. If they do, they will have waited too long. Commerce is doing a lot of outreach on the new rules and regulations and defense suppliers should seek out these meetings right away to get an understanding of how the USML and CCL are changing. What goes in the aircraft regulations becomes effective on Oct. 15, but you need to prepare for what is coming down the pike in the other USML categories in the export control reforms still to come."

Commercial satellite technology
It's likely no group of U.S. companies has been hurt more adversely by U.S. export compliance laws than suppliers of commercial satellite technology. Since 1999 when all satellite technology was moved back to the ITAR as a result of the Strom Thurmond NDAA of 1999, the industry has seen their international business slowly shrink as foreign satellite manufacturers started turning toward non-U.S. suppliers an in effort to have systems be ITAR free.

"The European satellite manufacturers are frustrated with U.S. export restrictions and often choose to go elsewhere for their technology to avoid costly ITAR headaches," says Chuck Tabbert, Vice President at Ultra Communications in Vista, CA, and a member of the President's Export Council Subcommittee on Export Administration (PECSEA). "This annoys the European satellite manufacturers but really hurts U.S. satellite technology suppliers since they lose out on contracts. Even after reform it is going to take time to build back that trust. We need to put our money where our mouth is and make changes that consider our allies, and make it easy for them to do business with us. It seems to be the Administration's intention to get commercial satellite components available for sale to our allies."

"The toughest challenges to U.S. space companies are the headaches that come from the ITAR," says Larry Longden, Vice President and General Manager, Microelectronics at Maxwell Technologies in San Diego. "We have major customers in Europe that we've been supplying for years, who are now getting reluctant about doing business with U.S. companies because of how volatile U.S. government decision making is when it comes managing ITAR and export compliance. For the European satellite community the ITAR is no longer just an irritant. These companies have direct activities to design U.S. products out even if they replace them with less reliable and lower-performance designs. Even if we change the ITAR restrictions, it will only reduce the paperwork for the U.S. as the Europeans just don't trust the U.S. government anymore when it comes to export regulations. They always buy European content before they buy U.S. content. In the past five years, the European Space Agency has spent a lot of money developing radiation-hardened technology so they don't have to buy from us."

Figure 1 | Items 'specially designed' for the F-35 Joint Strike Fighter and other crucial military combat aircraft will not be moving to Commerce, but will remain on the State Department's USML.

"The large companies with wide portfolios have been better able to weather the storm and are able to sell overseas with the constraints we currently have, but for the smaller suppliers business is down," Tabbert says. "They have not been able to access the overseas market as much and therefore rely specifically on the U.S. market. These companies need to be able to expand their business internationally or they will not survive. If the change occurs I estimate the semiconductor industry would likely see about a $5 billion increase in revenue over the next 5 years. That would be revenue gained from selling to countries they currently are prevented from selling to by the U.S. export laws."

Satellite export rules changes
Help looks to be on the way just as it is for aircraft suppliers as Congress passed legislation earlier this year to get it moving and State and Commerce have released the proposed rule changes. "When Congress passed the NDAA for fiscal year 2013 on Jan. 2, 2013, it paved the way for moving satellites and satellite related technology from State to Commerce," Georgi says. "However, this did not come without strings and it requires action by the Administration to take place. Administration officials will have to ensure the removal of satellites and related technology from the State USML is in the U.S. national security interest; if not, they won't be removed. Just like the aircraft rule change, the items may only be exported to one of the 36 approved nations. Each export also will require an STA license. Also, no satellite or its related technology may be transferred over to China, North Korea, or any state sponsor of terrorism, nor any entity or person from or acting on behalf of these countries or nationals. It's not going to be the change that some may have hoped for, but it is a major reform.

"From my perspective it is a big win getting de minimis rules under Commerce as many foreign satellite manufacturers eliminate all parts of U.S. origin to be ITAR free," Georgi says. "I remember when the Strom Thurmond NDAA of 1999 was passed and had all satellite and related items moved to the ITAR, which has a zero percent de minimis rule. However, you don't want too many different de minimis rules as that can be risky. For 600 series and satellite-related, we have 25 percent de minimis for most of the world and 10 percent for regular embargoed countries. It is zero percent for ITAR proscribed countries like Iran, Sudan, China, etc."

Taking commercial satellites from the USML and moving them to the CCL "is not decontrolling – it is just moving jurisdiction," Tabbert says. "Commerce is more flexible and they have exemptions. You don't have to ask a question, but just document what you did. We are striving for an easy demarcation point between Commerce and EAR.

"The categories that will enable commercial spacecraft and related technology to move from State to Commerce were published in the federal registry on May 24, 2013," Tabbert continues. "We have 45 days for industry to comment, followed by comment from the legislative branch. The NDAA had bipartisan support and I don't think it will run into any roadblocks. The new rules will have a probable implementation by the first quarter of next year. The team that's been rewriting the rules has had a gargantuan task – taking into account policy, law, and technical content. My hat is off to them. From what I've seen so far, there are common definitions that translate across all ITAR and EAR. It will have criteria for how rad-hard components have changed – boards, boxes, the whole food chain."

Big fines still happening

While export reform is happening and likely to create more opportunities for aircraft and commercial satellite technology suppliers, export compliance enforcement continues to hammer out big fines. Two of the most recent were United Technologies Corp. (UTC) and Raytheon, which got hit with $55 million and $8 million penalties respectively. UTC was charged with violating the Arms Export Control Act (AECA) and the ITAR "in connection with the unauthorized export and transfer of defense articles, to include technical data, and the unauthorized provision of defense services to various countries, including proscribed destinations," according to the proposed charging letter from the State Department to UTC. UTC was ordered to pay $35 million of its $55 million penalty to State in four installments with the remaining $20 million to be directed for remedial compliance measures. However, the $20 million may be suspended if the company makes certain certifications in their consent agreement.

Raytheon's violations were for "failure to properly manage department-authorized agreements; and … failure to properly manage temporary export and import authorizations," according to the charging letter from the State Department to Raytheon. The $8 million civil penalty leveled against Raytheon is being split two ways: $4 million was paid to State with the other $4 million ordered to be used for improving Raytheon's internal export compliance program. For more on ITAR fines, visit the State Department website at www.pmddtc.state.gov/compliance/consent_agreements.html.

"I see the State Directorate of Defense Trade Controls (DDTC) and the Department of Justice (DOJ) continuing to level ITAR fines and big ones," Georgi says. "Defense suppliers need to spend money for compliance now or spend more money in fines and penalties later. The fines have functioned as a deterrent as the multi-million dollar penalties have forced companies to get their act together so they don't get hit with a fine or even worse – criminal charges. The large companies have made strong efforts to put in place best practices on export compliance and then follow them."

Compliance and standards

Officials at VITA see companies being more diligent with ITAR compliance as a result of the fines. "In the beginning when large ITAR fines started getting published, the industry was in a tizzy," says Ray Alderman, Executive Director of VITA. "Three or four high-profile cases taught us a lot and companies have gotten better with export compliance, developing internal ITAR procedures and policies. People are no longer sitting around in open meetings talking about weapon systems and mission computers. Nobody wants to get one of those high-profile violations.

"There were two ways to enable compliance from a VITA perspective," he continues. "We could create a separate segment of VITA where only those

Export compliance in 15 steps

Kay Georgi, an export compliance attorney and partner at Arent Fox LLP in Washington, outlines 15 key steps to ITAR compliance – updated for 2013:

1) Get management buy-in for your compliance program – If management does not support the program, it likely will not work.

2) Identify two persons in your organization who will be your export compliance personnel – one is not enough. If you do not have good candidates, you might have to recruit from outside your organization.

3) Make sure your export compliance personnel have thorough export control training – For most companies except the largest, this usually means outside training.

4) Classify all the products, services, software, and technology that your company exports. This might mean classifying all items, even if you do not export them in the traditional sense, if you employ foreign nationals or procure offshore. Put in your new product development a gate for classification, and put in your new contract review system a gate for classification.

5) Make sure any controlled products are identified in your ERP system or in another fashion so that your personnel will know that those products are controlled. If you procure controlled products, be sure your vendor understands and agrees to implement export compliance procedures (and is ITAR registered as applicable). If you procure overseas, make sure you obtain any necessary license or other authorization to do so.

6) Put in place automatic and other gates in your ERP system and in your sales/customer service departments to make sure that any controlled products are not exported, re-exported, imported (for items on the U.S. Munitions List and U.S. Munitions Import List), or transferred without any required license.

7) Put in place a gate in your Returns and Repairs department, to make sure that all returns of defense articles to the U.S. are properly authorized (exemption claimed) and returned pursuant to license or exemption. Also make sure the department recognizes if the item has ended up in the hands of an unlicensed end user.

8) Create a technology control plan to cover controlled technology, and be sure to include IT, human resources, and procurement/purchasing (for offshore procurement) departments in your plan. In particular, with the assistance of IT, HR, and procurement departments:

- **a)** Put in place Standard Operating Procedures (SOPs) to identify, correctly label, and protect controlled technology.
- **b)** Put in place SOPs to identify and to obtain DSP-5 licenses for foreign persons hired both permanently and temporarily (for example, through temp agencies).
- **c)** Analyze the risks associated with your IT system and use encryption, secure FTP sites for communications with customers, user access controls, software that can identify access and the location of servers to reduce risk of inadvertent exports/access issues. Put in place SOPs for the above.
- **d)** Create and put in place a laptop, USB, Blackberry/smartphone SOP.
- **e)** Create and put in place SOPs for international travel.
- **f)** Create and put in place SOPs for visits.

9) Create a license/agreements management system, including the export process and filing of Automated Export Records, to ensure compliance with all licenses, license exceptions (EAR), or license exemptions (ITAR). Make sure your foreign licensees understand and agree to all license conditions.

10) Be sure to screen all customers and suppliers against the restricted party lists, both at the initial input stage and on a regular (or evergreen) basis, and also record, and preserve screens.

11) Train personnel for red flags of prohibited end use and diversion and create a process for resolution of red-flag screening.

12) Create a problem management SOP to deal with issues as they arise, as well as for government inquiries and visits and voluntary disclosures.

13) Put all of the aforementioned procedures into a compliance manual and SOPs.

14) Train and test all personnel, or at least most personnel, on the compliance manual and SOPs on a regular basis.

15) Audit regularly, alternating responsible internal auditors (if you have them) with experienced outside auditors. Follow up on audit results. File voluntary disclosures where warranted.

***Kay Georgi** is also the co-editor with Paul M. Lalonde of the new "Handbook of Export Controls & Economic Sanctions," published by the American Bar Association's (ABA's) Export Controls and Sanctions Committee. The book also is expected to be available in e-format for downloading on the ABA Web store shortly after the release of the printed book. For more information, visit http://bit.ly/10FDGtN.*

with a cleared U.S. passport could get in a room to work on a standard. This was frustrating for some companies that have personnel in Canada and the U.S – one could attend and one could not. After meeting with our attorneys we decided we wanted VITA standards to be viewable by anybody in world" – in other words be ITAR free. Therefore, VITA put the responsibility for removing ITAR content from standards specifications on the people working on those particular standards where ITAR is an issue – the individual working groups within VITA, Alderman explains. "This is the cleanest way of doing it because the working groups work independently and have prime contractor and military representatives that have a much better perspective on what is ITAR sensitive and what is not," he continues. "For public consumption we boil down the standards to basic engineering specs for the device and how it is hooked together; nobody knows what data is on the pins, what application the board will be used for, etc. We don't define what it does, what mission it will be used for, or on which platform."

Compliance pitfalls

Export compliance, while not rocket science, does require vigilance and a rigorous attention to detail if companies and individuals want to avoid big fines and in some cases criminal charges. Errors are bound to happen, but Georgi says there are three points that defense suppliers need to stay on top of in today's environment. "The first one is to make sure to disclose any unlicensed export or transfer of ITAR items immediately," she says. "Do not pass go, do not collect a hundred dollars. State Department agents might have a problem later, especially if the items went to China or other arms-embargoed countries. The State Department is very clear that they want to know now.

"The second one is not new, but still important," Georgi continues. "You must make sure you have your facts correct in any disclosure – the first time it happens. Minor voluntary disclosures are not what I'm referring to, but if it involves security or any intentional misdoing you really need to go on the deep dive and get outside legal counsel. This is not the case to skimp on but potentially abet the company case. Make sure you your get facts right because you are potentially at risk for criminal violations.

"The third one is make sure you don't skimp on compliance after you get your license," she warns. "State Department licenses such as Manufacturing License Agreements (MLAs) and Technical Assistance Agreements (TAAs) can last as long as 10 years. That is a long time and creates a huge potential for you and your company to make mistakes. Suppliers must be vigilant and do periodic checks on their compliance practices such as making sure no foreign nationals have been hired [who are] now working on ITAR technology. In that way, it is like raising children. Many first-time parents think it's all about the pregnancy, but that's nothing compared with raising the child. Once State approves the export license, the job isn't over – it's just beginning." **MES**

TRENDS IN RADIATION-HARDENED ELECTRONICS

Rad-hard requirements increase as space market slows

By John McHale, Editorial Director

Radiation immunity and signal processing requirements are increasing for spacecraft and satellite electronic systems as designers look to add more capability for government and civilian applications. Meanwhile, the U.S. military and commercial markets for space electronics remain flat, thanks to the slow global economy and government budget cuts.

An Expedition 30 crew member took this nighttime photograph of a portion of the U.S. Atlantic coast from the International Space Station. Photo courtesy of NASA.

Despite what has been a stagnant economy, military and consumer demand for increased bandwidth from their intelligence and communication systems has not slowed a bit. Regardless of budget cuts and program cancellations, system integrators want space systems with high-performance signal processing payloads that can survive in a variety of high-radiation environments for longer periods of time than ever before.

Space designers go where space designers have gone before. They need to trust where they get their radiation-hardened (rad-hard) electronic components from because swapping out bad parts in a satellite or spacecraft that has already launched is not an option. Stricter radiation requirements make proven flight heritage even more critical, making the barrier to entry in the space market formidable if not impossible for suppliers whose widgets have yet to leave the Earth.

"You can't cut costs in space, especially when you're sending astronauts to the moon or Mars," says Doug Patterson, VP, Military & Aerospace Business Sector at Aitech in Chatsworth, CA. "They don't have enough fuel to go three quarters of the way to Mars and have something go wrong. If it does, they can't get back as they need to loop around the back of the planet for a slingshot effect to get them started on their way home. Our space customers are pushing technology higher and higher, further and further, and for longer periods of time in space. As a result, component selection is becoming much more rigorous. Customers that would typically request 20 kilorad (krad) products now want a 100 krad pedigree. This also makes the development process even longer as radiation life testing needs to be done. Just running the test itself takes time and, on top of that, you have to make sure you have the right components, which is also a time-consuming process, although design cycles are coming down as the components produced with silicon on sapphire are more inherently rad-hard than other CMOS technologies."

"I think the current DoD [Department of Defense] budget cuts and sequestration are making integrators more cautious, but I think the need for radiation-hardened components is greater than ever before," says Jim Kemelring, CTO of Triad Semiconductor in Winston-Salem, NC. "The number of satellites being launched into space is just amazing. Rockets are going up and launching not one, but multiple satellites at a time and all the electronic components onboard each one need to be rad-hard. Missiles and avionics are also demanding more rad-hard parts. Even designers of medical X-ray technology are looking at using rad-hard components, thinking maybe their equipment would last longer with [that] type of rad-hard component."

"As you go up in radiation tolerance, the challenge is maintaining the same or similar performance levels," says Monty Pyle, VP of Sales & Marketing at VPT in Bothell, WA. "For

radiation-hardened components it is about the components you select, addressing their potentially differing footprints and/or electrical characteristics. It is not just a simple matter of swapping out components. We also have stringent TOR – Technical Operating Report – requirements that are becoming more and more fixed and demanding every year. *Aerospace TOR* refers to reports developed by Aerospace Corp. and flowed down as requirements on space asset procurements that cover technical requirements on electronic parts, mechanical parts, materials, and processes involved in the manufacture of components used on space-based systems. The requirements include guidance on analysis, component deratings, prohibited part types, part element evaluation, and screening that in many instances exceeds the requirements of MIL-PRF-38534 Class K."

"Qualifying and testing ASICs takes longer every process technology generation, it seems, as the complexity of the customer designs onboard has only grown," says Peter Milliken, Director of Semi-Custom Products at Aeroflex Colorado Springs. "Integrators are dreaming lots of wonderful things in software that can be quite complicated to manifest in silicon – especially when there are more than 10-20 million gates to play with in a component. The System-on-Chip (SoC) design flow has become more and more demanding. Customers use FPGAs to guarantee operation before they fly, so they can program FPGAs until you get it right. A good ASIC design flow makes sure the design and quality are right the first time. Right now, 90 nanometer is the technology of the day and we are on track under a government program to have our UT90nHBD ASIC library, design flow, and manufacturing offering fully 90 nm qualified by the end of the calendar year. For more complex flip-chip performance applications, we are executing in accordance with our Aerospace Corp. reviewed qualification plan with a certification expected in the middle of calendar year 2014. The toolkit has already been released to the community and can be downloaded from our website."

"As far as rad-hard designs, we see a separation in markets in commercial and military rad-hard," says Al Ortega, Marketing Manager, Military and Space Products, Microsemi High Rel Group in Lawrence, MA. "In military programs there are more requirements for higher radiation tolerance. We are seeing a lot of requirements out of Aerospace Corp. for additional testing of Single Event Upset (SEU) prompt dose and neutron radiation. The military segment wants more reliability and the Aerospace Corp. is constantly involved in increasing requirements in terms of reliability – wanting Enhanced Low Dose Rate Sensitivity (ELDRS) and SEU immunity at a minimum."

Increased requirements for SEU immunity and reconfigurability also drove the AFRL to fund Xilinx's Virtex-5QV FPGA. Many FPGAs for extreme rad-hard applications have been one-time programmable, says John Bendekovic, Director of Aerospace and Defense Sales at Xilinx in San Jose, CA. "Once a satellite is launched, whatever it took up there would have to stay up there for its mission life without any way to reconfigure it from the ground. What Xilinx has done is develop a reconfigurable FPGA that is SEU immune and latchup immune. There is a demand for reconfigurable computing in the upper rad-hard environments as complex, processing-intensive payloads are enabled by reconfigurable logic. If integrators can get some factor of reconfigurability in the system, they can access it from the ground and reconfigure it based on mission requirements. ASICs are not able to provide that feature. This is not the first Xilinx brought to market with reconfigurability, but its SEU immunity is the watershed that sets it apart from other FPGAs for space." The device has an SEU immunity of > 100 Mev-cm^2/mg and a Total Ionizing Dose (TID) rate of > 1 Mrad(Si). It has as fast as 450 MHz DSP technology with flexible embedded processing and as many as 130,000 logic cells.

Funding restrictions also are forcing integrators to look more closely at what they need more than what they would like to have. "Some U.S. military programs are looking more closely at what requirements they really need," Ortega continues. "If a program is not frontline and more experimental in nature, they may not need 100 or 300 krad pedigree products. If it is not mission-critical, they may take a step back regarding quality and radiation immunity."

"DoD programs today don't have the luxury of test driving multiple products anymore, so they are being much more selective in spending only on what is essential for their program," Pyle says. "We are seeing a higher level of critiquing in terms of what they really need. For example, does their launch vehicle really require 100 krad total dose? Or, what are the radiation requirements for that satellite over time? Maybe a 100 krad high dose rate is extremely unlikely in low Earth orbit, but continual low dose is very likely; therefore, they should use a product rated for ELDRS."

"One bad trend stemming from the shrinking geometries of space components and push for reduced Size, Weight, and Power (SWaP) is that as sizes shrink, we end up packing

Rad-hard market trends

"The U.S. space market is remaining flat at the moment," says Dan King, President of King Space Research in Albuquerque, NM. "All the uncertainty in the market and all the unknowns are forcing companies to kick everything to the right – not cancelling the funding, just postponing it. When you discuss flat in U.S. it means growth only by content per system growth – flat value on declining quantities of orders. We are building ever less systems as the bang for buck is literally declining because we debase currency value, meaning government spending is less. We are spending less of GDP on defense – despite the nominal increase in spending; a lot more of the spending is consumed in areas other than system production. Even though programs get cut, the overall threat and mission needs still exist. The larger issues are the amount of money wasted on engineering services that never made it to the Department of Defense manufacturing sector.

"Strategic rad-hard components are driven by the dose rate requirements for strategic satellite systems," King says. "Rad-hard numbers are driven by either Total Ionizing Dose (TID) for Geosynchronous Earth Orbits (GEOs) or by orbits or systems requiring higher Single Event Upset (SEU) assurances – lower memory upsets. Radiation-tolerant are Low-Earth Orbit (LEO) or cost-driven military systems or subsystems. They may also be used by assumptions of shielding or fault tolerance in the system designs. The COTS and upscreening market is at $300 million. Upscreening – no matter how you book it – always is a certain percentage of the market where radiation requirements are met using alternatives. It's where designers turn to if they can't find QML parts. If a Defense Supply Center Columbus (DSCC) part exists, they are required to purchase it first. However, the upscreening niche is increasing mainly because integrators can't find what they need off-the-shelf."

"The military space market is flat, and a bit murky as R&D and new program funding is beginning to wane," says Tony Jordan, Director of Standard Products at Aeroflex Colorado Springs. "Military and classified production programs continue to move forward. We believe that communication; Intelligence, Surveillance, and Reconnaissance (ISR); and force and homeland protection will continue to get funded going forward. The number of new commercial satellite awards worldwide decreased in 2012 from 2011. In 2012 there were less than 20 commercial satellite contracts awarded, down from 2011, which saw greater than 20 satellite contracts awarded."

The President's NASA budget request for fiscal year 2014 is slightly down at $17.715 billion from $17.893 billion in 2013 but is projected to be flat through 2018. Human spaceflight programs such as the Orion Multi-Purpose Crew Vehicle (MPCV) and the Commercial Crew program have healthy funding requested for 2014 and are moving forward. The Fiscal 2014 request for the Orion MPCV is at $1.026 billion with a slight increase the next two years, then remaining flat through 2018. The program has an uncrewed flight test of an early variant of the Orion MPCV in 2014, an uncrewed Space Launch System/Orion MPCV test flight in 2017, and a first crewed flight by 2021. The Commercial Crew program will continue to work toward U.S.-crewed flight to ISS by 2017. Its 2014 budget request is $821 million, remaining flat for 2015 and 2016, eventually dropping to $590 million in 2017 and $371 million in 2018.

"Politics ultimately determine what gets cut and what remains, and it will likely drag out for years with more delays leading to wasted spending not going to [the] manufacturing sector," King says. "Current plans have us spending more in interest payments than we spend on our own national defense. The bright side is that when they cancel new development, it typically results in more maintenance, repair and overhaul activity, and upgrade initiatives that actually have higher electronic and semiconductor spending than new development. The net impact on the value for the semiconductor market will be less volume in orders but higher overall value opportunities for critical components, which while likely to be dominated by cost issues will increase the pressure to shift to COTS technology.

"There is more growth in the overseas markets, especially in Russia and India," King says. "Europe is flat because of their own monetary problems. When you measure money alone you get less bang for your buck. While the cost of systems may be going down, so is the value of the currency so you end up paying just as much if not more for systems. Inflation in the business cycle is a big problem in Europe."

Sequestration Impact

U.S. Defense							
Semi/IC ($M)	2012	2013	2014	2015	2016	2017	2018
Strategic Hard	78.13	73.66	74.70	77.91	78.32	79.51	80.57
Radiation Hard	111.11	106.97	106.10	110.30	110.93	113.18	113.17
Radiation Tolerant	154.25	148.45	153.42	152.77	154.25	156.17	157.77
COTS/Hi-Rel	300.09	278.29	301.26	303.45	308.25	311.22	315.22
U.S. DoD Subtotal	643.58	607.37	635.48	644.43	651.75	660.08	666.73

Sidebar Figure 1 | 2012-2018 forecast for strategic rad-hard, rad-hard, rad-tolerant, and COTS high-reliability products in military satellites – classified and unclassified – nuclear missile defense systems, and strategic missiles. Numbers provided by King Space Research.

Rad-hard listing

Aeroflex
Colorado Springs, CO
www.aeroflex.com/radhard

Aitech
Chatsworth, CA
www.rugged.com

Aldec
Henderson, NV
www.aldec.com

Atmel
San Jose, CA
www.atmel.com

BAE Systems
Manassas, VA
www.baesystems.com

C-MAC MicroTechnology
Buckinghamshire, United Kingdom
www.cmacapi.com

Corwil Technology Corp.
Milpitas, CA
www.corwil.com

Crane Aerospace & Electronics
Redmond, WA
www.interpoint.com

Curtiss-Wright Controls Defense Solutions
Charlotte, NC
www.cwcdefense.com

Data Device Corp. (DDC)
Bohemia, NY
www.ddc-web.com

Harris
Melbourne, FL
www.harris.com

Honeywell Microelectronics
Plymouth, MN
www.honeywellmicroelectronics.com

Integra Technologies
Wichita, KS
www.integra-tech.com

International Rectifier
El Segundo, CA
www.irf.com

Intersil Corp.
Milpitas, CA
www.intersil.com

Jazz Semiconductor
Newport Beach, CA
www.jazzsemi.com

Linear Technology Corp.
Milpitas, CA
www.linear.com

Maxwell Technologies
San Diego, CA
www.maxwell.com

Microelectronics Research Development Corp.
Colorado Springs, CO
www.micro-rdc.com

Micropac Industries
Garland, TX
www.micropac.com

Microsemi
San Jose, CA
www.microsemi.com

Modular Devices
Shirley, NY
www.mdipower.com

MS Kennedy
Liverpool, NY
www.mskennedy.com

Novocell Semiconductor
Hermitage, PA
www.novocellsemi.com

Peregrine Semiconductor Corp.
San Diego, CA
www.psemi.com

Ridgetop Group
Tucson, AZ
www.ridgetopgroup.com

Robust Chip, Inc.
Pleasanton, CA
www.robustchip.com

Rochester Electronics
Newburyport, MA
www.rocelec.com

Semicoa
Costa Mesa, CA
www.semicoa.com

Silicon Space Technology
Austin, TX
www.siliconspacetech.com

Silvaco
San Diego, CA
www.silvaco.com/government/index.html

STMicroelectronics
Geneva, Switzerland,
www.st.com

Synopsys
Mountain View, CA
www.synopsys.com

Synova
Melbourne, FL
www.synova.com

Teledyne Microelectronic Technologies
Los Angeles, CA
www.teledynemicro.com

Texas Instruments
Dallas, TX
www.ti.com/home_p_hirel

TRAD
Lebarge, France
www.trad.fr

Triad Semiconductor
Winston-Salem, NC
www.triadsemi.com

Ultra Communications
Vista, CA
www.ultracomm-inc.com

VPT
Everett, WA
www.vpt-inc.com

Xilinx
San Jose, CA
www.xilinx.com

more and more transistors on a single device, which enables more performance in a smaller footprint; however, the device becomes more susceptible to contact radiation as one SEU or SEE can fry multiple transistors at once," Patterson says.

Reduced SWaP and enhanced signal processing

The more rigid rad-hard specifications often are coupled with demands for enhanced signal processing and higher-density memory devices in sensor payloads used for Intelligence, Surveillance, and Reconnaissance (ISR) applications.

"The biggest trend we are seeing is for more signal processing capability onboard the satellite to drive scientific and military sensor payloads for hyperspectral imaging, radar, etc.," says Ken O'Neill, Director of Marketing, Space Products, Microsemi SoC Group in San Jose, CA. "The science community wants more data and sensors with higher resolution, which requires more processing on the satellite payload. It is exactly the same challenge with Unmanned Aerial Vehicle (UAV) payloads, as we are dealing with a limited communication bandwidth down to the ground. In a UAV payload, FPGAs help fulfill the need for onboard processing that has historically been driven by new families of rad-hard ASICs and is now being driven by new families of FPGAs for onboard processing. We are in an advanced stage of development with an FPGA product that has significantly enhanced DSP capabilities." For signal processing applications, Microsemi also produces the RTAX-DSP space-flight FPGAs, which add embedded radiation-tolerant multiply-accumulate blocks that integrate DSP functions into a single chip without any external components for code storage and without using multiple-chip implementations for radiation mitigation.

"The primary trend today among our military customers is an increased demand for higher-density nonvolatile memory products and a higher demand for higher-speed and higher-resolution A/D and D/A converters," says Larry Longden, VP and General Manager Microelectronics at Maxwell Technologies in San Diego, CA. "They need more nonvolatile memory to run computers as the software becomes more complex in satellite systems. One of the big drivers is having the ability to store multiple images in flash to replace 'be able to keep reprogramming' with 'provide multiple images for the' new Xilinx FPGAs to support reconfigurable computing. Traditionally, our biggest product has been our EEPROM device. This year we will introduce new NOR flash and NAND flash products to provide higher-density nonvolatile memory. They have SEU-hardened flip-flops to protect against heavy ion radiation effects."

SWaP demands also are pushing military space system designers toward a higher level of integration. "[Many] today still go about developing rad-hard systems like they did in the 1970s and 1980s," Kemelring says. "They use off-the-shelf components such as op-amps, A/D or D/A converters, or build their own out of different components and maybe occasionally use an FPGA – or they use the old 4000/7400 devices to build up logic circuits. That is not how anybody makes anything anymore. If they could integrate all these components on one chip, they'd improve their SWaP by an order of magnitude.

"At Triad Semiconductor, we make a mixed signal Via Configurable Array (VCA)," Kemelring continues. "It is a semi-custom ASIC in that it takes silicon-proven analog and digital resources that are radiation-hardened by design or process into VCAs that can be configured in one chip with a single mask layer. VCA technology integrates analog and digital resources onto preconfigured ASIC arrays. The digital and analog regions are shielded and isolated to protect sensitive analog circuits, then the entire array is overlaid with a global routing fabric." The VCA has a TID of > 1 Mrad(Si) and an ionizing dose rate of > 5×108 rad(Si)/s, migrates ELDRS effects, and operates as high as 70 V, according to the Triad data sheet. "Semicustom ASICs could also be reused as the components have already been qualified for radiation environments," he says. "The only thing that would change would be the single configurable via layer to modify the IP. The AFRL is really behind us on this and is trying to drum up funds to get us to go further. Custom

CompactPCI in space

The CompactPCI form factor for Single Board Computers (SBCs) has never really cut into the market share held by the competing VME architecture in military applications, but it has built a nice bit of flight heritage in space applications. CompactPCI boards in 3U and 6U are used in many manned spaceflight as well as satellite programs.

"The real reason CompactPCI has flown in space is because of the connectors," says Doug Patterson, VP of Military & Aerospace Business Sector at Aitech in Chatsworth, CA. "The standard CompactPCI box connector was better than the VME connector at the time due to its higher pin density. Companies like Hypertronics [in Hudson, MA] then designed a more robust 2 mm Metral connector for CompactPCI boards that worked well in severe shock, vibration, and vacuum environments – which increased the connector's reliability. The Hypertronics connector and the standard 2 mm CompactPCI connector couldn't intermate, but both fit into the same 3U and 6U form factors, which worked out for lots of programs. VPX technology will be useful for space, once the high-rel connector in early development makes it to the final stages.

"We designed the SP0 3U CompactPCI SBC for commercial space vehicle and small satellite applications," Patterson continues. "Its 3U form factor is ideal for the smaller size requirements in these platforms and our 3U CompactPCI board has flown on about a dozen space programs. Our radiation-hardened (rad-hard) 3U CompactPCI SBC products are being used by various customers who are working on the Commercial Crew Vehicle development program. We also have nearly 100 6U VME SBC boards in active use in the International Space Station today."

Sidebar Figure 2 | The SP0 3U CompactPCI SBC from Aitech is being used by various integrators working on NASA's Commercial Crew Vehicle program.

Engineers at Maxwell Technologies produce the SCS 750 PowerPC-based board in a 6U CompactPCI form factor, says Larry Longden, VP and General Manager Microelectronics at Maxwell Technologies in San Diego. "We used to have an Intel-based VME board for space, but when we developed the PowerPC SBC we thought the industry was heavily moving toward the CompactPCI standard, which did not turn out to be the case. The trend going forward is to move away from CompactPCI and to provide higher computing performance by using a serial bus. Our SCS 750 has a major design win in the ESA [European Space Agency] GAIA program, which will use seven of the SBCs in one satellite. ESA runs the GAIA program while Astrium in Toulouse, France is the prime. Gaia launches in September 2013. We are looking to release another version of our SBC next year that will have a SpaceWire interface."

The Mars Curiosity rover now roaming the red planet is run by its Rover Computational Element (RCE) and CompactPCI Single Board Computers (SBCs). The RCE – the brains of Mars Curiosity – comprises two identical third generation BAE Systems RAD750 3U CompactPCI SBCs. NASA Jet Propulsion Laboratory (JPL) officials "selected the BAE Systems 3U and 6U RAD750 computers for a variety of reasons," says Vic Scuderi, Business Area Manager of Satellite Electronics at BAE Systems in Manassas, VA. "We know that the RAD750 ran navigation algorithms for the trip to Mars, handled the critical seven minutes of terror of the landing, and will be reprogrammed to run the science data processing programs once Curiosity gets down to the business of science on the surface of Mars."

The IBM PowerPC 750-based units have a radiation tolerance greater than 100 KRAD and are latchup immune. The onboard memory of the RAD750 3U SBC includes 128 MB of SDRAM for storing video and data for the 14-minute-plus transmission to Earth. RAD750s are designed in 3U and 6U CompactPCI form factors for control or payload processing applications in 30 different space satellites and missions.

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40 W	SVRTR2800S/D	Single 3.3, 5, 12, 15 Dual ±12, ±15	100 krad(Si)	85 MeV-cm²/mg	Yes	5962R13209 5962R13210
100 W	SVRFL2800S/D	Single 3.3, 5, 12, 15 Dual ±5, ±12, ±15	100 krad(Si)	85 MeV-cm²/mg	Yes	In DLA review
Point of Load DC-DC Power Converters—Non-Isolated						
8 A	SVRGA0508S	-1.5% to 1.5% of Vout	100 krad(Si)	85 MeV-cm²/mg	Yes	5962R13217
EMI Filters						
2 A	SVRMH28	Single 28	Immune	Immune	Yes	In Qualification
4 A	SVRMC28	Single 28	Immune	Immune	Yes	13010
10 A	SVRME28	Single 28	Immune	Immune	Yes	13009

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rad-hard mixed signal VCAs also are available. The VCA still has yet to go through Aerospace Corp. for full radiation testing."

Power management

"Our customers want faster systems with more baud rate, more bandwidth, more computing capabilities – all at lower power," says Tony Jordan, Director of Standard Products at Aeroflex Colorado Springs. "That is our focus – to get more compute capability while keeping power consumption flat or reducing it. It is about increasing the logic per square millimeter. The request for increased computing capability is all about sensor processing – acquiring the data, processing the data, and either moving the data or making a decision. ASIC technology excels in these types of computing- and communication-intensive applications. Aeroflex is working on high-efficiency power, clock, voltage supervision/monitoring, and fault monitoring solutions."

"The increase in processing power of today's devices has increased demands on power systems," VPT's Pyle says. "Increased device speeds plus transistor density require operation at low voltage and high current. This is tough on a power supply and not compatible with efficient distribution. For systems with multiple low-voltage load requirements, users should have one isolated converter to provide the critical isolation barrier and feed the power to multiple, high-efficiency, nonisolated Point Of Load (POL) converters. This brings improvements such as better efficiency and reduced size and weight.

"VPT's new SVR series grows from the company's SV series. There was a need for a higher-radiation-level product – SVR is 100 krads TID while the SV is 30 krads – and new requirements with TOR through the Aerospace Corp.," Pyle continues. "The SVR also is 85 MeV-cm²/mg standard compared to 44 MeV-cm²/mg standard for SEU resistance. The SVR product family includes DC/DC power converters, EMI filters, and a point of load converter. It has pin-for-pin compatibility with existing designs and is flexible due to its hermetic hybrid construction. Both SVR and SV are available in Class H and K, have ELDRS, and have a temperature range of -55 °C to +125° C."

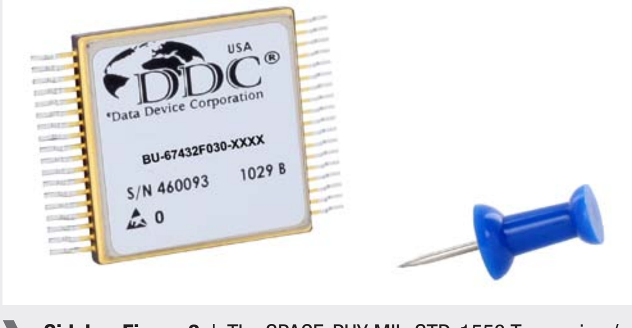
"Going forward, we need more components onboard with better efficiencies to manage all that power consumption," Microsemi's Ortega says. "We are doing a lot of work with higher efficiencies in DC-to-DC converters and experimenting with wideband semiconductors in those designs. We expect to come out with high-efficiency products in the next year or two. All new technology will be Gallium Nitride-based technology, and we will integrate those with our hybrid products as well. Microsemi has had capabilities in DC-to-DC converters through our Power Management Group (PMG) in La Mirada, CA, and is developing point of load converters."

(For more on rad-hard power trends, see the article from Crane Aerospace on page 24.) **MES**

MIL-STD-1553 still getting wins in space

MIL-STD-1553 with its 1 Mbps rate is still winning new programs on Earth and in space. The venerable databus technology continues to fill the basic databus needs despite newer standards that promise faster performance.

"The MIL-STD-1553 databus is still being used on platforms, being designed into new programs, and coexisting with new technology like SpaceWire," says Sean Sleicher, Marketing Manager for 1553 Databus and Fibre Channel at Data Device Corp. "It's proven, it's tried, and has less risk." DDC released a new MIL-STD-1553 transceiver/transformer called the SPACE-PHY +5V. It is an integrated MIL-STD-1553 physical layer in a single package, including dual transceivers and transformers for space with an extended -55 °C to +125 °C temperature range. It replaces two transceivers and two transformers, meets MIL-PRF-38534, and will be space qualified, Sleicher says.



Sidebar Figure 3 | The SPACE-PHY MIL-STD-1553 Transceiver/Transformer from Data Device Corp. consists of the physical layer only, enabling users to add their own IP.

"The SPACE-PHY is a physical layer only," he continues. "Before we'd have the transceiver and transformer inside the package and provide the protocol. For SPACE-PHY we are not offering the protocol, just the physical layer. Users can pair it with a custom ASIC or rad-hard FPGA and use their own IP on the top of the physical layer. We are saving in size and weight for this product as it is small for a space device – one inch by one inch square – smaller than existing components. It is a 50 percent reduction not including external transformers. It has improved reliability and Mean-Time-Between-Failure (MTBF). Adding a single package simplifies design."

"SPACE-PHY saves design and production time and costs by reducing the number of MIL-STD-1553 components to be installed by up to 60 percent," Sleicher says. "Instead of using five components – including an FPGA, two transceivers, and two transformers – with SPACE-PHY, only an FPGA and SPACE-PHY are needed. We already have a lead customer that's designed the SPACE PHY in for a manned space application that is still in the preliminary phase. Our legacy 1553 product in this area is the SP'ACE RT II, a dual redundant MIL-STD-1553 remote-terminal hybrid. It comes with a complete 1553 transceiver and protocol implementation that includes mode codes, SEAFAC testing, and other high-reliability applications."

Rad Hard Product Spotlights

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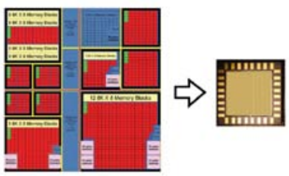

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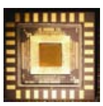

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Trends in radiation-hardened electronics testing shape future designs

By Jay Kuehny

Recent trends in electronics testing for space missions are focused on rigorous testing with attention to the complexities of space weather and the impact on the component and system design.

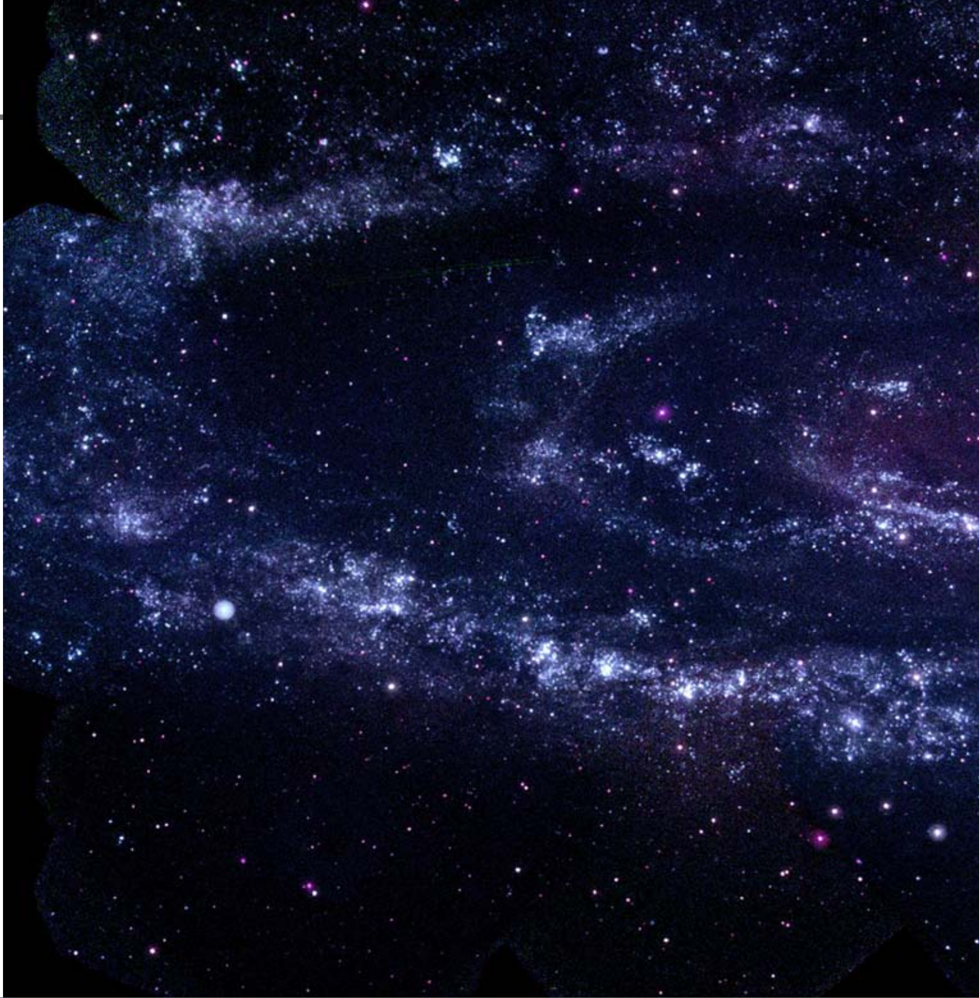


Photo courtesy of NASA/Swift/Stefan Immler (GSFC) and Erin Grand (UMCP)

Historical testing, often based on military standards, has been increasingly replaced with a "test as you fly" rigor. Historical radiation testing has its basis in military standards where high dose rates and neutron fluence from a weapons environment were the prime concerns. These historical methods do not test for many of the important, emergent space requirements. Thus, the test standards for components and systems, although still used today, are being replaced or supplemented in many cases. The recent emphasis on the effects of Enhanced Low Dose Radiation Sensitivity (ELDRS), Single Event Effects (SEEs), and proton belts, which contribute to ionization and displacement damage simultaneously, are examples of such changes.

Mission-specific requirements are becoming increasingly common. The environments for Earth-orbiting satellites versus interplanetary missions to the gas giants are very different, with the latter introducing requirements for operation in extreme cold and extremely high ionizing dosage.

Consequently, this shift in understanding and approach to radiation hardness assurance has changed the way the space electronics industry tests, and therefore designs, components and systems. The following examines space radiation effects and how historical test methods fit into emerging trends.

Space radiation effects: A closer look

The space environment for electronics is complex, with a broad range of particle types and energies, as well as electromagnetic radiation. The effects of these many sources of radiation on electronic devices depend on the component type and technology. They are often dependent on the rate and energy of the radiation source. The space environment is dominated by proton and electron belts with particle energies ranging from 1 MeV to 100 MeV for electrons and up to 400 MeV for protons arranged in belts as shown in Figure 1. The total ionizing dose rate in Earth orbit does not exceed 10 mrad(Si) per second. Single events with high-energy particles are occurring with a high frequency for low energies and low frequency for higher energies.

The resultant radiation effects on components are often broadly categorized as ionization, displacement damage, and single event effects:

Ionization

Ionization radiation effects are induced by electromagnetic radiation greater than electromagnet radiation ultraviolet and beyond: by alpha particles (helium nuclei) or by beta particles (electrons). The effect of ionization on semiconductors is the addition or removal of electrons from atoms because of the columbic interaction with the radiation source. Ionizing radiation is measured by the Total Ionizing Dosage (TID) in Rad or Gray units. TID damage is generally reversible with time and temperature as recombination occurs with drift and diffusion. As will be discussed later and has only recently been understood, the rate at which ionization occurs can affect the results for some component types.

Displacement damage

Displacement damage is caused by energetic protons and neutrons impacting the crystal lattice of the semiconductor material. Vacancies are created in the lattice of silicon resulting in changes in gain and leakage. The resultant radiation damage is permanent, affecting components like bipolar devices and opto-isolators in particular. The effect on the semiconductor can be very different for the two particles and depends on the particle energy. Protons, because of their charge, will cause ionization in addition to displacement damage. Neutrons will only contribute to displacement damage. In the space environment, protons are the prime source of radiation effects. Neutrons can be generated as a result of protons interacting with materials in the spacecraft.

Single event effects

Single event effects result from highly energetic particles, either protons or cosmic rays. Cosmic rays are most frequently protons, less frequently alpha particles and heavy nuclear ions. These highly energetic ions leave tracks of electron-hole pairs in the semiconductor material or in the dielectric. The unit used to measure the particle energy and impact on the material is Linear Energy Transfer (LET). If the charge created reaches a critical level, it can affect the semiconductor device with soft errors or state changes in memory or computing devices. In analog devices transients can be induced. Depending on the depth of penetration in multilayer devices, it can result in a latchup and high current draw. The ionic track in dielectrics can result in a conductive channel and current flow in MOS devices and can be destructive.

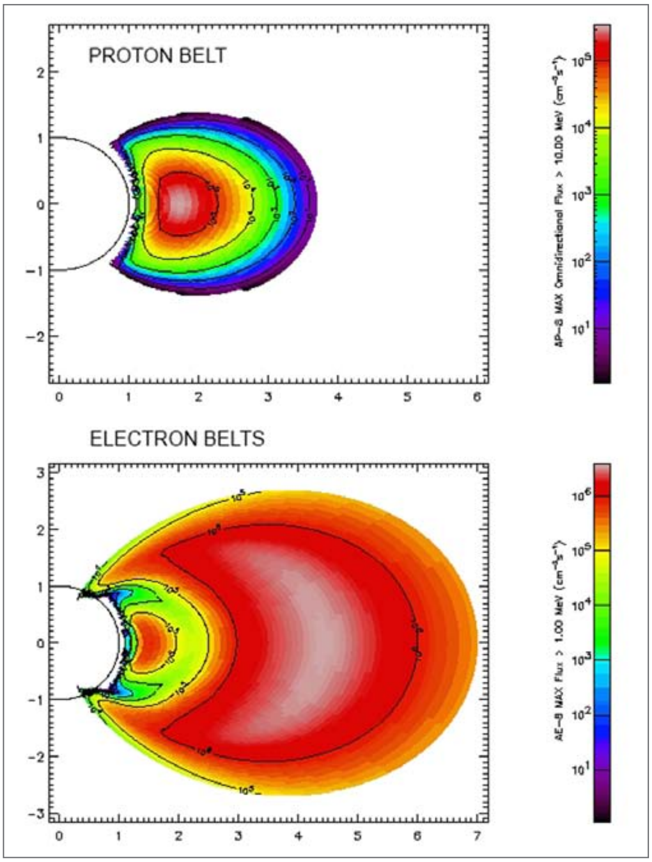


Figure 1 | Top image: proton belt, scale in earth radii. Bottom image: electron belts, scale in earth radii (courtesy of NASA).

Historical test methods versus emerging trends

As mentioned, historical test methods for the effect of radiation on electronic devices have often failed to simulate the space environment for Earth-orbiting missions.

TID testing to ensure component survival has historically been performed at very high dose rates, typically greater than 50 rad(Si) per second. At these rates, the TID that would require 10 years in orbit can be accomplished in less than an hour. The dose rate in orbit will not exceed 10 mrad(Si) per second and will be orders of magnitude lower. The high dose rate test is often followed by an anneal period of a day to a week in an effort to account for the low dose rate in orbit. The test method most often used is detailed in military standard MIL-STD-883, Test Method 1019. However, studies show that there can be serious radiation effects on bipolar devices that cannot be predicted based on high dose rate testing. With the trend toward reduced supply voltages for digital and analog components and the reduction in device geometries, these effects have become more pronounced.

ELDRS refers to the low dose rate effect. Requirements for ELDRS tests have been added to Test Method 1019 in the most recent revisions in an effort to address this requirement. Unfortunately, testing at low dose rates to achieve the mission TID objectives can take six months to a year or longer, creating a real problem for component design and mission planning. Efforts have been made to develop methods to accelerate the effect by using elevated temperatures and slightly higher dose rates. Nearly all customers and agencies now require that the potential for ELDRS be addressed.

Test methods like 1019 include requirements for displacement damage tests using neutrons. Neutron testing is important in a weapons environment and these test methods were developed as military specifications. Increasingly, customers are requesting proton displacement testing at multiple particle energies. The proton sources complicate radiation testing because inevitably, there is total dose accumulation along with the displacement damage and effects cannot be easily separated. In addition, there can be an interaction with the metal packaging or shielding, which produces a greater TID, particularly with lower energy protons. Current standards often require testing for TID and displacement damage as separate tests and do not combine the effects on the same electronic component. Recent product testing performed by Crane Aerospace & Electronics used a combination of proton energies on packaged electronics to achieve a more realistic simulation of an orbital environment.

Single event testing has historically been performed at low particle energies often with low mass particles, in part resulting from facility availability and cost. The space environment includes a broad range of energies and particle mass. Higher mass and high energies result in the deposition of energy levels deeper in the device. In space, the particle impact can occur at any angle with respect to the device features. Current standards such as ESCC25100 and JESD57 do not adequately address or require multi-angle testing or testing with a variety of particle species and energies. The increasing complexity and density of modern digital devices have increased the sensitivity of these components

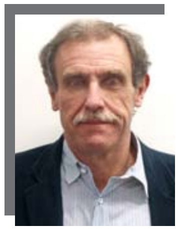
“The test method most often used is detailed in military standard MIL-STD-883, Test Method 1019. However, studies show that there can be serious radiation effects on bipolar devices that cannot be predicted based on high dose rate testing.”

to single event effects. The lack of effective standards has resulted in the development of many internal test methods. Crane Aerospace & Electronics, in union with NASA, performs SEE testing using a range of particle species and with LET ranges that ensure that data sheet specifications are met. This kind of testing is costly and can only be performed at a select group of facilities; however, it does more realistically reflect the conditions of a space environment.

Industry efforts unfold to keep pace with trends

In summary, there is a greater understanding of the limitations of traditional test methods for electronics in simulating the complex nature of the space environment. A notably significant trend in radiation hardness design and assurance is a greater sophistication in the approach to more accurately simulate the space environment. This trend is resulting in a considerable effect on component design and development as well as system-level tests.

Customers increasingly require testing tailored to specific mission requirements and are less reliant on traditional test methods. The "test as you fly" philosophy is being driven by the radiation hardness assurance groups at major agencies like NASA and space hardware suppliers. Significant experimentation is underway to effectively accelerate ELDRS tests. New methods are in development using laser simulation to induce single event effects. More sophisticated proton fluence tests utilizing multiple particle energies and updates to software modeling for the effect have been published. Also, new versions of standards, for instance, MIL-STD-883, TM 1019, MIL PRF 38534, Appendix G, and ESCC 25100 are in the works, and new standards that address single event tests and proton tests will emerge from JEDEC and NASA to better address limitations. **MES**



***Jay Kuehny** is a Principal Engineer with Crane Aerospace & Electronics at the Redmond, WA location, where he also serves in a Radiation Hardness Assurance role. Jay has more than 20 years of experience in the design and development of Interpoint power converter products for space applications, which have been used on missions including Mars Science Lab Curiosity, Hubble, Mars Rover, and Cassini in addition to most military and space satellites. Contact him at Jay.kuehny@crane-eg.com.*

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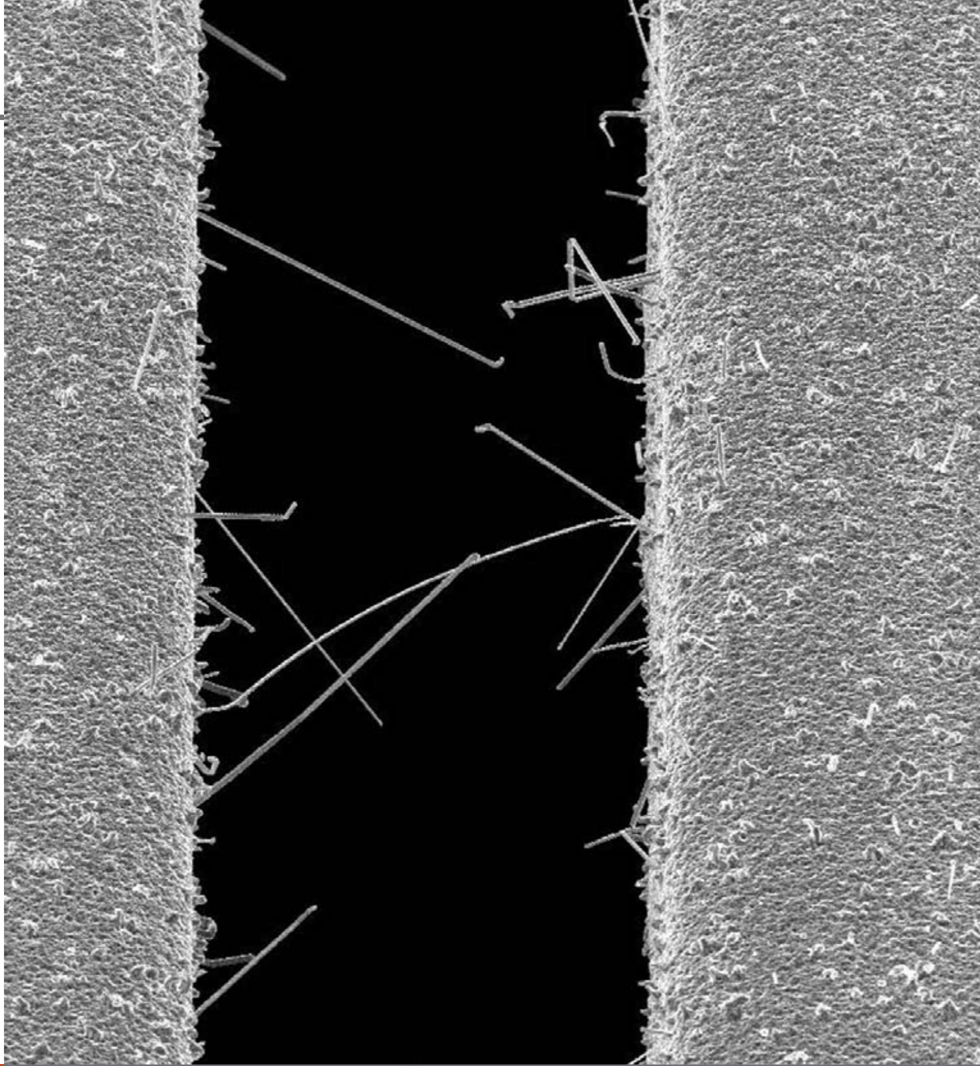


Tin whiskers growing on tin-plated copper leadframe (Courtesy: P. Bush, SUNY Buffalo)

Lead-free rising

By Ivan Straznicky

As Lead-Free (LF) electronics continue to supplant Tin-Lead (TL) alternatives, new research shows LF devices can match or exceed the reliability of TL components with proper mitigation techniques.

The use of Lead-Free (LF) components in commercial electronics, driven in large part by the European Union's Restriction of the use of certain Hazardous Substances (RoHS) and Waste Electrical and Electronic Equipment (WEEE) directives that ban the use of lead and five other substances in many electronics applications, is of great interest and concern to designers of COTS-based modules and systems for the Aerospace and Defense (A&D) markets. As LF component use expands, it will become more difficult to obtain Tin-Lead (TL)-based devices. This issue is especially urgent for COTS products designed for use in harsh environments.

As LF devices replace TL alternatives, the LF components will increasingly form the foundation of advanced technology military applications. The reliability risks introduced by the use of LF devices must be carefully investigated, understood, and addressed. The good news is that the results of recent tests and research show that there are effective mitigation approaches today to address the leading risk concerns associated with the use of LF parts, and even better, that the reliability of LF devices can in fact match and even exceed that of TL parts. This new test data can help speed the adoption of LF while reassuring COTS customers that their risk is being reduced without compromising their application's performance.

In recent years, as component manufacturers have increased the production of LF devices and the availability of TL parts has substantially decreased, leading COTS vendors, individually and in concert with related consortia, have undertaken deep research into the behaviors of LF components and assemblies. Such LF behavior was measured while assemblies were subjected to the harsh environments that rugged embedded products using these devices frequently endure (see Figure 1). The intense level of scrutiny and scientific research applied to the physics of failure of LF has resulted in some recent discoveries, both surprising and counterintuitive, that strongly suggest that in the near future the reliability of LF assemblies might actually outpace that of TL assemblies. One example is the discovery that small LF solder joints are often significantly more reliable in thermal cycling than larger LF solder joints. This bodes well for the COTS world as it aligns perfectly with the continued trend for higher-density, smaller interconnect microelectronic components over the foreseeable future, when tough design choices have to be made.

Concerns about lead-free

The Pb-Free Electronics Risk Management (PERM) Consortium's Lead-Free

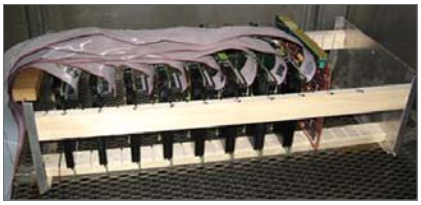


Figure 1 | Lead-free assemblies in thermal cycling chamber

Electronics Manhattan Project (LFEMP) reports identified two of the most important risk factors associated with LF as tin whiskers and pad cratering.

Tin whiskers

For most A&D customers, the biggest concern about LF devices has been the proliferation of tin whisker risk. (See this article's lead-in photo of tin whiskers growing on a tin-plated copper leadframe, opposite page.) Over the years there has been much work done to characterize and address this phenomenon. A specification has emerged, the GEIA-STD-0005-2 Standard for Mitigating the Effects of Tin Whiskers in Aerospace and High Performance Electronic Systems. Recently revised, this standard identifies Conformal Coating (CC) as the main mitigation technique of choice to combat tin whiskers. And while many different CC materials are available, not all have the same level of efficacy. Parylene, which uses a vapor deposition process, is a leading approach to prevent tin whiskers from forming or to slow down their growth on a particular surface. In the case that a tin whisker should penetrate the coating, parylene is also effective in preventing an electrical short to an adjacent circuit. Additionally, test data has shown that parylene actually strengthens solder joint reliability. While parylene usage is sometimes encouraged, two alternative materials, acrylic and urethane, can also be used on a program-by-program basis when appropriate.

Pad cratering

Another large concern associated with the introduction of LF is pad cratering (see Figure 2). This phenomenon is an insidious failure mode that can easily escape detection and can be an issue with both LF and TL assemblies. The main culprit in pad cratering is the brittleness of many new PWB materials. The problem is mechanical in origin and tends to occur most often when the PWB is bent, during instances of high vibration, for example, or from BGA package warping. Mitigating pad cratering involves making changes to the pad geometry in select locations such as the corners of the BGA. Making changes in the type of PWB laminate, such as selecting materials with greater ductility, can also be helpful in mitigating the problem.

Stronger, smaller solder joints

The increased amount of research into the behavior of LF devices has also shown that small LF solder joints can last significantly longer than larger solder joints (see Figure 3). This surprising result is the complete reversal of what is found with TL components. With lead-based devices, a BGA with a fairly high standoff is more reliable than a BGA with smaller solder joints and a lower standoff. This knowledge drives the popular use of solder columns to improve solder joint reliability for

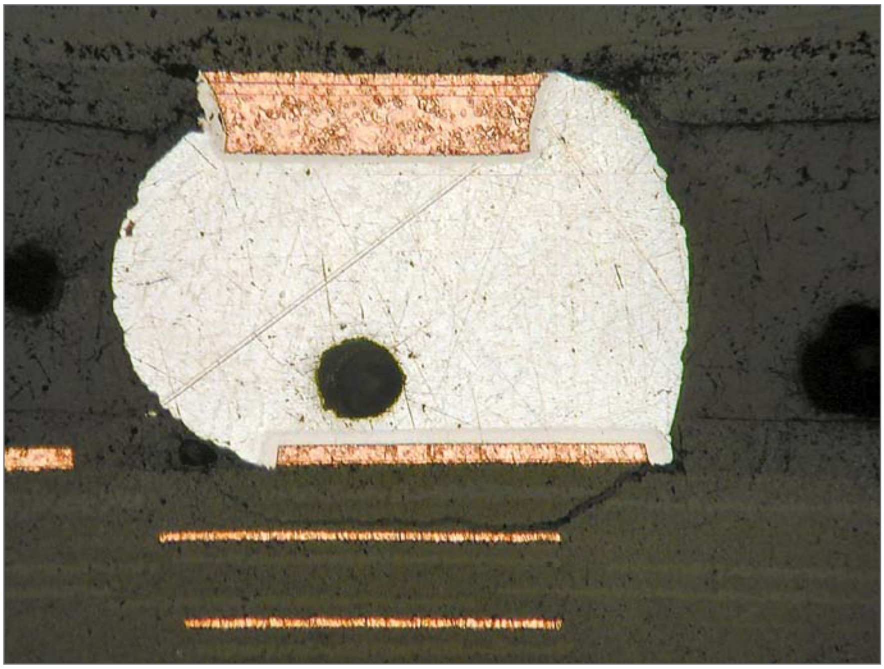


Figure 2 | Pad cratering on memory device

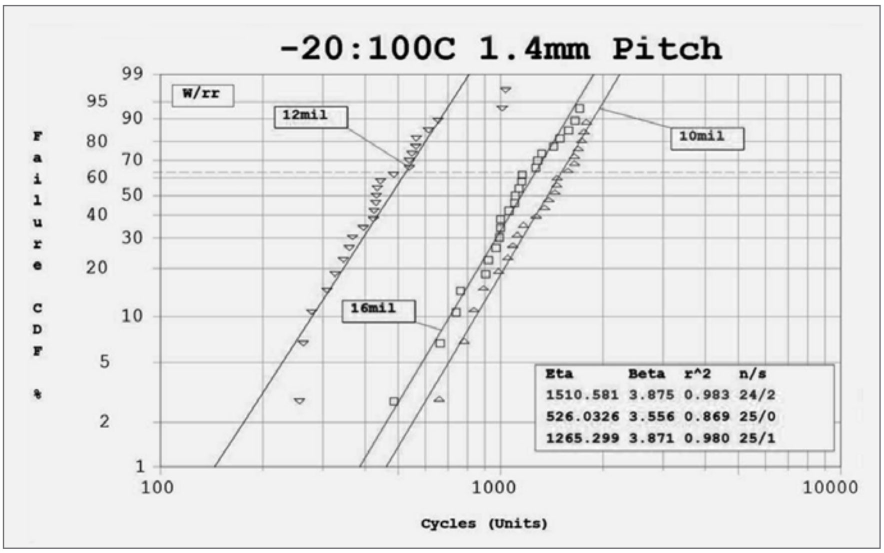


Figure 3 | Thermal cycling results of different sized lead-free solder joints (Courtesy: Universal Instruments) leaded components. Counterintuitively, new materials science research into LF parts/assemblies shows instead that small solder joint sizes – on the order of 100 microns or less – produce a different and beneficial solder microstructure (see Figure 4) that provides significantly greater reliability for LF devices than that found in solder joints larger than ~100 microns. As electronic devices continue to get denser, the trend toward miniaturization is likewise making solder ball pitches much more dense. The higher reliability of smaller solder joints that comes with LF components aligns well for future design trends in A&D system design.

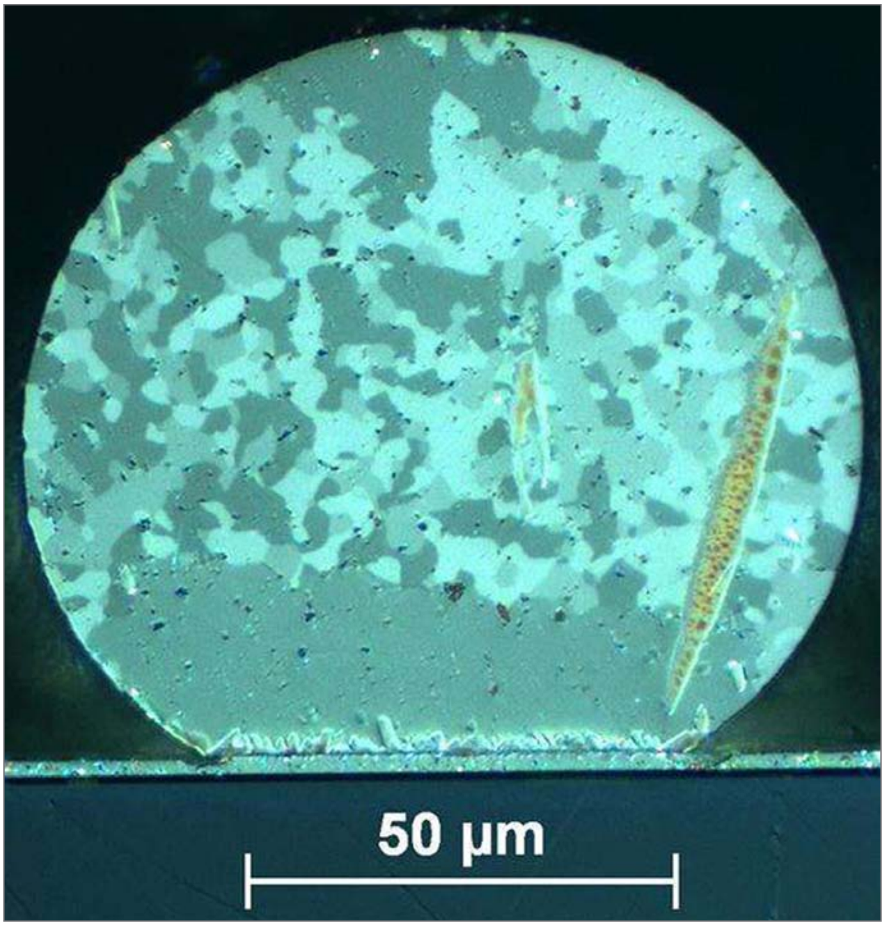


Figure 4 | Small lead-free solder ball with beneficial microstructure (Courtesy: Universal Instruments)

Choosing lead vs. lead-free options

Each designer has to make decisions about how and when to proceed with LF components. Today, there are three main options available to COTS vendors when deciding to adopt or avoid use of lead-free components:

1. Reball area array components to tin-lead, and solder with tin-lead solder.
2. Accept lead-free components and solder with lead-free solder (predominantly SAC305).
3. Take lead-free components and solder with tin-lead solder.

When done properly, the first approach essentially brings electronic assemblies to the baseline solder joint reliability of TL. This approach does not eliminate concerns about tin whiskers and, possibly, printed circuit boards, but further mitigations can be put in place such as solder dipping of non-BGA components and/or conformal coating. Reliability concerns also arise because of additional heat exposure and handling required for component reprocessing, although these can be mitigated through appropriate process controls. The direct costs associated with this approach are likely to be the highest of all three scenarios.

We now know that LF devices soldered with LF solder can be as reliable, or more reliable, than reballed LF parts soldered with TL. Results from recent testing that compared the reliability of LF BGAs soldered with LF solder with the performance of reballed BGAs soldered with SnPb, show that while both LF and TL typically deliver acceptable reliability, in virtually all cases, the LF/LF BGA outperformed the reballed TL configuration. Another surprising result in favor of LF is that thermal aging did not degrade the reliability of LF devices to less than that of TL devices; in fact, thermal aging improved the reliability of LF devices relative to TL-based parts. This is also good news because of the high cost in both time and money that reballing LF devices incurs.

The second approach, using LF devices with LF solder, is being used worldwide in other industries, and has been favored by some in the COTS industry because of lower direct costs and reduced lead-time impact. However, reliability risks remain with this approach and the burden of reliability proof will lie with the customer unless the supplier can show how they have addressed reliability risks and knowledge gaps. There is a large amount of data available for some aspects of this approach (for example, thermal cycling), but the details need to be assessed as to applicability to a manufacturer's products. Curtiss-Wright endeavors to be at the forefront of producing LF test data in A&D environments (for example, extended temperature cycling, vibration) on representative COTS components and assemblies, and comparing these to tin-lead and mixed solder approaches.

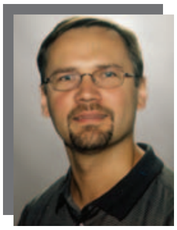
The third option available to COTS product designers is the mixed solder approach. In this tactic, area array components (for example, BGAs) with LF solder balls are soldered with TL solder.

This approach is an attempt to get the best of both worlds in terms of lower costs and lead-time impact (no time-consuming component reprocessing required) and less perceived risk (TL solder). Once again, the burden of reliability proof lies with the customer unless the supplier can convince them otherwise. While some studies have shown that this approach might result in acceptable thermal cycling reliability when using commercial temperature ranges, others have shown inconsistent reliability across several component packages using an extended temperature range. Overall, the details of this approach (for example, solder microstructure, strength, fatigue, and acceleration factors) are less understood than the LF approach.

Today, it appears that the first of the three approaches (reprocess to TL) is favored by the majority of A&D system integrators and prime contractors. However, the continuing drive to lower costs in A&D makes this approach less attractive. The second and third approaches involve lower direct cost, but until recently (for option 2), reliability has been a question mark for A&D customers.

Lead-free today

Recent research indicates that the reliability of LF components/assemblies can match and exceed that of leaded devices. The results so far suggest that TL-based components might soon become a thing of the past without reducing the reliability or performance of critical A&D embedded systems. Additionally, Curtiss-Wright continues to produce legacy products with lead-based components, and though we do not foreclose the possibility of designing new products using lead components, today most of our new products are lead-free designs. Recently derived extensive test data and industry experience have thus enabled the necessary "secret sauce" to develop mitigation techniques that ensure the successful use of LF components in the harshest military environments. **MES**



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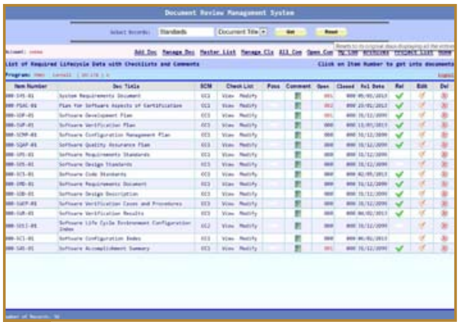

Managing FAA DO-178B/C, 278A, and 254 with one system

Certifying to FAA applications is an expensive, time-consuming process, but required for any software or hardware that is flight-critical on aircraft that travel through civil airspace. LDRA engineers in Wirral, United Kingdom, have found a way to make that process more manageable by creating the LDRA Compliance Management System (LCMS), which is a resource for developing infrastructure that supports DO-178B/C, DO-278A, and DO-254 compliance. LCMS ensures certification readiness through a process that includes LDRA Certification Services (LCS) professionals support from development and production through the maintenance life cycle.

LCMS combines detailed certification document templates with LCS consultation and training, guiding avionics engineers while they create the planning and life-cycle documents, process checklists, and problem reports required for certification. Developed by systems and equipment FAA Designated Engineering Representatives (DERs), the solution enables compliance with ARP-4754A, ARP-4761, DO-178B/C, DO-278A, DO-254, and DO-297 aviation standards. LCMS also may be integrated with the LDRA tool suite to match verification processes with the certification processes outlined by FAA and European Aviation Safety Agency (EASA) officials. The system is available in local and cloud-based environments. For information, view an LCMS video at http://opsy.st/LCMSvideo or visit http://opsy.st/LCSteam.

LDRA | www.ldra.com | http://mil-embedded.com/products/id/?9911983

ISR and big data applications enabled by high-density server

Limited server Size, Weight, and Power (SWaP), high-performance cluster computing environments are enabled by the RES-XR4 High Density (HD) Server and its Intel-based architecture from Themis Computer in Fremont, CA. The system can double the compute density of a stack of 1U servers with a weight savings of about 50 percent. It combines the kinetic and thermal management technology of the company's RES-XR4 rack-mountable server family, Intel Xeon E5-2660 Series processors, and Supermicro X9DRT-IBFF motherboards. Military applications for the server include ISR, virtualization, big data analytics, image processing, radar processing, and large Hadoop clusters.

The 40 lb. RES-XR4 HD system also has a rugged 20" deep chassis that can hold combinations of three separate, hot-pluggable HD compute modules: RES-XR4-HDC High Density Compute Module; RES-XR4-HDS High Density Storage Module; and RES-XR4-HDFS High Density Flash Storage Module. Each RES-XR4-HDS and RES-XR4-HDFS module has a companion high-density compute module. Storage and flash storage modules occupy two of four chassis slots. Six configuration options are available. RES-XR4 HD modules support as many as three 56 Gbps InfiniBand or 40 Gb Ethernet ports. Basic specifications include: two 8-core 2.2 GHz Intel Xeon E5-2660 Series processors, eight 16 GB memory modules for a total of 128 GB, and a redundant 1,200 W AC power supply.

Themis Computer | www.themis.com | http://mil-embedded.com/products/id/?9911984

Small, rugged push-pull connector has a 24-contact configuration

Fischer Connectors engineers in Alpharetta, GA, are targeting small military devices used in harsh environments such as portable communications equipment with their MiniMax rugged push-pull interconnect solution that provides more connections in a smaller space. The product is an all-in-one 20 signal (0.5 A) and 4 power (5 A) connector that has a patents-pending 24 mixed contacts. It has a durability of more than 5,000 mating cycles and has passed extreme temperature tests including 1,000 hours of saltwater spray.

Designed to meet reduced size and weight requirements, the MiniMax also cuts down on cost because it is not only a physically smaller connector, but its 24-contact configuration can mean fewer connectors are used. In addition, fewer cables are needed, and the solution is also 100 percent pre-cabled, which cuts down on integration time. The MiniMax is available in three latching systems: push-pull, breakaway, and screw lock.

Its profile is less than 7 mm inside the box. The device is sealed to 120 m both mated and unmated, has a keying system that can withstand more than 4 Nm of torque, and has overmolded assemblies that can withstand 100 lbs. of pull (breakaway) force.

Fischer Connectors | www.fischerconnectors.com | http://mil-embedded.com/products/id/?9911987

Object-oriented tool provides enhanced realism for military simulation and training

Military training and simulation systems need high-fidelity graphics avionics displays, communications equipment, maintenance systems, and automotive dashboards. The GL Studio designed by engineers at DiSTI Corp. in Orlando, FL, provides enhanced realism through its reusable 2D or 3D graphical user interfaces. The human machine interface development tool is an object-oriented design paradigm that produces self-contained smart graphical elements called Reusable Software Objects (RSOs). Each RSO includes the behavior and appearance of the object coupled with a well-defined interface. They are easily merged into master design projects by integration teams supporting large modular designs.

GL Studio's benefits include: reducing production and training costs, enhancing safety, improving learning and retention, increasing throughput on training assets, accelerating production cycles, and content supporting the total product life-cycle development. A Lumen runtime engine enables GL Studio users to expand their platform reach to include DirectX-based rendering. It also includes features such as animations, multitouch, support for new graphics card features, and advanced text capabilities. Users of Lockheed Martin's Prepar3D simulation software are using the Lumen engine feature of GL Studio to create cockpit and instrumentation content for their avionics simulation and training.

DiSTI | www.disti.com | http://mil-embedded.com/products/id/?9911986

Ultra small reed switch created via MEMS technology

Experts at Coto Technology Inc., in North Kingstown, RI, have leveraged high aspect ratio MEMS technology to create a small magnetic reed switch for high-performance applications that require extremely small switch size. The RedRock RS1-A-2515 reed switch provides all of the capabilities of conventional magnetic reed switch technology, such as zero power operation and high-power hot switching and brings them into a robust MEMS-based design and manufacture that uses wafer-level packaging.

The switch's footprint is less than 2.1 mm^2 (1.01 x 2.08 mm) and .94 mm high. The device has closure sensitivity ranges from 5 to 25 millitesla, enabling operation as high as 20 mm using a small NdFeB magnet – allowing it to address a wide range of applications. The switch has a release sensitivity of approximately 60 percent of the closure sensitivity. This high level of hysteresis minimizes the potential of sticking when the magnetic field is removed, greatly adding to the switch's reliability. The RS1-A-2515 has a maximum switching voltage of 100 VDC with a switching current of 50 mA DC or 35 mA AC, RMS. The zero operating power is important in power-sensitive applications, especially those operating with battery power.

Coto Technology Inc. | www.cotorelay.com | http://mil-embedded.com/products/id/?9911979

ARM-based SBC enables high-performance graphics

WinSystems engineers in Arlington, TX, are enabling high-performance graphics processing with their new line of Multicore ARM Single Board Computers (SBCs) based on the Freescale i.MX6 family of Cortex-A9 multicore processors. ARM cores coupled with readily available software tools help military and industrial embedded system engineers balance increasing performance requirements with low power constraints. The SBC35-C398Q comes with single-core, dual-core, or quad-core processor options. The low-power 800 MHz SBC35-C398Q SBCs provide high-performance and a rich array of onboard I/O for embedded designs.

The new product family features the scalable Freescale i.MX 6 processors in the 3.5" SBC format, 102 x 146 mm. The i.MX 6 processors make use of dedicated hardware accelerators to reach high-performance multimedia at low power consumption, while leaving the CPU core relatively free for performing other tasks. The video engines can drive three simultaneous display interfaces while still performing communications and control functions. The SBC35-C398 series also has the IO60 expansion connector to enable additional functionality. The specification supports I^2C, SPI, TTL-UART, and PWM signals enabling stackable expansion via off-the-shelf 72 x 50 mm modules or application-specific designs.

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