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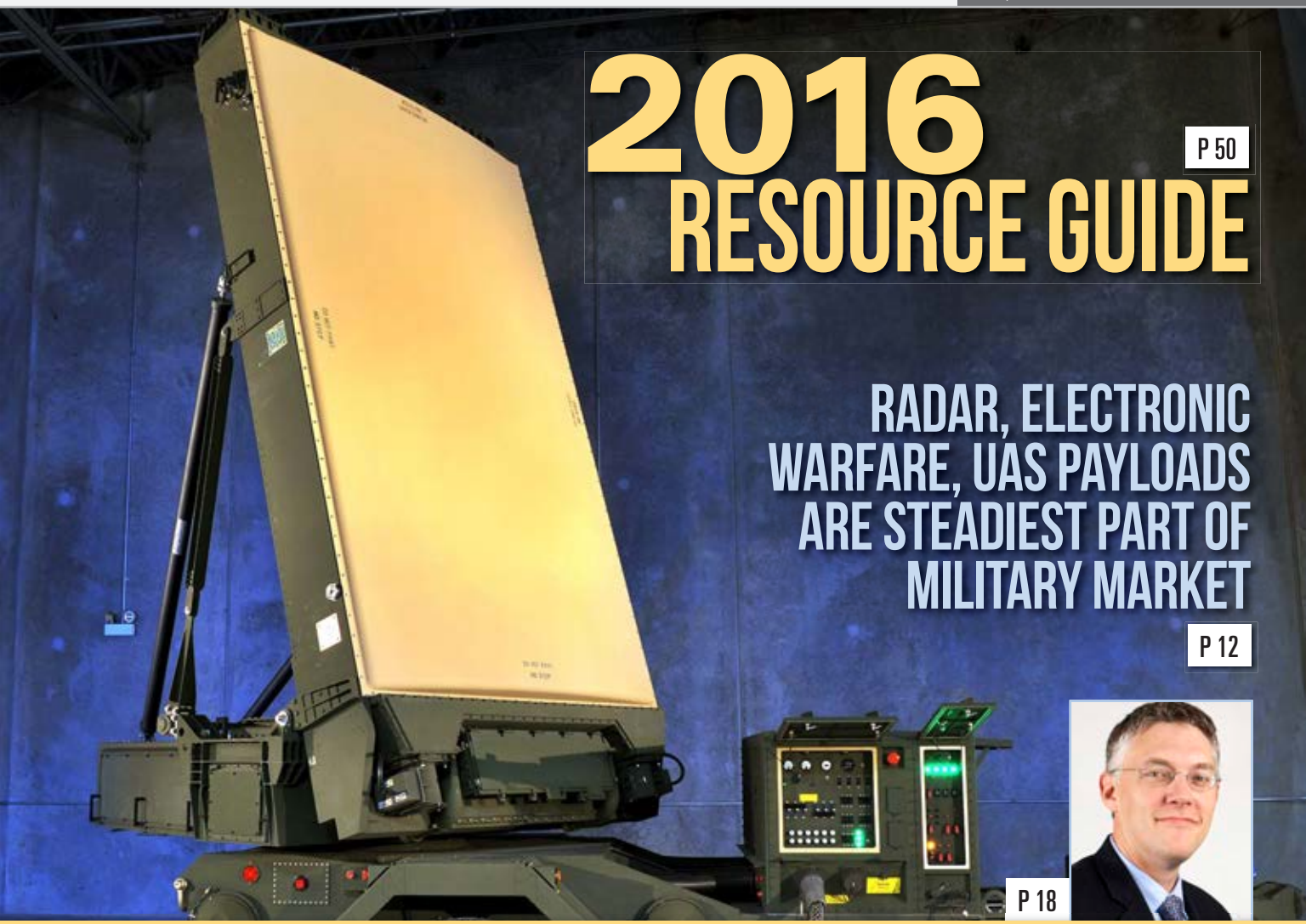

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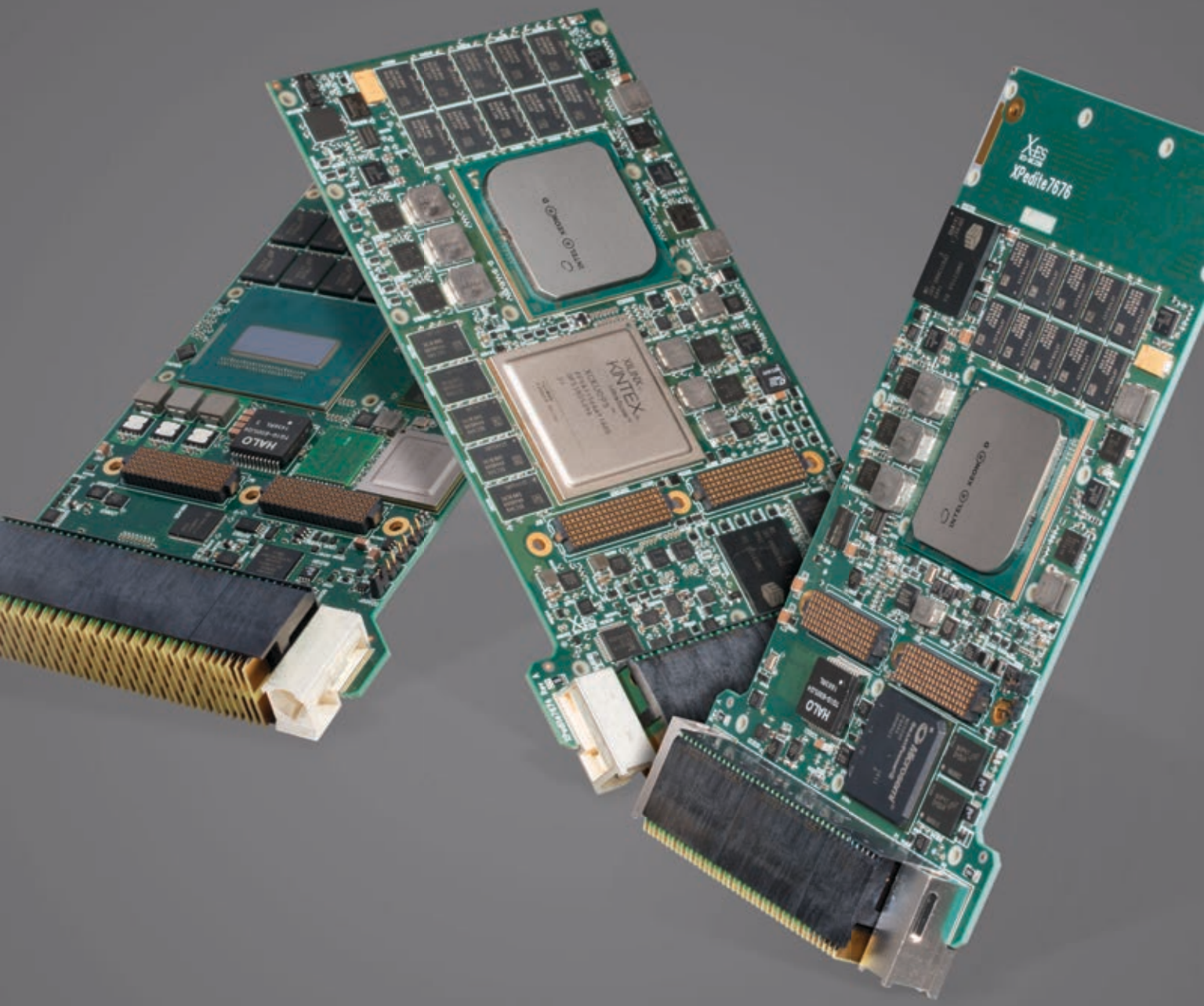

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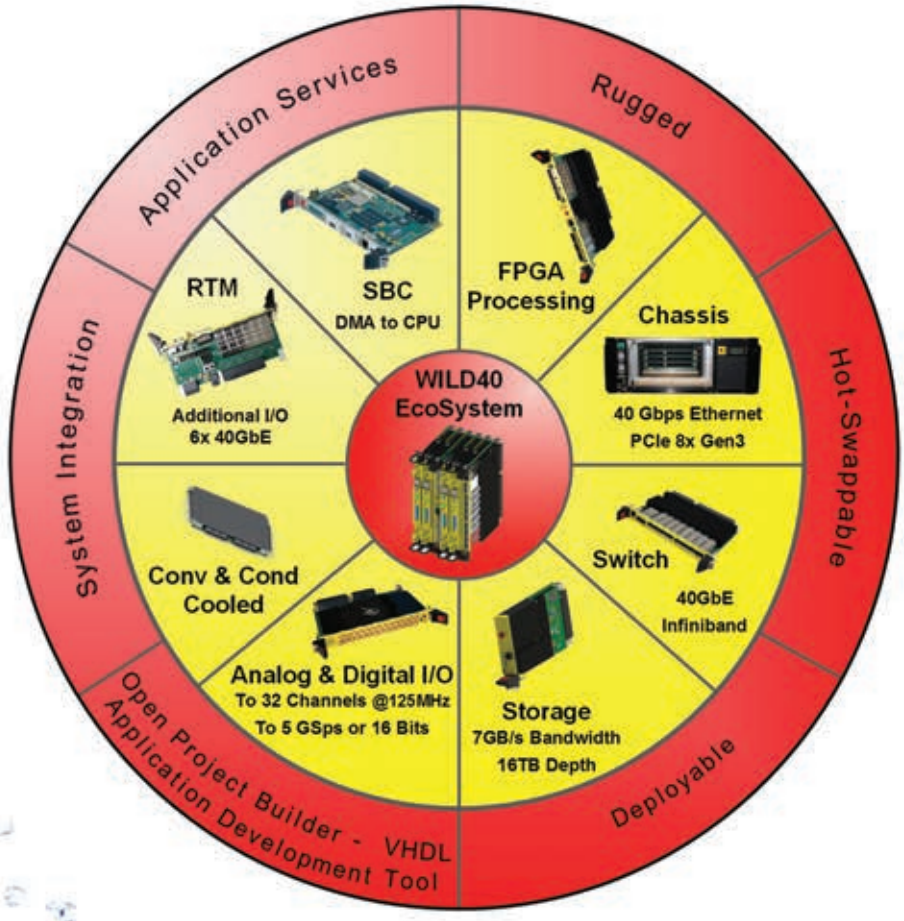

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ON THE COVER:

Top image: Demand for modern radar systems such as the Ground/Air Task Oriented Radar (G/ATOR) from North Grumman continues to be steady. Photo courtesy of Northrop Grumman.

Bottom image: The USS John Finn (DDG 113) is pictured here post launch. It is the 63rd Arleigh Burke Class destroyer and equipped with the Aegis Combat System. Photo courtesy of Lockheed Martin.

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Military market focused on sustainment and keeping ahead of obsolescence

By John McHale, Editorial Director

As we do in every September issue, we give an overview on the defense market from the perspective of industry analysts. We also take a closer look at how the military electronics community manages the obsolescence headaches that come with using commercial off-the-shelf (COTS) technology.

Never have these two subjects gone more hand-in-hand than they do now, as the U.S. Department of Defense (DoD) budget is essentially flat with the focus on sustaining major platforms through upgrades and modernizations, which are only effective if they stay ahead of obsolescence challenges.

"Programs are getting pushed off or delayed and when funding does come through it typically is not for the original full order, but often for significantly less product," says Doug Patterson, vice president of the Military and Aerospace Business at Aitech Defense Systems in Chatsworth, California. "DoD and production program budgets just haven't been there to support the defense industry and infrastructure, which is exactly what many in the current administration wanted – to cut deeply into the defense primes so that pain was felt."

Yet there are still opportunities even in this sustainment market, but they are not as huge as they would be if the DoD was spending billions more on Research, Development, Test, & Evaluation (RDT&E) or on launching new aircraft or ground platforms. (For more on market trends, see analysis on page 12.)

Steve Motter, vice president of business development for IEE in Van Nuys, California, says that "the budget cuts of recent times have actually created an opportunity in the sustainment of existing platforms [with] a demand for more tech insertion at the LRU [line-replaceable unit] level and major system-component level. This is an opportunity for small businesses that can leverage COTS [with] quick turnarounds [on] small orders In many cases end-users just want to replace a component, board, or display and find it [more efficient] to go around the integrator and right to the component [provider]."

That is good for the few small businesses that can perform that service, but not so much for the primes. The barrier of entry at any time in the defense electronics market is high, and is especially so now. You have to speak the procurement language of the DoD, know where the funding goes, have the relationships, and – most importantly – have the proven pedigree of product that has actually been deployed.

"Both primes [and COTS suppliers] have been hurt by sequestration, but one side effect of all this that definitely hurts the primes is the government labs going around [them] and acting as prime integrators themselves," says Roy Keeler, president of MilDef North America in Alexandria, Virginia. "They are managing programs to have more control and are outsourcing directly to embedded suppliers who in the past would have sold to prime contractors. They don't want to be held hostage later to expensive upgrades that are ten times the initial price of the product. It's about managing long-term life cycle costs and the labs feel the best way to do this in some cases is to cut out the middleman, meaning the primes."

He's right. It's about managing the long-term costs, which only gets harder as the funding dollars shrink, the programs order fewer spares, and program managers just try to keep their systems going till the next modernization cycle comes around – which could be anywhere from two years for the better-funded programs to a decade or more for others less fortunate.

To succeed in this environment, you have to hold up your end on obsolescence management, as military programs today literally can't afford to get hit with an end-of-life announcement on key components. The answer might not always be to go with COTS, due to its obsolescence problems; COTS also comes with other risks in complex systems, as Rick Fitzgerald, vice president of business operations for Avnet in Phoenix, Arizona, points out in the Industry Spotlight on page 42.

"Government agencies, designers, OEMs, distributors, and integrators can't simply put their heads in the sand," he says. "Everyone is accountable for the actions and outcomes of designing COTS solutions into technology, and the military space isn't a place for it to play a significant role."

Despite those legitimate concerns, COTS will continue to play a key role as budget cuts drive commonality to save money across multiple platforms by leveraging the same equipment and also leveraging common standards, which often mean more COTS use.

Even more than commonality, budget cuts drive uncertainty in all corners, from the component supplier to the embedded computing vendor to the prime contractor. This uncertainty will continue as we still don't know who the next president will be or what defense footing they will push forward.

The best bets for embedded COTS suppliers remain radar, electronic warfare, and unmanned systems payloads, as those areas have steadier funding levels and depend on commercial signal-processing and computing technology. Those companies that can succeed in this environment will be those that maintain capability while keeping costs down and remaining patient, as large RDT&E windfalls won't appear for some time.

Obsolescence insurance

By Charlotte Adams

An Abaco Systems perspective on embedded military electronics trends

In the commercial off-the-shelf (COTS) era, electronics obsolescence is a fact of life. Military demand represents only a tiny fraction of the commercial semiconductor market and the imperatives of the two sectors are worlds apart. The consumer market prizes constant innovation, despite the disruptions this drive entails. The military market, on the other hand, looks for the latest technology at the outset of a project, but requires logistics stability through extended development, production, and fielding cycles. Managing obsolescence issues has never been more important, given today's budgetary austerity.

Many COTS components become obsolete during a platform's development phase. An extreme example is the F-35 fighter aircraft: It's been 15 years in development and is almost 10 years behind schedule. The military is looking at major avionics upgrades for the platform even before declaring full initial operating capability. Part of the obsolescence problem may result from successful malicious cyberattacks, but some of it is also probably attributable to simply falling behind the technology curve.

Nevertheless, even relatively quick-turn programs are susceptible to obsolescence issues; they simply can't be avoided, given the relentless pressures in the consumer market.

What to do?

Program managers are not defenseless, however: Suppliers of embedded computing products typically offer product lifecycle management (PLM) services as insurance against disruptions in the supply chain. Although many small-buy programs would rather make upfront lifetime buys, multiyear programs planning larger buys frequently opt for long-term support contracts.

Lifetime buys of enough material to support all future builds and repairs are problematic, involving many unknowns. A program might buy too many boards, wasting precious funds, or too few, necessitating unplanned expenditures in the future. If the program tries to buy out-of-production components from a broker, there is the additional risk of introducing counterfeit parts. In addition, the go-it-alone approach involves the cost of storing parts in secure, climate-controlled facilities.

PLM services typically include elements such as obsolescence monitoring and reporting, configuration management, test and repair capability, knowledge and equipment retention, engineering and redesign expertise, and component storage. Another piece of PLM is collaborative planning with the customer to put together the best strategy. Strategies can range from defensive – where parts are amassed after the design is set – to progressive – where technology refreshes are planned at regular intervals. Hybrid approaches can combine elements of both defensive and progressive strategies. Users also can evolve from one strategy to another as the platform ages. The B-52 aircraft, for example – which has been out of production for 54 years but is still in use – has used both defensive and progressive approaches, as its upgrade requirements change. (Figure 1.)

An example of obsolescence support is Abaco Systems' PLM program, which includes long-term supplier relationships, storage facilities, and repair capabilities – including the retention of all test equipment – and dedicated teams of engineers to provide monitoring/reporting, repair/refresh, and configuration management for the life of a program.

It ain't easy

Obsolescence can be hard to predict. Memory chips, for example, can go out of production in two or three years, sometimes without warning. If a safety-critical flight control computer is affected, even such a modest change as the insertion of a new memory chip could require the requalification of the entire system.

Figure 1 | The B-52 has used a combination of defensive and progressive approaches to manage obsolescence. Vintage B-52 image courtesy Abaco Systems.

Processor suppliers typically provide more information about their roadmaps; even so, special-purpose processors, such as application-specific integrated circuits (ASICs), can be expensive to replace.

Managers of programs that will last a decade or more need to have some kind of mitigation plan. An unforeseen end-of-life component or product event – if no compatible drop-in replacement is readily available – could force time-consuming and expensive redesigns, possibly impacting operations. If a user without a prior support contract zooms in to a board vendor to make an end-of-life buy, for example, the premium for doing so might be two or three times the price of the original product. In contrast, if the customer is armed with a support contract and a long-term pricing agreement then the premium would be much more manageable.

Given that obsolescence is a fact of life, it makes sense to plan for it rather than just react to it. At moderate cost, obsolescence management programs offer ways to mitigate risks and keep a platform running as long as the user desires.

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NSA-approved two-layer encryption approach slashes cost and development time

By Paul Davis
An industry perspective from Curtiss-Wright Defense Solutions

In today's world, it is becoming increasingly important to be able to protect classified data-at-rest with encryption for critical data, such as that captured and stored during airborne intelligence, surveillance, and reconnaissance (ISR) missions. For some programs with limited budgets and schedule, using National Security Agency (NSA)-approved Type 1 encryption, the highest level of data protection, may prove impractical due to the high cost – typically several millions of dollars for a new development – and long process – typically two to three years that it takes to reach full certification. The cost and schedule required to deliver Type 1 encrypted hardware has meant that industry's ability to provide robust data protection has lagged far behind the demand.

The good news is that, in response to the growing need to protect increasing amounts of sensitive data, the NSA has initiated an alternative approach that provides a route for the use of commercially sourced encryption technologies for applications that do not require the highest levels of protection (for example, Top Secret/Unattended). For these transactions, the NSA/Central Security Service's (NSA/CSS) Information Assurance Directorate (IAD) launched the Commercial Solutions for Classified Program (CSfC).

According to the NSA, the CSfC Program "enables commercial products to be used in layered solutions to protect classified NSS (National Security Systems) information." The goal of the program is to "provide the ability to securely communicate based on commercial standards in a solution that can be fielded in months, not years." This means that commercial off-the-shelf (COTS) vendors can now, for the first time, significantly reduce the cost and time needed to deliver data security solutions that meet NSA approval. CSfC includes a definition in its "Data at Rest Capability Package" for two-layer encryption that incorporates software full disk encryption (SWFDE) combined with hardware full disk encryption (HWFDE).

In one approach to two-layer encryption, the hardware layer protection is handled by an application-specific integrated circuit (ASIC) that provides AES 256-bit encryption. The ASIC has been certified under National Institute of Standards and Technology (NIST) standards to the FIPS140-2 specification. While a software encryption layer can be done in a variety of different ways – using, for example, Linux or Windows – for the CSfC program NSA defines use of a certified version of an operating system, and points to Red Hat Enterprise Linux (RHEL). RHEL includes an encryption layer, dm_crypt, that performs the AES 256-bit encryption in software.

For COTS vendors who to want to use two-layer encryption in a product, the process starts by signing a Memorandum of Agreement (MOA) with the NSA to undergo CSfC certification. After the proposed product is successfully evaluated, it is placed on the CSfC Component List that integrators, such as prime contractors, can use to identify certified products for data protection. The system integrator can then apply to the NSA to use a specific approved product included on the Component List to encrypt the level of data required by their particular program. This approach enables system integrators to begin evaluating their data-security architecture and greatly reduces program risk.

Figure 1 | The Curtiss-Wright Data Transport System 1-Slot (DTS-1) supports the NSA two-layer encryption approach.

A rugged COTS product designed to support the NSA-defined two-layer encryption scenario described above, combining the ASIC and Linux O/S hardware and software encryption methodology in a single device, is Curtiss-Wright's Data Transport System 1-Slot (DTS-1), a rugged network attached storage (NAS) file server that provides high-capacity secure storage. (Figure 1.) The small-form-factor, single-slot NAS data transport system provides 2 TB of storage and supports two-layer encryption.

For aerospace and defense COTS customers, the advantages and benefits of the CSfC-defined two-layer encryption approach are clear. After a product is listed on the Component List, the cost of data protection essentially disappears, dropping from several million dollars to zero, since the COTS vendor has absorbed all the costs of the approval process. Once the system integrator gets the "go-ahead" from the NSA to use a particular Component List product in their program, they can simply purchase the desired product. This approach, using commercial encryption technologies, promises to speed the protection of vast amounts of critical data using COTS hardware.

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Director of Product Development – Data Solutions
Curtiss-Wright
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By Mariana Iriarte, Associate Editor

NEWS

U.S. Army's Apache helicopter gets radar upgrades

U.S. Army officials tasked LONGBOW LLC – a joint venture between Lockheed Martin and Northrop Grumman – engineers to upgrade the Army's Apache helicopter with the company's LONGBOW Fire Control Radar (FCR) under a contract worth about $89.8 million.

The company will also produce 84 Radar Electronics Units (REUs) and software upgrades. Work for this contract will be performed through January 2019 at Lockheed Martin's facilities in Orlando and Ocala, Florida, and at Northrop Grumman's facility in Baltimore. The FCR will provide Apache aircrews with target detection, location, classification, and prioritization. Officials also say that the REU is set to replace two FCR electronics boxes to reduce overall size, weight, power, and maintenance requirements.

Figure 1 | Two AH-64D Apache attack helicopters taxiing to their parking spot. Photo courtesy of the U.S. Army/CW4 Daniel McClinton, 1-227th, 1st ACB, 1st Cav. Div. Public Affairs.

DARPA selects Raytheon to develop NextGen communications network for airborne platforms

DARPA officials heading the Dynamic Network Adaptation for Mission Optimization (DyNAMO) program selected Raytheon BBN Technologies – a Raytheon subsidiary – to provide next-generation communications for manned and unmanned aerial vehicles. The two contracts total an estimated $9 million.

Under contract, engineers will develop two new capabilities, says Jason Redi, vice president for Raytheon BBN Technologies' Networking and Communications unit. "First, we will adapt radio parameters in reaction to changing information needs and conditions, so current and future airborne networks can communicate with each other." Next, Redi says, the company "will create an efficient way to share information across and between networks that are currently incompatible so that applications operating on them can share relevant data."

SOCOM tasks Battelle to build non-standard commercial vehicles

U.S. Special Operations Command (SOCOM) officials tasked Battelle to build non-standard commercial vehicles (NSCVs) under a five-year contract, with an additional option for two years, valuing $170 million.

Under contract, engineers will build armored and unarmored vehicles for SOCOM. Work will be performed at the company's manufacturing facility in Ohio. Officials say that Battelle vehicles have completed formal durability testing and system level armor testing.

Battelle officials also said in a release that their armored vehicles retain the Original Equipment Manufacturer (OEM) appearance, whether Hilux, Land Cruiser, and Ford platforms. The vehicles are re-engineered with crew protection, enhanced suspension for improved off-road mobility, and a reinforced chassis for durability.

Spaceship gets FAA operator license

Officials at the U.S. Federal Aviation Administration Office of Commercial Space Transportation (FAA-AST) have granted Virgin Galactic an operating license for SpaceShipTwo, also known as VSS Unity. This license award will ultimately permit commercial operations of the vehicle.

The license action was the culmination of several years of interaction between the FAA and Virgin Galactic. The license review process includes an in-depth review of the vehicle's system design, safety analysis, and flight trajectory analysis, eventually resulting in FAA-AST approval.

The Unity spacecraft made its first taxi test during August to evaluate and calibrate the navigation and communications/telemetry systems.

Figure 2 | VSS Unity will be able to perform commercial operations. Photo courtesy of Virgin Galactic.

3-D-printed, safety-critical parts fly on V-22 Osprey

Naval Air Systems Command (NAVAIR) officials announced the completion of a flight demonstrating critical aircraft component that were built using additive manufacturing (AM) techniques, also known as 3-D printing.

Pilots on a MV-22B Osprey performed a test flight of the aircraft outfitted with a titanium, 3-D printed link and fitting assembly for the engine nacelle, one of four that secure a V-22's engine nacelle to the primary wing structure. The 3-D printed equipment will remain on the aircraft for continued evaluation. According to the Navy, the flight was operated using the standard V-22 flight performance envelope.

"The flight today is a great first step toward using [additive manufacturing] wherever and whenever we need to. It will revolutionize how we repair our aircraft and develop and field new capabilities – [additive manufacturing] is a game changer," says Liz McMichael, [Additive Manufacturing] Integrated Product Team lead. "In the last 18 months, we've started to crack the code on using [Additive Manufacturing] safely."

Figure 3 | An MV-22B Osprey equipped with a 3-D printed titanium link. Photo courtesy of the U.S. Navy.

DoD selects Rockwell Collins' CRIIS to modernize test ranges

U.S. Department of Defense (DoD) officials selected Rockwell Collins for production and initial fielding of the Common Range Integrated Instrumentation System (CRIIS) to support and upgrade test ranges in the U.S. Air Force, Navy, and Army.

Under contract, Rockwell Collins will provide 180 ground and airborne subsystems to seven DoD test ranges; initial spares to establish a repair pipeline for system support; and support site activation with production hardware at NAS Patuxent River, Eglin AFB, Edwards AFB, and White Sands Missile Range.

Production work will be performed at Rockwell Collins facilities in Richardson, Texas, and Cedar Rapids, Iowa. The contract's estimated worth is $31 million.

U.K. aviation industry and Brexit

A Frost and Sullivan analyst says that the U.K.'s vote to leave the European Union (EU) will likely result in uncertainty in the aviation industry as well as a decline in traffic and revenue. The Brexit decision will have three major impacts on this aviation market, says Diogenis Papiomytis, Consulting Director, Aerospace & Defence, at Frost & Sullivan.

The first, he says, is major uncertainty, as it is still early since the vote for anyone to have developed a concrete view on what comes next. The analyst says that the second effect is the impact on trade and business traffic, while the third is the Brexit's effect of a drop in outbound traffic.

The new Prime Minister, Theresa May, has stated that she will not trigger Article 50 of the Lisbon Treaty, which would formally take Britain out of the EU after as many as two years of negotiations, before the end of 2016, Papiomytis says. Officials expect a new Transport Minister to be appointed and will likely make changes at the top of the Department for Transport and the U.K. Civil Aviation Authority.

USAF LVC training event integrates fourth- and fifth- generation aircraft

The U.S. Air Force collaborated with Northrop Grumman to integrate a 4th- and 5th-generation fighter aircraft during a live, virtual, and constructive (LVC) training event, part of Distant Frontier training at the Joint Pacific Alaska Range Complex.

During the demonstration, Northrop Grumman engineers integrated two virtual F-22 Raptor 5th-generation fighters to fly and train alongside four live 4th-generation F-16 Fighting Falcons. Northrop Grumman's LVC Experimentation, Integration, and Operations Suite (LEXIOS) linked the F-16 and F-22 participants.

The fighters trained for air-to-air combat against four live F-16s from the 18th Aggressor Squadron based at Eielson Air Force Base, near Fairbanks, Alaska. Distant Frontier provides unit-level training for local and deployed units to enhance tactical interoperability.

Figure 4 | F-16C Fighting Falcon. Photo by U.S. Air Force/Senior Airman Jake Carte

Radar, electronic warfare, UAS payloads are steadiest part of military market

By John McHale, Editorial Director

Demand for modern radar systems such as the Ground/Air Task Oriented Radar (G/ATOR) from Northrop Grumman continues to be steady. Photo courtesy of Northrop Grumman.

"Uncertainty" best describes the current outlook for the U.S. military market, with the next presidential election still undecided, as is the nation's future defense outlook. Regardless of inertia or doubt in Washington, military program managers and industry engineers must continue to keep the current defense electronics systems in air, ground, and sea platforms running efficiently to ensure continuing military readiness. Moreover, key radar, unmanned, electronic warfare, and other systems must still be modernized. All of this means that opportunities still exist for embedded electronics suppliers.

Sustainment environments in the Department of Defense (DoD) community mean there are few new programs demanding an avalanche of funding; most dollars are targeted to keeping the current systems running via upgrades/modernizations until more funding comes down the road. These modernizations – often for systems such as radar platforms; unmanned sensor payloads; electronic warfare (EW) systems; and command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) – leverage open architecture designs, say market analysts in the defense industry.

"There have not been any big changes and there are definitely fewer platforms these days," says Brad Curran, Aerospace and Defense Industry Principal at Frost & Sullivan. "The FY 2017 DoD budget request was not much different than the year before, where President Obama and his team kind of punted the ball down the field. My guess is that if Hillary Clinton wins it will be more of the status quo and a smaller force and if Donald Trump wins, we will see a pretty sharp spike in Special Operations forces, but will still overall have a smaller force."

Radar

One area that looks to be steady with upgrades and new contracts is the military radar market. "For 2015 there were $2.50 billion in new radar contracts awarded with 64 new awards," Curran says. "This is slightly down from the $2.95 billion awarded in 2015. So far in 2016, through August 15, $821 million in new military radar contracts have been awarded."

Leading the way, as always, "in 2015 was Raytheon, which had $871.5 million in Army, Navy, and Air Force contracts," Curran continues. "Lockheed Martin came in at $426 million in contracts, led by its Long-Range Discrimination Radar for the Missile Defense Agency and the Army's AN/TPQ-53 radar. Northrop Grumman had $480.8 million in radar contracts in 2015 led by its G/ATOR [Ground/Air Task Oriented Radar] work and also the Counter-Rocket, Artillery, and Mortar (C-RAM) Intercept for the

Army, which is a neat program as it helps combat small shells and also serves as a counter-unmanned aerial vehicle system. (Figure 1.)

"Boeing also won $340.6 million in 2015 contracts, with the biggest one focused on modernizing the radar systems for the entire F-15 fleet of aircraft," he adds.

Radar, like many other application areas, is not receiving much research, development, testing, and evaluation (RDT&E) attention in the DoD's FY 2017 budget request.

"While funding for radar has not been coming so much for RDT&E, there have been a number of service contracts awarded and there is still quite a bit of procurement happening," Curran notes. "Raytheon continues to sell Patriot radars and is enhancing the Navy's Relocatable Over-the-Horizon Radar. Harris also won a $70 million contract in May from the Navy to provide 42 COTS [commercial off-the-shelf] precision

Figure 1 | The Lockheed Martin TPQ-53 radar continues to be in demand from the U.S. military. Photo courtesy of Lockheed Martin.

approach radar systems for the Army, Navy, and Air Force. Another interesting radar system in development is Lockheed Martin's Silent Knight terrain following/terrain avoidance radar for Special Operations applications."

China's increasingly aggressive actions in the Asia Pacific region are also forcing U.S. military planners to take a look at upgrading their maritime missile-defense and radar capability.

"Another strong area for radar modernization is in maritime systems, as the U.S. looks to upgrade its missile-defense capability in the Pacific and that of its allies like Japan and South Korea," Curran says. "The Navy also continues to modernize the Aegis Combat System in the fleet, as well as Aegis Ashore. The Navy wants to ensure that their ships in the Pacific can defend themselves against incoming anti-ship missiles."

Radar outlook – long-term

"Looking ahead, how the U.S. deals with laser-based weapons, power-based weapons, and hypersonic missiles from a radar perspective will also be important as our adversaries develop these threats," Curran says.

"A big decision will also have to be made fairly soon regarding the replacement of the Patriot radar, as it is getting pretty long in the tooth," he adds. "There has been system development and incremental improvements to the current system, but some say – to deal with new technology and new threats – it will need to be replaced. It's also not a guarantee for Raytheon that they will win the replacement contract, as Northrop Grumman and Lockheed Martin are going to look to make bids as well."

"Radar modernizations are also opportunities for COTS suppliers, as you have to use COTS on signal processing capability, high-performance FPGAs, and now gallium nitride (GaN) technology, which is becoming essential on the RF and microwave side of radar systems," Curran says.

Electronic warfare

Another military application area dependent on GaN technology and innovations in embedded signal processing is EW.

The total EW funding in the FY 2017 budget request increased to $3.75 billion from the FY 2016 DoD budget request of $2.9 billion, Curran says. "The total number of new contracts awarded for EW in 2015 was 61. In 2014, the EW segment was at about $2.75 billion, with 67 contracts.

"For EW operations, a good bit of funding still goes toward Cold War near-peer adversary operations," he continues. "For example, whenever the Russians overfly U.S. ships they paint us [target the ships with their radar] and we gather electronic intelligence (ELINT) and signals intelligence (SIGINT) data from them. It helps us learn more about the capabilities of their new systems and update our countermeasures appropriately. Counterinsurgency operations are also being supported.

"I'd wish they'd spend a lot more on EW as our adversaries continue to enhance their own EW capability," Curran says.

C4ISR and cyber

Another area seeing an increase in funding is also one embedded-computing companies serve – the C4ISR market and its increased emphasis on cyberdefense.

"I had C4ISR at $43.6 billion in the FY2017 budget, an increase over the $39.54 billion estimated in last year's budget request," Curran says. "One of the big increases was in Operations and Maintenance (O&M) funding for enterprise IT, especially for a defense healthcare network. About 15 to 20 percent of any enterprise network spending is also going to be for cyber – for cyber after the fact or to have more cyber included in a new program. But now the emphasis is shifting to securing networks to securing combat systems.

"The increase in cyber funding is unlikely to subside any time soon, as an inherent portion of enterprise networks for health care, logistics, administrative functions are still important to secure and then you have the additional contracts to plug any holes in these systems," he continues. "Other DoD cyber applications that could be opportunities for commercial companies include cybersecurity for cloud infrastructures and big-data activities. Commercial encryption and cyber is nearly as good as most government technology, so most applications are perfectly fine to use for government-issued mobile devices."

Military communications

Software-defined radio (SDR) technology for military communications systems continues to move forward in development and in fielded equipment, though a bit more slowly than other application areas.

"A radio that can switch back and forth between multiple waveforms is still a goal the government is aiming for, even years after the Joint Tactical Radio System (JTRS) faded away and split up into other programs and nondevelopment items (NDIs)," Curran says. "The technology – SDR – is still too hard to do, so we have to lower operational expectations while continuing to make improvements. We recognize switching simultaneously between waveforms with small radios is not as easy as we thought. To maintain operational reliability, the U.S. is making sure they have separate sets for unique missions.

"Having said that, most of the SDR action today is with Harris and their Falcon family and the FlexNet from Thales," he adds. "One thing for certain is that future radios will have a small-form-factor requirement, with an emphasis on reducing thermals to enable the use of more signal processing. I'm a fan of SDR and see it continuing to be an investment for the U.S. military."

Analysts at Technavio in Elmhurst, Illinois, also see increased requirements driving the global military mobile-computing systems market over the next five years. They forecast the market to grow at a CAGR of more than 7 percent by 2020.

Avionics outlook

"The military avionics market has been kind of quiet with few new starts hogging the attention and most of the money – to be blunt – being spent on the F-35 Joint Strike Fighter," says Wayne Plucker, Aerospace and Defense Director at Frost & Sullivan. "The market has had small negative CAGR even with most spending going toward the F-35.

"When it comes to avionics upgrades, the modernizations that are ongoing are not the wholesale kind of modernizations we've had in past," he continues. "They are more minor tweaks than anything else. And that is one way of saving money – to temporarily bite the bullet and upgrade only a certain number of systems now, essentially holding your fire until more funding becomes available downstream."

Rockwell Collins and Honeywell are still the leading providers of military flight avionics systems, "but there are a myriad of other computing elements on these aircraft such as mission computers for managing the ISR data on aircraft such as the P-8," Plucker states. Companies such as BAE Systems, Thales, CMC, and GE Aviation contribute in this area as well as in flight systems, he adds.

U.S. military unmanned aircraft funding

While the commercial unmanned aircraft system (UAS) market gets most of the press attention these days, with the Federal Aviation Administration (FAA) opening up portions of the national airspace to these aircraft, the military market has been more of a sustainment market focused more on payload designs than on new platform designs.

"The market right now is mostly one of sustainment as certain programs like the MQ-9 and the MQ-1C are dropping off in terms of production," says Mike Blades, Aerospace and Defense Senior Industry Analyst at Frost & Sullivan. "Meanwhile, the Triton MQ-4C is still in steady production. Then you have Unmanned Carrier-Launched Strike and Surveillance (UCLASS) aircraft going away and essentially becoming the Carrier-Based Aerial Refueling System (CBARS), which will have similar RDT&E funding levels to UCLASS but be pushed further to the right with regard to spending years." (Figure 2.)

The DoD's funding plans bear this out: "Based on the most recent DoD budget request, FY 2017, U.S. spending will be at about $4 billion for 2015, growing to $6.25 billion by 2021, with a CAGR of about 7 percent," Blades continues. "So we can't ignore a program that size, even if there is a chance it could be another totally manned bomber. If not for the B-21, the U.S. military unmanned aircraft market would be fairly flat through 2021, as the $2.5 billion increase we see by 2021 is all due to B-21. The B-21 is slated for just over $3 billion in RDT&E funding in the FY 2017 budget. These market totals aren't just platforms, but also include sensors, subsystems, and aircraft support and maintenance funding in the full estimate.

"Many of the smaller aircraft still being built are replacements for those lost in battlefield operations or those that have already flown their maximum amount of sorties and are being used for training in guard units," Blades says. "Where you will see growth at the platform level is with the small or micro UASs, but there are not a lot of official programs of record in this unmanned aircraft class. You will see a lot of funding going toward tactical small- and micro-UAS platforms that have medium-altitude long-endurance (MALE)-type capabilities and enhanced sensor payloads."

Figure 2 | The Northrop Grumman Triton MQ-4C unmanned aircraft is still in steady production, according to Frost & Sullivan analysts. Photo courtesy of Northrop Grumman.

Payload trends

"Unmanned aircraft funding today is targeting the payloads more than the new airframe designs," Blades says. "It is better and more cost-effective to upgrade the sensor payloads. Whatever may be the platform, the important thing is not flying 30 to 40 hours, it is about increasing the capability of the sensors.

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Other analysts also see the sensor payload market as a bright spot. Markets and Markets analysts in Vancouver, Washington, say they estimate the unmanned aircraft payload market's value at $3.63 billion in 2016, and are forecasting it to reach $7.72 billion by 2021, at a CAGR of 16.25 percent between 2016 and 2021.

"From what I know that number is not outrageous," Blades says.

"With any military platform, the smaller you get, the more the percentage of that platform is taken up by payload," Blades explains. "The payload consists of sensors, SATCOM [satellite communications], and data links and with the small ones you're talking about half the cost of a UAS. Even with large platforms, it applies proportionally. If you take the MQ-9 Reaper, 25 percent of it is payload – that does not count the ground-control station or extraneous equipment. For the Army Predator, about 20 to 25 percent is payload."

The question remains whether to process the payload sensor data on board the aircraft and then send it down, or to send the data down first. "The problem with sending the data later is that the data links are not capable of handling all the data being generated," Blades says. "Then when you scramble data and encrypt it, even more space is taken up. A solution to this bottleneck remains elusive. Optical data links, while wide, have to be line-of-sight, as the atmosphere can interrupt the link."

Who is best poised to grab the opportunities in sensor payloads?

"COTS and open architectures are growing in unmanned circles, but there will be areas that are proprietary for classified," Blades says. "I think the bottom line goes back to cost. For sensor payloads today, you need embedded computing on the front end and the back end; there are many companies that can build that capability, but the best will enable that capability in a way that costs less money."

Military vetronics

Over the last few years, the military-vehicle electronics, or vetronics, market has been the most quiet area of the DoD budget. The recent Joint Light Tactical Vehicle (JLTV) award to Oshkosh Defense did add some minor excitement to it last year, however. (Figure 3.)

Figure 3 | The Joint Light Tactical Vehicle (JLTV) award to Oshkosh Defense in 2015 was big news in the military vetronics community. Photo courtesy of Oshkosh.

"The military vetronics world is still quiet, even with the JLTV being alive and well," Plucker says. "There is still refurbishing going on for Foreign Military Sales and also upgrades happening, based on lessons learned in battle. We took some platforms in Iraq that we were able to make adjustments to in the field, but some need long-term fixes such as enhancements to situational awareness and improvement in power distribution.

"There are also some vehicles that will never be retrofitted, as they've been worn out, but there are some lightly used platforms that may have be around for many years," Plucker continues. "Stryker [armored combat vehicle] is a good candidate to last, as it probably has better legs than some other vehicles. Much of the work on military vehicles is low-level right now, as the revenue in this market segment is barely moving. Realistically, until the next president takes office and sets an agenda with a new Congress, we won't get a clear picture on ground-vehicle funding."

JLTV

"The JLTV getting life was a surprise to some and is kind of a neat opportunity," Plucker says. "It's just that the JLTV won't be a target-rich environment for the proliferation of computing systems because it's the jeep of the military world. As we start using the JLTV for special missions and such, we will see folks like DRS and BAE Systems having more to do in this area. But the initial JLTV investments will be to see if the vehicle works properly." **MES**

Counter-UAS market potential

As unmanned aircraft systems (UASs) grow in use for commercial purposes, they are also increasingly used as lethal threats. In response, a crop of counter-UAS systems have popped up to detect, identify, and mitigate or defeat these dangers.

"It is incredible to me how much this nascent market has exploded over the past year," Mike Blades, Aerospace and Defense Senior Industry Analyst at Frost & Sullivan. "We did a market insight on this about a year ago and had about 20 companies serving the counter-UAS market – separated out by defense and commercial. Now there are 60 or 70 companies trying to be a part of this market.

"Many solutions will use technology such as radar, RF components, acoustic microphones, etc.," he continues. "Some companies will use one of those sensors or a mix of them. Some solutions will just leverage a little bit of counter-UAS capability that can deployed to a forward operating base or carried over to airports. There a lot of ideas out there, such as firing nets at the drones, and even one that proposes to use eagles and other birds to take the UAS down."

"We will see a lot of partnerships form to build an effective counter-UAS system," Blades says. "Some that have already organized include Airbus partnering with Dedrone for defense and commercial applications. Blighter Surveillance Systems has worked with Chess Dynamics and Enterprise Control Systems to build what they call the Anti-UAS Defeat System, or AUDS. It is a military-grade counter-UAS system that will leverage RF and EO/IR [electro-optical/infrared] capability and will be able to jam the targets. Liteye Systems is their U.S. partner."

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Demand for RF technology for electronic warfare and radar systems increases

Ian Dunn

By John McHale, Editorial Director

Increased demand for electronic warfare (EW) systems and radar modernization means opportunities as well as increased pressure to innovate for radio frequency (RF) and microwave suppliers. In this Q & A with Ian Dunn, Vice President and General Manager of the Embedded Products Group in Mercury Systems' Commercial Electronic Business unit, he discusses this market trend as well as his company's acquisition of the RF and microwave business from Microsemi, where open architecture and commercial off-the-shelf (COTS) parts fit in EW systems, and enabling security in future sensor networks.

MIL-EMBEDDED: ***Please provide a brief description of your responsibility within Mercury Systems and your group's role within the company.***

DUNN: I am Vice President and General Manager of the Embedded Products Group, part of Mercury Systems' Commercial Electronics business unit. The group encompasses all of the traditional Mercury computing systems and some new investments in secure processing as well as system integration.

MIL-EMBEDDED: ***For many years Mercury Systems was seen as a large embedded-computing supplier for intensive signal-processing applications such as radar and electronic warfare (EW). Now the company has acquired key business lines from Microsemi, including its RF and microwave group. Does this acquisition change how Mercury defines itself in the military market? If so, how?***

DUNN: This acquisition is right in line with the transformation we've been going through since 2007 when Mark Aslett took over as CEO. He performed divestures of some of our nonperforming businesses in 2008 and 2009 and restored the economic core of the company to focus on embedded computing for defense, then laid out a plan with the management team to transform Mercury into a subsystems company. Mercury went from building just blades to building complete embedded-computer subsystems, which set the foundation.

Based on conversations with our customer base, we then focused on adding missing elements such as RF and microwave. Our customers told us that to be in the subsystem business, our systems need to be application-ready with RF capability in the designs and with the necessary manufacturing capacity to back it up.

MIL-EMBEDDED: ***Will the acquired Microsemi businesses keep their branding or be rebranded as Mercury Systems divisions and products?***

DUNN: There is only one brand – Mercury Systems – and we have been pretty disciplined about that inside and outside the company. As we've brought acquisitions online, we've often sold assets that were not a fit investment- or culture-wise. All of these actions have been strategic, meaning not simply buying something and stripping it down into subset of capability, but rather building a creative engineering organization complementary to the company's sensor chain strategy.

As far as reorganization is concerned, the acquired Microsemi businesses fit very nicely into our portfolio. Microsemi, over its years of acquiring companies, kept its inherent engineering culture intact. The company acquired a couple of RF institutions centered on a core expertise that we will preserve within Mercury. The Microsemi facilities we acquired will remain, increasing our global footprint, such as those in San Jose and Camarillo, California. This is somewhat different than our past strategy, which was to have facilities kept close together geographically. One unwritten rule within the military RF and microwave business is that customers buy near where their engineers reside. This is not the same in the computing market, because the work can be done in software.

MIL-EMBEDDED: ***Will there be consolidation, staff reduction, or other major reorganizations?***

DUNN: Our strategic acquisition goal is to grow the acquired business in a way that is complementary to other Mercury businesses.

MIL-EMBEDDED: ***Radar and EW are defense applications that have shown steady growth the last few years. How do you see the market for each application today and going forward the next few years? Where will the most opportunities reside? In radar upgrades? New EW systems?***

DUNN: We still think the fundamental growth area for the company is in EW with the right mix of RF capability to do broadband systems, getting as close to the antenna as we can get. You will see that in our marketing and the way we organize along the sensor chain. There is also a modernization revolution on the horizon in radar with elemental digital tiles. The U.S. government, defense prime contractors, and others are working to bring that to fruition.

If the radar revolution occurs in the near term it will create a tremendous computing challenge for designers to enable the tile concept in small, affordable solutions that are adaptable to meet the variety of threats out there.

For example, Mercury's signal processing solutions are deployed in the Patriot Air & Missile Defense System's radar and other defense radar and EW modernization programs.

MIL-EMBEDDED: ***Last month in San Francisco the RF and microwave community gathered for the International Microwave Symposium (IMS). What military RF and microwave design trends are you seeing emerging in this community?***

DUNN: In the sensor chain from the network on back there is a need for more multi-function systems. This puts pressure on designers to architect a system that enables multispectrum digital acquisition while simultaneously designing for multifunction capability to adapt to different threats. There is also a lot of pressure to reduce SWaP in these systems.

MIL-EMBEDDED: ***Are you seeing an increased demand for commercial off-the-shelf (COTS) technology and open architectures from your defense customers – in signal processing and RF & microwave designs?***

DUNN: What if open architecture can play any role in this area? You can custom design the antenna, then build a custom distribution system for that antenna, and then connect to a COTS solution. The antenna will likely stay a custom solution, but will distribution logic? This is not clear yet, but maybe if the right technology comes along.

Digital acquisition architecture? We have developed a portfolio to have that conversation with customers, talk about trade-offs and as part of our research and development are looking at what if any open architecture elements apply to enable multifunctionality more affordable and more configurable.

Right now you can take the custom antenna all the way through to digital acquisition. Custom designs and multifunctionality are not equal. Customization has limitations, as it does not necessarily enable affordability and adaptation of new technology in the long run.

MIL-EMBEDDED: ***In 2014 you penned an article for Military Embedded Systems titled "Is open delaying the future of cognitive computing." A concept called cognitive EW is gaining traction in military circles. Can it thrive with open architectures and standards? How does Moore's Law play in the RF & microwave world?***

DUNN: I alluded to a challenge there. If you can push my premise that proprietary architecture brings cognitive capability to life faster than with an open architecture, then there will be a fundamental delay before you have an open alternative. You are going to start to see open cognitive libraries. For example, Elon Musk [founder of PayPal] has announced that he will use open AI [artificial intelligence] as a tool for architecting intelligent cognitive capability. We are already seeing this concept

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For the DoD the problem is that cognitive data in the digital world is about data in the spectral world and for them converting the spectral environment into a searchable, exploitable, digital environment is an open architecture challenge in RF. To solve that we're investing in designs that move the open architecture interface closer to the antenna. The big dream is having an Ethernet interface on the back of antenna, enabling the antenna to see a fair amount of spectrum, which will enable the spectrum to be more exploitable.

It will most likely happen in the commercial world first, but DoD agencies such as DARPA can accelerate the adoption curve, not meaning that they deploy it, but that they can demonstrate the power of cognitive operations in spectral environments.

MIL-EMBEDDED: ***Looking forward, what disruptive technology/innovation will be a game changer in RF & microwave as well as signal processing applications? Predict the future.***

DUNN: One is direct digitization and we're amassing a portfolio for a day when direct digitization is possible. Currently it is not possible without more mixed analog infrastructure going into the chip itself because the broader you get the more you need RF circuitry in front of the device to shape the spectrum and to make it flatter and more linear in behavior.

Another is secure networking. The DoD has to get a lot smarter about secure processing and networking to realize the future of large sensor networks such as a future manned or unmanned aircraft with 100 sensors feeding a network of consumers across the globe. **MES**

Ian Dunn, *VP and General Manager of the Embedded Products Group within Mercury Systems' Commercial Electronics business unit, is responsible for embedded product development across the entire sensor processing chain. Previously, he was VP and General Manager of Mercury's Microwave and Digital Solutions Group. Before that, he was the company's CTO responsible for technology strategy and R&D projects. Dr. Dunn joined the company in 2000 as a systems engineer upon completing a Ph.D. at Johns Hopkins University in Electrical Engineering. As a doctoral student at Johns Hopkins, Dr. Dunn consulted for Disney Imagineering and Northrop Grumman on distributed automation and various high-performance computing projects. He has 20 years of experience designing and programming parallel computers for real-time signal-processing applications and has authored numerous papers and a book on designing signal-processing applications for high-performance computer architectures.*

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Shipboard embedded computing and COTS

By John McHale, Editorial Director

The U.S. military's funding for defense systems has been relatively flat in recent budgets, but Navy applications are seeing an uptick. The Navy is seeing a focus on modernization of shipboard systems – which require more rugged, embedded-computing systems processing – as well as rugged, state-of-the-art displays.

The aircraft carrier USS George Washington conducts a live-fire exercise of its Phalanx close-in weapons system (CIWS) in the Pacific Ocean. The Phalanx CIWS uses real-time video enhancement technology from ZMicro. U.S. Navy photo by Petty Officer 3rd Class Bryan Mai.

China's aggressive moves in the Pacific region over the last few years have forced U.S. Navy leaders to refocus their efforts not only on procuring new surface ships and submarines, but also on modernizing their current fleets and helping their allies do the same.

"The U.S. Navy plans a substantial expansion of undersea warfare capabilities even as the U.S. defense budget declines," according to Deloitte's "Global Defense Outlook 2016." The report says that recently announced plans include the acquisition of nine new Virginia-class attack submarines, development of new torpedoes and unmanned undersea vehicles (UUVs), and increased procurement of maritime and surveillance patrol aircraft. Nearly $42 million is budgeted for these naval spending programs.

Navy officials talk of applying Commander of Naval Surface Forces Vice Admiral Tom Rowden's vision of distributed lethality throughout the surface Navy, which means every platform will have an offensive capability to better counter threats from potential adversaries. This strategy will require enhanced networking and embedded-computing capabilities as the solutions fuel the performance of modern combat systems and intelligence, surveillance, and reconnaissance (ISR) applications

Embedded COTS tech

The increase is absolutely good for commercial off-the-shelf (COTS) embedded computing suppliers, "however, the budget does not necessarily mean new weapons systems," says Michael Carter, president of IXI Technology in San Diego. "I believe there will be continued focus to replace or upgrade aging systems through data conversion, emulation, virtualization, and the use of embedded, small-form-factor computing devices." IXI Technology offers the IXI-1 general-purpose processor solution on a configurable single-board computer (SBC) that integrates an Atom chipset into a small and low-power package that supports video processing for image recognition and analysis.

"The Navy embraces COTS as much as the other forces," Carter continues. "The Navy wants to buy COTS, but requires companies to design and develop products to Navy requirements and qualify them at company expense. If a company has a ready-made off-the-shelf product, it is still required to qualify it to Navy requirements; that's the real world. If that is the definition of COTS, the Navy has it down to a science."

Navy programs and priorities reflect the push toward COTS. "They don't have the same SWaP [size, weight, and power] constraints and so the Navy is able to save

some costs by using less-expensive technology," says Jason Wade, president of ZMicro in San Diego. "They definitely embrace COTS and an example would be the upcoming CANES [Consolidated Afloat Networks and Enterprise Services] program that represents a new, more cost-effective business model for delivering capability to the fleet. Where Navy shipboard applications differ from others is that they have more available space and less sensitivity to weight and power than, say, an aircraft or a ground vehicle.

"We definitely see growth in the military naval market," he continues. "This is attracting new entrants, such as Dell, who can provide low-cost commodity computer systems. Where we see new opportunities is in addressing the need for advanced video capability on virtually every Navy ship, aircraft, and vehicle."

Other embedded computing suppliers also see their COTS business growing in this application area as the gain in capability does not equate to a drop in environmental performance.

"The naval market continues to be very strong and growing for [us]," says Scott Kongable, president of Crystal Group in Hiawatha, Iowa. "Programs are willing to explore using rugged COTS servers in their technology-insertion and next-generation development efforts. "We find once clients realize they are gaining important advantages while giving up nothing in terms of environmental performance it is an easy decision to change architectural approaches." Crystal Group offers the RE1218M with SM XS11SSV-Q, which accepts the 6th-gen Core i7/i5/i3 processors and has 32 GB of DDR4 SO-DIMM. (Figure 1.)

Figure 1 | The rugged RE1218M from Crystal Group is used in Navy shipboard applications.

However, the choice of COTS is not always service-based, but rather more application-based and is often based on mission parameters.

Whether or not to use COTS often "boils down to the application, not necessarily the service itself," says Amos Deacon III, president of Phoenix International Systems in Orange, California. "Some naval-aviation platforms might use more COTS than, say, an Army platform, or vice versa. It really depends on the mission parameters and on the environmental requirements. Platforms with more benign environmental specifications, regardless of service branch, will likely use more COTS. Surface ships in the Navy have more room and more benign environments for electronics to save money and buy more COTS technology for their 19-inch rack systems. Submarines not so much.

"Those with more stringent requirements might need more custom-designed solutions," Deacon continues. "It also depends on how much funding a program has. They might like a certain commercial product, but the supplier or customer isn't willing to spend the extra dollars to get it up to snuff in terms of environmental or security specifications." Phoenix International offers the RPC24 4004 Series Drive magazine-based rugged storage solution, which supports TCG-compliant and FIPS 140-2-certified AES 256 encryption as well as instant secure erase when configured with solid-state disks and hard disk drives that have these capabilities.

Naval applications likely to use embedded COTS technology "in order, but not necessarily in volume, from first to last: unmanned systems, naval aviation, submarines, and shipboard applications," IXI Technology's Carter says. "The exact inverse order is in volume. SWaP requirements dominate unmanned systems and naval-aviation applications – both are searching for new technology to increase operational functionality while reducing weight. Submarines and ships are less impacted by SWaP, but are faced with aging systems and obsolescence that is driving the use of more embedded computers. The sale by IBM to Chinese company Lenovo of its blade servers has wreaked havoc on the Navy. Now Ingram Micro, the largest VAR of network servers in the world, is selling to a Chinese company."

Computing requirements

Some of the new technology that Navy program managers are getting excited about are innovations popular in commercial markets, as well such as virtualization, cloud computing, big-data solutions, and the like.

"The need for virtualization is becoming standard and not just for niche applications," says Chip Thurston, technical director at Crystal Group. "This means more compute, more memory, and less reliance on configurations that cannot change (as virtualization adds an abstraction layer between hardware and the [operating system]). The result is additional power draw requiring bigger power supplies."

"Technology exists today that can translate data from one protocol to another, with the use of an electronic interface with software operating code," Carter says. "Technology also exists that can use the same operating code, without the electronic interface running on an embedded computer in a server – true virtualization. Embedded computing, especially products with multiple processors and interfaces and that are small, light, and consume little power will dominate."

"Customers are also following the IT industry's lead on storage, mainly the shift to hyperconvergence," Thurston continues. "Over the past five years, hard drives were removed from servers, and most storage was on a local cloud, such as a SAN [storage area network]. With hyperconvergence, we use software to combine the disks on the individual compute notes into a networked cluster, and share them as local storage with backups, [which enables] scalability of the entire virtualization cluster with additional capacity in both compute and storage, dynamically and as needed."

Space-saving technology such as zero-client servers are gaining favor with the Navy as well. "Navy shipboard users are looking at saving space by leveraging thin-client or zero-client systems with no application software," says Steve Motter, vice president of business development at IEE in Van Nuys, California. "They are networked, and those networks are similar to other networks and will scale higher and higher as the size of the application continues to grow."

Shipboard displays

Much like the computing systems they are paired with, shipboard computing displays and video systems are also leveraging commercial innovations.

"Primarily, the types of displays placed onto submarines and surface ships have been operator consoles," says Motter. "Many of the ships are small cities themselves, with all sorts of different infrastructure, from the CIC [combat information center] to maintenance panels. What each display requires is an operator interface that accepts input of data, status, or maintenance information and then communicates back to a central location. The typical size is 24 or 25 inches." IEE offers the 24-inch Rugged Military Display for shipboard environments. It is based on a high-performance, heavy-duty, industrial grade, full-color, high bright, WUXGA resolution active-matrix liquid crystal display (AMLCD) with very wide viewing angles. (Figure 2.)

As Navy users look to present more and more info on the same display, they are exploring 4K technology for better resolution on a console that is typically viewed at arm's length, Motter explains. "The balance is to make sure you have effective pixel resolution while not flooding the operators with a lot of pixels shining at them."

"We are definitely seeing an emerging requirement for sophisticated real time video processing, including video enhancement, management and routing," Wade of ZMicro says. "I'm talking about the kind of real-time video ISR capability we see on an UAS [unmanned aircraft system] that provides actionable intelligence and supports split-second decision making. The Navy is looking at longer range "fixed-wing" UASs (like STUAS) on all ships. [Our] real-time video enhancement technology is already being used in the Phalanx CIWS, a close-in weapon system for defense against anti-ship missiles." ZMicro's ZX2-VCES video-capture and encoding platform is specially designed for high-performance video exploitation and integrates Intel Xeon processors, the latest e-ATX motherboards, high-performance NVidia and ATI graphic cards, and the GE ICS-8580 card for video capture, compression, streaming, and archiving capabilities.

The touch interfaces of Navy consoles are also becoming more commercial-like. "Touch screens are popular with the Navy as well, especially as everyone today is so accustomed to gesturing with tablets and cell phones," he continues. "They want multipoint gesturing on touch screens, which in the past has been a problem when it came to meeting the gloved-hand requirements of the Navy and other services. But touch screen controllers are accommodating gloved-hand operations now, enabling multiple levels of sensitivity that you can adjust on the fly."

Ruggedization demands

Navy shipboard applications, which have more benign environments than, for example, a fighter jet or an armored ground vehicle, still have tough

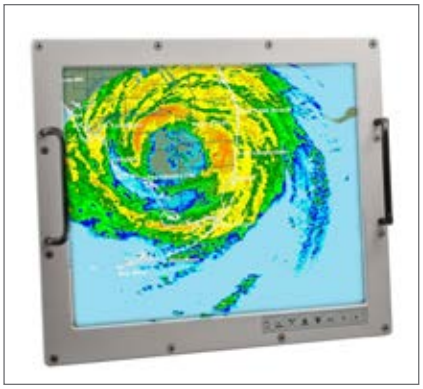


Figure 2 | The Rugged Military Display from IEE offers full-color display technology and wide viewing angles.

ruggedization requirements for computing and display systems that operate in their unique mission environments.

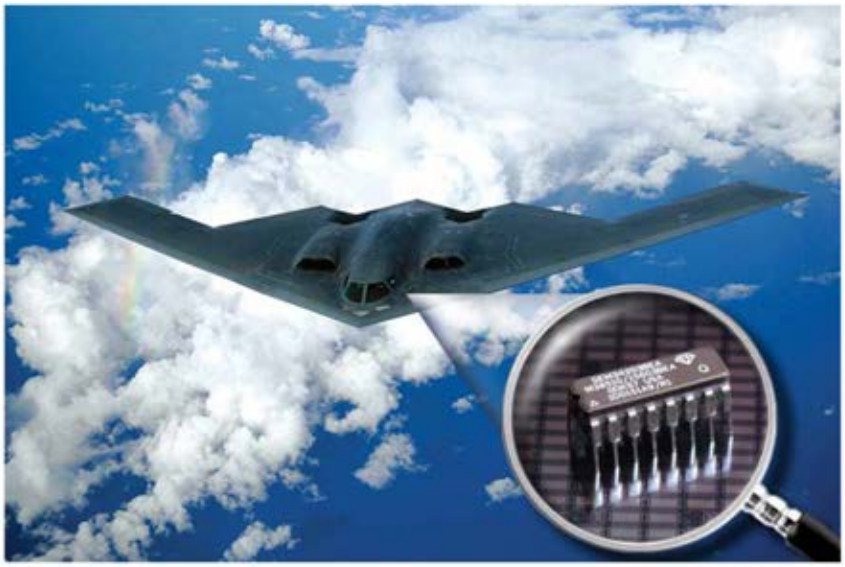
In terms of ruggedization and thermal management, shipboard requirements "tend to be much less stringent," Wade says. In fact, in many cases, commodity hardware will suffice. "While the open sea can certainly be a very rough environment, a Navy ship actually provides a relatively controlled equipment environment, not unlike a data center. So, in general, there has not been a stringent requirement for ruggedization or thermal management. Navy customers have traditionally come to us to help solve many of the logistical challenges associated with the shipboard environment, which is essentially a moving city. They want reliable servers and displays that are easy to maintain and upgrade. For example, the biggest value-add we provide beyond baseline environmental requirements are removable disk drives and fault-tolerant and failover power supplies for shipboard applications."

"When not on deck, many of the naval shipboard environments are shirt-sleeve ones, where it can be pretty benign in terms of temperature and they can get away with air-cooled and light ruggedization," Motter says. "The displays typically have the same ruggedization requirements as the computing systems – they have to be shock-isolated at the console level. It is nowhere near as severe an environment as a fighter aircraft."

Some shipboard environments do have tough ruggedization requirements to deal with, such as fog, salt, and corrosion, he continues. "They also require systems that meet MIL-STD 901 for big-impact shock, which is very challenging."

Rugged-computing supplier Crystal Group breaks its ruggedization techniques down "into three categories: 1) temperature, 2) shock/vibration, and 3) humidity," Kongable says. "To address temperature, we focus on moving a significant amount of air through our units by using high-speed, redundant fans. We provide a base system that operates at 55 °C or higher without the processors throttling at 100 percent. Custom systems to operate significantly above the 55 °C threshold [may] also be produced. In addition, we develop custom heatsinks to better cool processors and other high-temperature components. In some units, we integrate very-high-power GP/GPU cards with a liquid cooling system." **MES**

HIDDEN WEAPON



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The USS John Finn (DDG 113) is pictured here post-launch. It is the 63rd Arleigh Burke Class destroyer and equipped with the Aegis Combat System. Photo courtesy of Lockheed Martin.

The Aegis Combat System's continuous modernization

By John McHale, Editorial Director

The Aegis Combat System has been around since 1969, but modernizations of the Aegis fleet happen regularly, enabling the system to have the latest signal-processing technology, radar systems, electronic warfare capability, and more. In this Q&A with Jim Sheridan, Vice President of the Naval Combat and Missile Defense Systems (NC&MDS) market segment within the Integrated Weapon Systems and Sensors (IWSS) line of business at Lockheed Martin, he details the latest Aegis Combat System Baseline 9.C1 and the new capabilities it provides, the use of commercial off-the-shelf (COTS) parts and products and open architectures in the program, reduced SWaP trends, and potential game changers to naval warfare such as kinetic weapons. Edited excerpts follow.

MIL-EMBEDDED: ***Please provide a brief description of your responsibility within Lockheed Martin and your group's role within the company.***

SHERIDAN: I am the acting Vice President of the Naval Combat and Missile Defense Systems (NC&MDS) market segment within the Integrated Weapon Systems and Sensors (IWSS) line of business. I am also the acting General Manager for the Lockheed Martin Moorestown, New Jersey, site.

My group is responsible for the following roles: Aegis Weapon System computer program design, development, integration and test; Aegis Ship Integration and Test; Aegis International Programs; New Jersey Sites Operation and Maintenance; Aegis Product development for the Common Source Library (CSL); and LCS [Littoral Combat Ship] combat system development within the CSL.

MIL-EMBEDDED: ***The Aegis Combat System has been around for many years; what capabilities does the current iteration – 9.C1 – provide?***

SHERIDAN: It is true that the Aegis Combat System has been around for many years; in fact, the first Aegis Combat System development contract was awarded in 1969 to RCA. RCA later was bought by GE, which then spun off the military business to Martin Marietta, which later merged with Lockheed. The Aegis story has been one of continuous evolution. The program has continued to evolve since inception to pace the threat.

The current version being fielded offers the warfighter numerous new capabilities. I think the two most significant capabilities in that configuration are BMD 5.0 CU and NIFC-CA. Baseline 9.C1 offers a robust Integrated Air and Missile Defense (IAMD) capability. Both IAMD with second-generation BMD and Integrated Fire Control make these ships the most capable warships afloat – linking fire-control data with an airborne asset.

MIL-EMBEDDED: ***How has the SPY-1 radar been upgraded and/or what plans are there to upgrade this system?***

SHERIDAN: As part of the Aegis Weapon System, the SPY radar has evolved through many variants over the years, each offering significantly increased capability over the predecessor. These upgrades are not limited to the antenna: Signal processing capability improvements have been at the center of Ballistic Missile Defense capability improvements, with the latest for Aegis referred to as the Multi-Mission Signal Processor (MMSP). The MMSP is being installed onboard destroyers receiving Baseline 9 via modernization or new construction. The MMSP is also part of the Aegis Ashore configuration. SPY-6 comes on board with Flight III destroyers.

MIL-EMBEDDED: ***How many surface combatants have been outfitted with the new baseline capabilities?***

SHERIDAN: Six surface combatants are being upgraded, while three new ones are in construction. Here is a breakdown.

With Baseline 9:

- USS MILIUS (DDG 69) has Build 18.1.3.1 installed
- USS ARLEIGH BURKE (DDG 51) has Cert Build 18.1.2.2 installed
- USS BARRY (DDG 52) has Cert Build 18.1.2.2 installed (18.1.3.1 install scheduled in August)
- USS JOHN PAUL JONES (DDG 53) has BMD 5.1 / 9.C2 Build 21 installed
- USS MITSCHER (DDG 57) has Build 18.1.3 installed (18.1.3.2 install scheduled in September)
- USS BENFOLD (DDG 65) has Cert Build 18.1.2.2 installed (18.1.3.1 install scheduled in August)
- Aegis Ashore AAMDTC has Build 18.1.3.1.1 installed.
- Aegis Ashore AAMDS Romania has Cert Build 18.1.2.1 installed

Under construction:

- JOHN FINN (DDG 113) has Cert Build 18.1.3.1 installed
- RALPH JOHNSON (DDG 114) has Cert Build 18.1.3.1.1 installed
- RAFAEL PERALTA (DDG 115) has Cert Build 18.1.3.1.1 installed

MIL-EMBEDDED: ***In the Aegis upgrades, what is your approach to using COTS embedded computing technology and open architectures? What is the mix of custom versus COTS designs?***

SHERIDAN: The majority of technology on Aegis modernizations is straight COTS, except in specialty areas such as the MMSP. Aegis Open Architecture was introduced with the first cruiser modernization of USS BUNKER HILL (CG 52) in 2008. Since that time, we have been able to successfully separate dependencies of the Aegis Weapon System (AWS) computer programs from specialized computer infrastructure. We routinely work with mainstream computing companies such as Mercury Systems for signal processing and other capability.

When we transitioned to an open architecture in 2008 it enabled us to utilize software development tools through the Aegis Common Source Library (CSL). The CSL enables customers to rapidly integrate new capabilities and processes across the fleet in a "build once, use many times" framework. Aegis CSL can be used across a variety of platforms, ranging from multiple classes and types of ships to land-based systems. Through the Aegis CSL, an innovation or new systems integration made for one Aegis vessel can be leveraged across the fleet and around the world. It enhances life cycle affordability by reducing costs for integration, test, and certification.

Common is key. This commonality allows far greater interoperability across the fleet, which will further reduce training costs and improve flexibility in crew assignments.

MIL-EMBEDDED: ***How do you manage the associated obsolescence challenges with COTS?***

SHERIDAN: By working closely with the Navy customer on a preplanned rhythm for technology refreshes. We perform the refreshes on a four-year cycle – Tech Insertions (TI): TI 2008; TI 2012; TI 2016. The TIs are basically preplanned, thus eliminating many of the COTS obsolescence challenges so long as we maintain the spare systems long enough to get upgraded with the next TI. If you are short on spares you may encounter end-of-life issues. The key is getting a commitment to the process from the Program Executive Office (PEO) and the OPNAV resource sponsor. Effective obsolescence management requires teamwork at multiple levels. [Editor's note: OPNAV is short for Office of Chief of Naval Operations.]

MIL-EMBEDDED: ***How have you enabled cyber protection into the latest Aegis upgrades? If so, how?***

SHERIDAN: We obviously have cyber requirements and are addressing those requirements with the PEO. I prefer not to get into specifics, but it is a challenge and the bar continues to be raised as to what you need to protect.

MIL-EMBEDDED: ***Reduced size, weight, and power (SWaP) requirements are hitting all applications in defense electronics. How are they impacting the Aegis Combat System? What are the tradeoffs with smaller tech?***

SHERIDAN: SWaP has been impacting the Aegis Weapon System computer infrastructure in a positive manner. We look for ways of improving modularity, which lends itself to more rapid modernizations or technology refreshes. Reducing SWaP on programs also enables us to eliminate some cabinets and the real benefit to fewer cabinets is that you will have fewer cables. This is a big time saver, as removing cables and adding new ones takes many man-hours to not only install the cables, but to ensure the fiber-optic connection is right and that the connectors are transferring data the proper way.

Power demands will increase on the Flight III destroyer with the addition of the AN/SPY-6 and potentially the Surface Electronic Warfare Improvement Program (SEWIP) Block III active component. Both of those items require a great deal of energy and we need to make sure the ship has the ability to deliver the power necessary for each design.

MIL-EMBEDDED: ***What feedback did you get from naval crewmembers and commanders that impacted the upgraded designs – from human factors to capability enhancements?***

SHERIDAN: The majority of feedback has to do with the user's experience with the system – specifically, the man-machine interface/human factors. On occasion, the displays are such that a wealth of information, sometimes too much, is available to the operator. The crew wants as much data as possible, but too much can sometimes prevent them from executing their missions successfully. It's a balancing act and that's why it's essential to work closely with not only with our own human factors groups but to get feedback from the crewmembers themselves. Crew feedback is critical for making improvements, particularly when making a new capability introduction.

MIL-EMBEDDED: ***How has technology changed since you served in the Navy? What are the most impressive improvements?***

SHERIDAN: When I served on a ballistic missile submarine – a long time ago – I worked with monochromatic displays, which are ancient compared to the capabilities of the full color displays and user interface systems onboard Navy ships today. They are so much more intuitive now.

The size of the computing plant has also shrunk significantly. I remember an upgrade back in the 1980s that we thought was exciting because we were transitioning from a 256k system to a 512k freestanding computer that was five feet tall and about a foot-and-a-half wide. The entire computing power we had on the submarine I served on would likely be exceeded by an iPhone 6 today.

Technology development happens so much faster today and much of the innovation is happening in software. Our CSL consists more than 50 million lines of source code. We have more software engineers than hardware engineers, as

hardware has become a commodity, which we outsource to experts. Today we focus on designing militarized enclosures that enable this sophisticated technology to have a comfortable ride in maritime environments.

MIL-EMBEDDED: ***As Aegis continues to upgrade its capability, the enemy threats continue to evolve as well. What threats keep you up at night and how can technology effectively combat those threats?***

SHERIDAN: There is not any specific threat, but rather the pace at which potential adversaries increase their capabilities and the quantity of those threats that has me most concerned. Baseline 9 and future upgrades currently in development provide capability against those threats, but we need to go faster and get these capabilities installed on more ships sooner.

It takes 52 weeks to modernize ships – 26 weeks of industrial time and 26 weeks of testing. These ships are being outfitted with incredible capability, but the Navy can't afford to have more ships offline. Funding for Aegis capabilities has been steady because the technology is proven and works, but we need to find a way to modernize ships faster, possibly by looking toward more design modularity like we do with the Aegis Ashore program. Perhaps we should be expanding beyond just the current inventory of Aegis cruisers and destroyers, helping enable Commander of Naval Surface Forces Vice Admiral Tom Rowden's vision of distributed lethality, the adding of more combat power to all existing Navy platforms.

MIL-EMBEDDED: ***Looking forward, what disruptive technology/innovation will be a game changer for shipboard electronics and maritime radar systems? Predict the future.***

SHERIDAN: This goes hand in hand with what keeps me up at night. Adversaries are developing weapons at a faster and faster pace and we need to be even faster. Nonkinetic and soft kill technologies such as electronic attack (EA) and laser technologies will be game changers for the U.S. Railguns will also be fielded in the future. While power technologies for shipboard applications of these capabilities will be a challenge, it is a surmountable one. **MES**

Jim Sheridan, *Acting VP, Naval Combat and Missile Defense Systems with Lockheed Martin – Rotary and Mission Systems (RMS), has been with Lockheed Martin for more than 30 years. Currently he is responsible for all development activities associated with domestic new construction on the AEGIS Destroyer as well as the AEGIS Modernization Programs for both Cruisers and Destroyers. Additionally, he is responsible for the Ship Integration and Test (SI&T) activities as they pertain to AEGIS programs domestic and international efforts comprising more than 140 functional employees in both engineering and program-support organizations in Moorestown, New Jersey, and four field sites including two shipyards and a Washington field office. SI&T organization also includes a program management team of responsible for managing the $60-million-per-year SI&T contracts. Sheridan is also a retired Navy captain following a successful 26-year career in both an active duty and Navy Reserve capacity.*

Hardware-in-the-loop simulation testing for defense and aerospace systems

By Mariana Iriarte, Associate Editor

With hardware-in-the-loop (HIL) simulation testing, engineers are able to cost-effectively test aircraft components such as electronic control units (ECUs) and line-replaceable units (LRUs), running these components through complex scenarios.

Gripen aircraft make use of National Instruments' HIL-simulation technology for integration testing of its LRUs. Photo courtesy of Saab Aerospace/ Stefan Kalm.

HIL simulation is well-known in the automotive industry, enabling engineers to test embedded systems by simulating real scenarios. "HIL is putting hardware systems into control or measurement loops that will emulate or supplement behavior that you might get from a real-world part," says Dave Baker, vice president of engineering at test-and-measurement automation company G Systems in Dallas, Texas.

Cost and functionality factor into any design and development phase of a system: "HIL testing is invaluable because it allows these dangerous or difficult tests to be conducted with a great deal of fidelity, which saves cost and improves safety and reliability," says Bill Eccles, principal electrical engineer at automated test, data acquisition, and control system manufacturer Bloomy in Hartford, Connecticut. "Though manufacturers always test their products in the real world, there's simply no way they can exercise them in all conditions."

The scalability and maturity of this technology has enabled aerospace and defense companies to use HIL simulation to test RF signals. "That's pretty revolutionary that someone is using HIL with RF signals," says Adam Foster, senior product manager for test systems at National Instruments in Austin, Texas. "HIL is a big thing for aerospace and defense. It allows them to go after more corner cases in complex situations."

HIL subjects the part "to signals and conditions similar to those found in the real world. These signals are under the control of models of the real world, which run in a real-time test environment," says Eccles. The part "then produces signals which feed back to these models, and that makes a complete loop. The result is that the flight control, system computer, engine control, or whatever 'thinks' it's happily flying or rolling along even though it's stuck on a rack in a lab somewhere."

Signal testing

HIL-simulation testing can be helpful when conducting coexistent-signal studies in radar applications. With the signal generator and spectrum analyzer, "one of the important elements for the hardware-in-the-loop studies for coexistence is the ability to do radar echo generation," McCarthy states. Engineers can "set up a benchmark with the radar echo generator. You can put that at a runway at a fixed position, downrange of the radar, with 'X' number of signals at various amplitudes. Then as you introduce an interference signal, it could be cosite, it could be at an off-azimuth angle, it could be at a different amplitude or frequency," McCarthy explains. At this point, he says, "you can start to test the immunity of the radar."

The technology is also based on the same used in the wireless industry: "It is basically taking the communication technology used to create fading and multipath conditions to emulate cellphone propagation patterns." The technology to create those

multipath reflections is the same technology used to create echo returns in a radar, McCarthy notes.

Similar technology has been used in the automotive industry for several years to functionally test radars in a development and manufacturing environment and it has been used on military radar systems only within the last year or two, McCarthy says. "It has been starting to take off for people to functionally test the radar."

With military radars, for example, "you can benchmark the radar and conduct a full functional performance validation of the radar by putting in different echo returns," says Darren McCarthy, A&D technical marketing manager at Rohde & Schwarz USA in Beaverton, Oregon. "If your radar has the ability to receive a signal of -120 decibel-milliwatts (dBm) you can emulate ten targets offset in frequency, amplitude, and distance with ten returns.

"A couple dB each step and then you can test this sensitivity or selectivity of the radar as you introduced coexistent

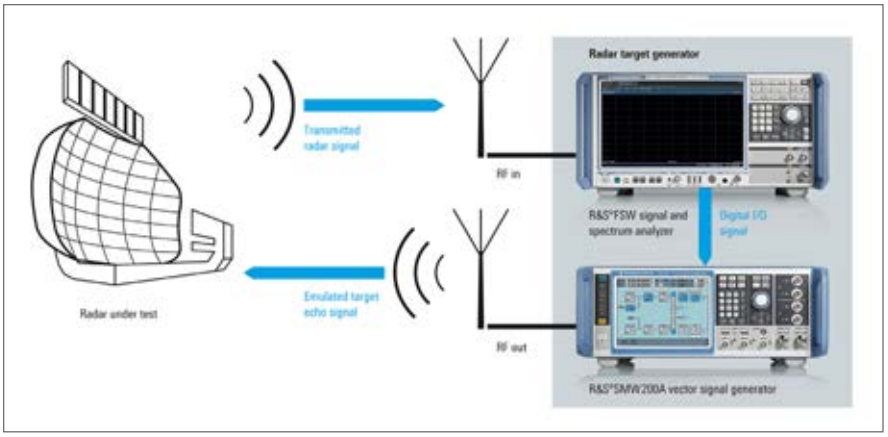

Figure 1 | The SMW200 and the FSW43 can create radar echoes up to 40 GHz. Photo courtesy of Rohde & Schwarz.

networks such as an LTE user device at a certain channel or frequency offset from that radar," he continues. "By varying the frequency offset and amplitude, a complete evaluation of the radar's performance and its susceptibility can be determined. By physically moving the coexistence signal to other angles of incidence, you can fully characterize the radar/antenna combination and come up with performance guidelines for the radar."

An issue is that "radars don't conform to any standard and so they don't really have set guidelines of how close a cellular network can be in frequency and not impact the radar," continues McCarthy.

Rohde & Schwarz has commercial off-the-shelf (COTS) vector signal generators and spectrum analyzers, such as the SMW200 and the FSW43 (Figure 1), that "basically receive a signal, loop it back, and then allow users to control offsets and targets using

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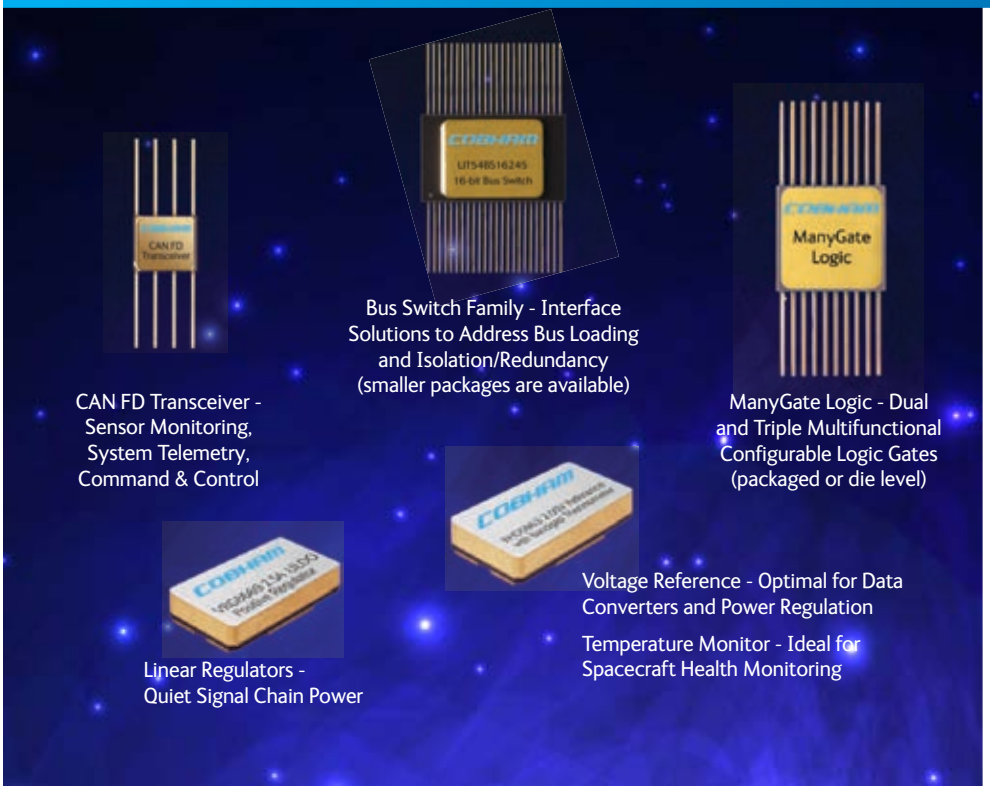

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Doppler, doing attenuation to emulate different radar cross-sections. Then as targets move away you can choose to have a typical link budget roll off of what the typical target would do."

Using HIL testing for aircraft

With airborne platforms, such as Saab Aerospace's Gripen fighter aircraft, engineers used National Instruments' HIL-simulation technology (Figure 2) for integration testing of its LRUs. "Saab Aerospace is focusing on HIL simulation to help drive down cost. Aircraft simulations can be done using physics models and using signal processing. It's not all software but it does require some hardware functionality in it," Foster says. "There are certain safety factors; you want to ensure you have as much test coverage in as many of the corner cases that this vessel or instrumentation could be put in."

Some simulations the aircraft can be placed in could be, for example, "If your airplane has engine failure, you need to be able to simulate how ECUs or LRUs are going to behave in these situations," Foster continues. "HIL lets you simulate those things without having to do all of the physical tests for it. So you're not going to have to build a prototype and staff it with somebody flying it and force them to do a nose-dive or blow up one of the engines."

Essentially, "HIL tricks the LRU, or ECU, or onboard control unit into thinking it's actually flying, and so it requires a lot of sophisticated instrumentation both to send the stimulus signal as it would be recorded or determined from physics models or recorded from empirical data," he says.

Testing the aircraft requires the engineer to understand every minute detail of the aircraft, from what type of material the wing is made of, to how fast the airplane will go, to what the wind conditions look like with humidity, Foster explains. "All that simulation and information requires an immense amount of processing power, but what you do is you basically plug in the ECU and run it through various permutations of flying conditions and failure modes, all while you're logging data."

As software becomes more prevalent, the "microtrend of hardware-in-the-loop would be as we digitize everything, and as we switch from mechanical control to electronic control, you get the ability to test it and continue to squeeze cost out of it. All the while you are creating physics models and running simulations that would give you very reliable results between simulated and real," he adds.

Testing and life cycle management

The data gathered from testing helps with life cycle management of these systems. "Life cycle management and obsolescence management is really a lot about software," says Adam Foster, senior product manager for test systems at National Instruments in Austin, Texas. "We're seeing software play a really big role in helping these folks, with programs like the B-52, the A-10 and F-18, the JSF [Joint Strike Fighter] – all of them are being asked to slowly augment the life cycle of these test systems."

Military and aerospace programs "last for decades and demand their own dedicated resources, either because of the amount of testing required or because of programmatic restrictions, which actually prevent sharing," says Bill Eccles, principal electrical engineer at automated test, data acquisition, and control system manufacturer Bloomy in Hartford, Connecticut.

Ultimately, when designing new systems, "we actually go through a pretty rigorous review of all the hardware that's involved to make sure that it has a known life cycle that will support the systems," says Dave Baker, vice president of engineering at test-and-measurement automation company G Systems in Dallas, Texas. "If there's not a known life cycle, we make sure that it's a piece of hardware that can be replaced and refreshed at some point in the future with a drop-in replacement. It's actually part of our design process to evaluate the product's life cycle to ensure it will sustain over the number of years that it's required."

Figure 2 | HIL simulation can be customized through open software, modular PXI and CompactRIO instrumentation, and signal conditioning (SLSC) modules. Photo courtesy of National Instruments.

Signal coexistence and finding a common ground

What's driving the industry to HIL simulation testing is more than just cost and functionality. The spectrum continues to be sold outside the military arena; with the coexistence of signals within the same spectrum, it has brought the industry to "look at coexistence studies and interoperating signals with the radars at the same time as communication systems," McCarthy explains.

Bringing more commonality into test systems across the industry will help in setting a standard across the board. As the military adopts LTE technology, there is a need to complete the standards and finish adding the functions by the working groups, he says. "You need to have spectrum studies for coexistence and allocations of that spectrum, selling the spectrum, but you also need to set policy for interoperability."

An ideal test-and-measurement industry would "have the same kind of architecture and basic platform design," Baker notes. "For instance, we might have an I/O map or interconnect system and that I/O map would be shared across six different test systems. Even though all six of those systems don't use the same map, we would reserve locations in that test system that would be common. You could replicate that many times and still support any of those six test articles." **MES**

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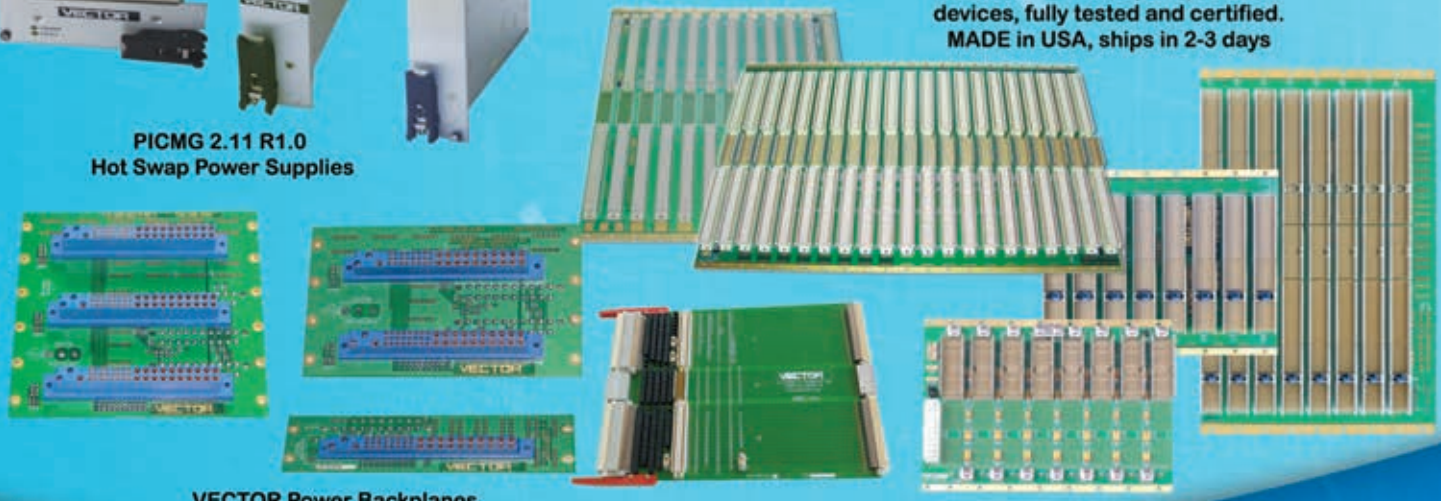

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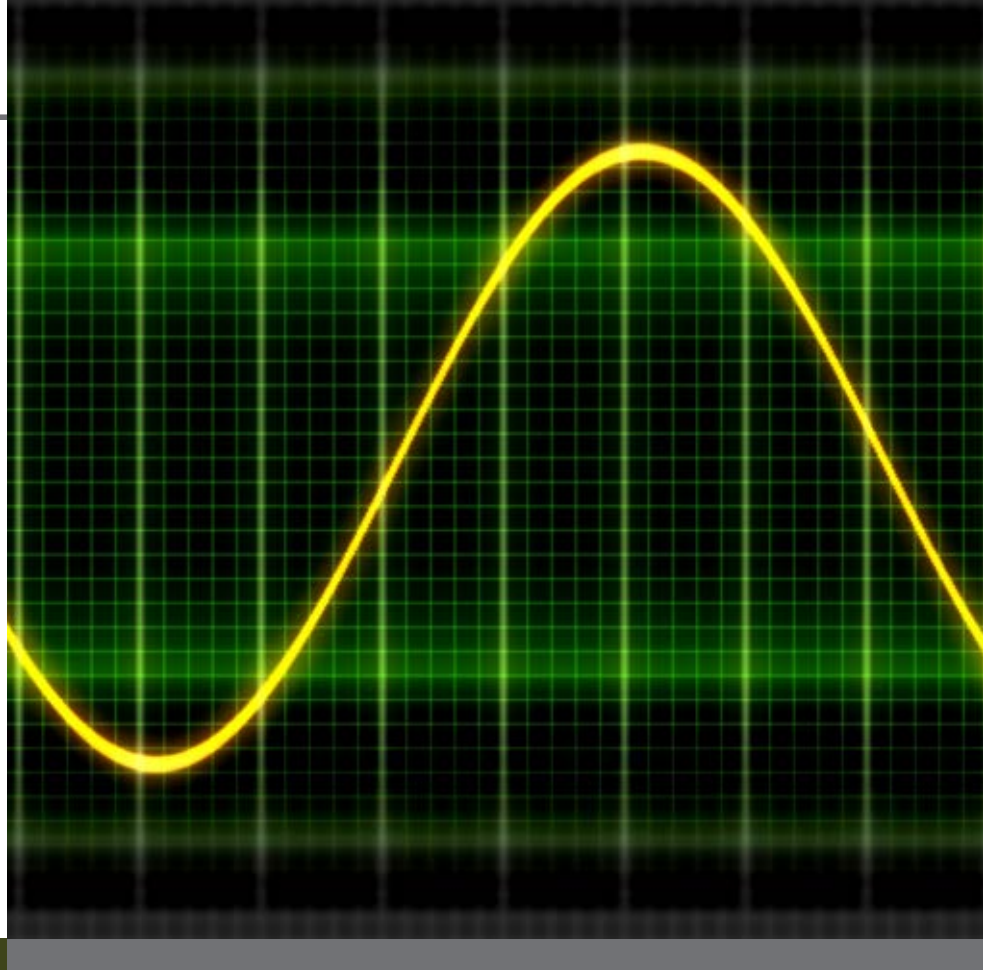


Oscilloscope segmented memory and pulse analysis software provide FM chirp pulsed RF evaluation

By Brad Frieden

A class of pulsed radio frequency (RF), microwave, and mmWave applications present a measurement challenge to radar and electronic warfare (EW) designers due to the need for wide analysis bandwidth, as well as a desire to evaluate a significant time period of system activity. Segmented memory in wideband oscilloscopes may be used, including pulse analysis software, to address these challenges. Radar and EW applications can also be further explored in terms of pulse amplitude, frequency and phase measurements, and optimizing accuracy.

If direct digitization techniques are used to achieve amplitude and phase-flatness advantages in pulsed RF measurements – as is the case when using particular high-bandwidth oscilloscopes – the related high-speed sampling approach will consume acquisition memory very quickly. Thus arises the need for "segmented memory" in which signals of interest are placed into memory segments and the receiver ignores the time when signals of interest are not present, as shown in Figure 1.

Achieving long target time capture in pulsed RF applications

Consider the example of a pulsed RF signal with a 15 GHz carrier frequency and 2 GHz-wide modulation. The oscilloscope must sample fast enough to handle the modulated 15 GHz RF pulse signal. That would require a sample rate of at least ~ 2.5 x 16 GHz, or 40 Gsa/s (gigasamples per second). To have some margin beyond the 2 GHz modulation on the carrier, and to avoid the rolloff of the scope bandwidth, the next highest sample rate selectable is the full 80 Gsa/sec of the scope for 33 GHz bandwidth capture.

Using a standard capture approach – where all samples simply go into the available memory regardless of what signals are present – at the full 80 Gsa/sec sample rate of a 33 GHz bandwidth scope, and using the full 2 Gpts (billions of acquisition samples) memory depth available, that corresponds to 25 msec of capture time:

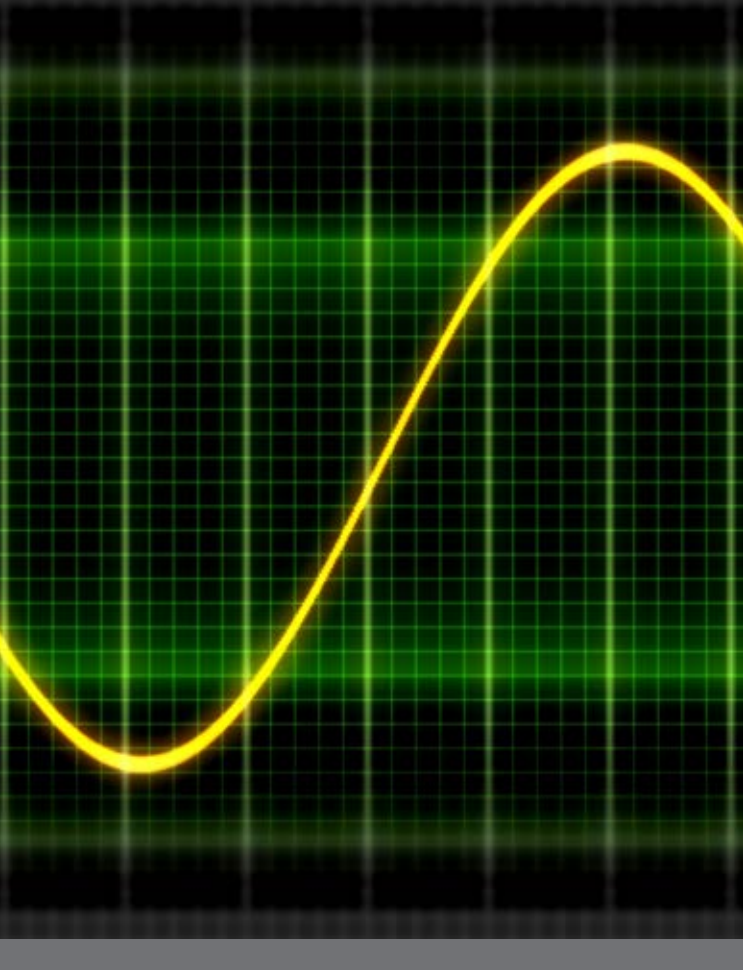
(2 Gsa) / (80 Gsa/sec) = 25 msec

Now consider a pulse train that has a pulse repetition interval of 100 usec (a pulse repetition rate [PRI] of 10 kHz) and 1 usec wide pulses. The related scope capture would include close to 250 pulses based on the following calculation:

(25 msec) / (100 usec / pulse) = 250 pulses

By using oscilloscope segmented memory, the number of pulses captured can be increased dramatically. With segmented memory mode, memory segments can be defined to be a little longer than the longest pulse captured. A 1.2 usec-wide segment size can be used to capture the 1 usec-wide pulses, for example.

The segmented memory capture can be set up to achieve 1.2 usec wide segments, where the memory depth is chosen to be 96 kpoints, and 32,768 segments as shown in Figure 2.



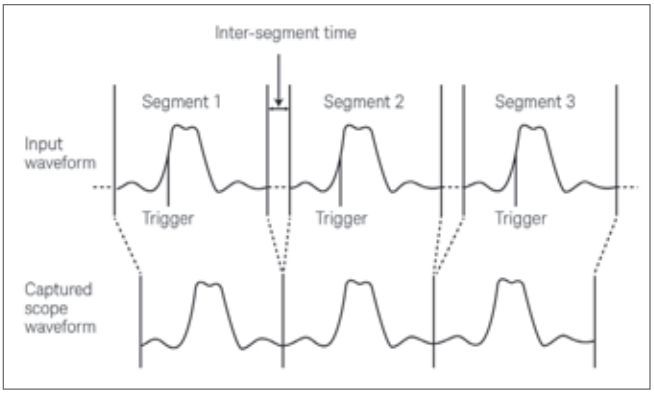


Figure 1 | Segmented memory approach, in which signals of interest are stored into memory segments.

The calculation for the required segment memory depth is very simple, knowing the sample rate is 80 Gsa/sec, and that a 1.2 usec segment length is desired:

(80 Gsa/sec) x (1.2 usec) = 96,000 samples

Now, by pressing the "Single" capture button, 32k pulses are captured and brought into 32k segments, which corresponds to 3.3 seconds of target activity time.

The segmented capture can be seen in Figure 3, taken on a pulsed RF signal with a 15 GHz carrier and 2 GHz-wide linear FM chirp modulation. Notice there is a "Play" button that allows a playback of the 32k segments. Notice also that statistics are calculated on the 32k pulses that were captured.

BY USING OSCILLOSCOPE SEGMENTED MEMORY, THE NUMBER OF PULSES CAPTURED CAN BE INCREASED DRAMATICALLY.

Figure 2 | Segmented memory setup to choose 1.2 usec wide segments for 1 usec wide pulse capture.

Figure 3 | 33 GHz oscilloscope segmented memory capture of 32k pulses into 32k segments, 1.2 usec per segment.

Enhancing pulse/radar measurements

The segmented memory can be controlled by vector signal analysis software so that statistical pulse analysis can be conducted on many RF pulses captured into segmented memory. Such analysis can be performed on digitally downconverted oscilloscope samples, where the format is now baseband I/Q and the measurement has been tuned to the center frequency and a frequency analysis span chosen to be just a little wider than the signal spectral width. This allows processing gain to reduce noise in the measurement.

After noise reduction, many measurements can be taken on the in-phase/quadrature (I/Q) data, including how the amplitude, frequency, and phase change across an RF pulse. An example of such measurements can be seen in Figure 4, where memory segments 3, 4, and 5 and the pulses contained in those segments are being analyzed.

In this example, the linear FM chirp frequency shift across the RF pulse is measured and compared to a best-fit linear ramp (see center-right pane). The difference between the measured pulse and the best-fit straight line ramp is calculated and displayed (horizontal trace with noise). One can see that the measured ramp and reference ramp have very little difference between them. The error trace is displayed with a 1 MHz/div scale and around 500 kHz peak deviation, and the Freq Error RMS in the bottom-right table is showing around 300 kHz of frequency error.

In a similar fashion, the phase shift across a pulse is compared to a best-fit parabolic phase shift (see top-right pane), characteristic of linear FM chirp modulation on radar pulses. It is possible to zoom in on the difference between the measured and reference to see how much a target system is deviating from the ideal, and see around +8 and -5 degrees peak deviation and a Phase Error RMS of 2 degrees (as shown in the bottom-right table of Figure 4.)

Figure 4 | Pulse-analysis software calculations based on measurements taken on oscilloscope segmented memory.

The spectral content of the RF pulse is seen in the left-center pane, a view of RF pulse envelope amplitude in the upper-left pane, and a view of the difference between the measured amplitude envelope and a best-fit straight line reference signal in the lower-left pane.

Finally, statistical analysis is possible on the measured parameters on the number of pulses captured into segments. In Figure 5,

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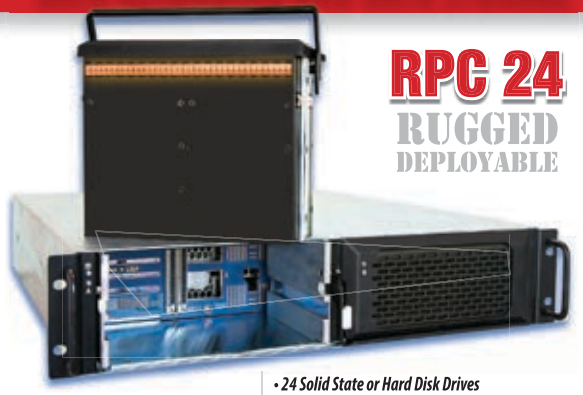

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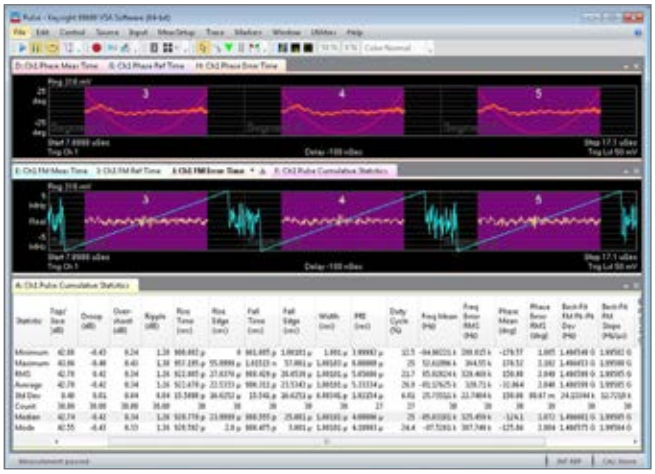

Figure 5 | Statistical analysis on 1,000 memory segments.

the statistical analysis can be seen in the pulse table based on 1,000 memory segments captured.

When directly capturing wideband pulsed RF signals, the fast sampling rate required can make the capture of many pulses a challenge since the available acquisition memory is consumed quickly. However, segmented memory is one way to address this problem by acquiring RF pulses into memory segments, and then turning off the acquisition during "quiet" time until the next RF pulse occurs. Pulse analysis software can both control a segmented memory capture and digitally downconvert captured signals into baseband I/Q data. This method effectively tunes the measurement to a specific carrier frequency with a frequency measurement span slightly wider than the signal under test, thus reducing noise and increasing measurement accuracy. System validation time is decreased through the ability to compare actual, measured pulse characteristics against ideal, relative, best-fit reference signals for amplitude, frequency, and phase, thus enabling the user to identify issues in signal creation or system performance. **MES**

Brad Frieden *is an applications engineer for the Aerospace/Defense Industry Solutions team of Keysight Technologies focusing on radar, EW, and satellite-related RF measurements using high-bandwidth, deep-memory oscilloscopes in conjunction with arbitrary waveform generators. He has been with HP/Agilent/Keysight since 1984. He received his BSEE from Texas Tech in 1981 and his MSEE from The University of Texas at Austin in 1991. Email the author at brad_frieden@keysight.com*

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Test and analysis tools help verify and enforce security in military systems

By Jay Thomas and Chris Tapp

Secure coding practices, properly tested and verified, can help assure the reliable and safe operations of military systems. Organizations should start from the ground up, using a combination of static and dynamic analysis, unit and integration testing, and requirements traceability.

Artist's rendering of the U.S. Air Force RQ-170 Sentinel unmanned aerial vehicle (UAV). A similar craft was said to have been captured over Iran during 2011 through hostile access to its internal control and navigation software. Artwork courtesy LDRA.

Security breaches in military systems can be devastating. An example of a security disruption with severe consequences was the purported capture in 2011 of a U.S. RQ-170 unmanned aerial vehicle (UAV) operated by the CIA over Iran. According to Iran, the craft was safely landed by Iranian cyberwarfare units that managed to take it over. The assertion was that the UAV was captured by jamming both satellite- and land-originated control signals to it, followed up by a GPS spoofing attack that fed the UAV false GPS data to make it land in Iran at what the drone thought was its home base in Afghanistan.

While the actual details may never be clear, it does appear that the drone was compromised to the extent that it could be safely landed in Iranian territory and passed into the possession of the enemy for possible reverse-engineering. Something in the software of that drone allowed access to at least one part of the system, which apparently opened access to its vital internals.

Securing embedded systems

Embedded systems now pervade the military in everything from vehicle control, communications, weapons control, and guidance to autonomous and semi-autonomous systems, including UAVs and similar craft. These devices are now interconnected for control and coordination purposes. In the interests of personnel safety, the ability to accomplish their mission, and often of national security, these devices must be safe for their operators and reliable in their operations. In addition, it is imperative that they be secure from unauthorized access and attack. If they are not secure, they cannot be considered safe or reliable. Thus the requirements for safety, reliability, and security are inseparable and interdependent.

Such requirements cannot be afterthoughts, but must be built in from the ground up. They also often require that software adhere to certain coding guidelines such as MISRA or CERT C and must follow industrial or government-mandated standards such as DO-178C. As these systems increasingly become subject to certification requirements, correctness in coding and functionality must be proven and documented.

Despite the fact that there are many strategies available to implement security, it is still necessary to ensure that these are also correctly coded – both in terms of coding standards and in terms of correct functionality in the overall application. Transfer protocols such as transport layer security (TSL) – which is an improvement over the secure sockets layer (SSL), the secure file transfer protocol (SFTP), and other protocols – are now widely used but are often acquired from outside the organization. Other strategies can include the use of secure device drivers, procedures for remote implementation of secure and encrypted firmware upgrades, and personal-verification protocols such as passwords, retina scans, and radio-frequency identification

(RFID) chips to secure access. Other layered security strategies allow only selected access to parts of the system, but these can also introduce flaws that can be exploited if not detected.

In the past, organizations may have been able to check their code with manual code reviews and software walkthroughs. However, the size and complexity of today's critical programs make it impossible to assure complete analysis with such methods and means. A new arsenal of test and analysis tools and methods is needed to meet today's security requirements.

Establishing and enforcing security

Today's comprehensive tool suites integrate tools for testing, analysis, and verification in a single development environment. The use of the tool environment may also help establish a disciplined methodology within an organization that can help teams cooperate even though they may be working in different locations.

In order to meet certification or qualification requirements, tools that enable bidirectional requirements traceability – from requirement and design to implementation, verification activities, and artifacts – can differentiate an organization from the competition and ensure the shortest path to device approval. A requirements-management tool allows teams to work on individual activities and link code and verification artifacts back to higher-level objectives.

Bidirectional traceability, based on a requirements document, is needed to ensure that every high-level requirement is covered by one or more low-level requirements and that every low-level requirement can be traced back to a high-level requirement.

Beyond that, the tools are also needed to perform extensive foundational tests that are based on static analysis, dynamic coverage analysis, and unit/integration testing. These results help assure security, functional safety, and compliance with coding standards, as well as the ability to trace requirements and see that they actually function as expected through extensive testing.

Static and dynamic analysis: partners in security

In assuring security, the two main concerns are data and control. Designers must consider who has access to data, who can read/write from it, how the data flows, and different levels of access and control. To address these issues, static and dynamic analysis must occur together.

On the static-analysis side, the tools work with the uncompiled source code to check the code against the selected rules, which can be any combination of the supported standards as well as any custom rules and requirements that the developer or a company may specify. The tools can also look for software constructs that can compromise security, check memory protection to determine who has access to which portions

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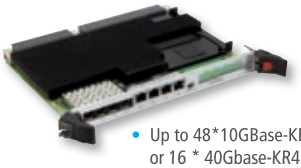

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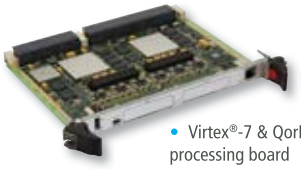

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of memory, and trace pointers that may traverse a memory location. For best results, the information should be presented in graphical screen displays for easy assessment to assure coding standards compliance.

Dynamic analysis tests the compiled code, which is linked back to the source code using the symbolic data generated by the compiler. Dynamic analysis, especially code-coverage analysis, requires extensive testing. Developers may be able to manually generate and manage their own test cases – the typical method of generating test cases – working from a requirements document, a process that may stimulate and monitor sections of the application with varying degrees of effectiveness. Given the size and complexity of today's code, however, often this method is insufficient to achieve certain required certifications.

Security requires rigorous and thorough test for functional vulnerabilities as well as for adherence to the coding rules and directives in the running application. If the coverage analysis requirements include statement or branch/decision coverage, procedure/function-call coverage, or – in more rigorous environments, modified condition/decision coverage (MC/DC) – these can often require both source and object code analysis. It will likely also require automated test generation, as well, as a means of measuring the effectiveness of the testing (Figure 1).

Automatic test generation is based on the static analysis of the code and uses this information to determine proper stimuli to the software components in the application during dynamic analysis. This backbone of essential boundary value testing can easily be extended with functional tests created manually from the requirements document. These should include any functional security tests such as simulated attempts to access control of a device or feed it with incorrect data that would change its mission. In addition, functional testing based on created tests should include robustness such as testing for results of unallowed inputs and anomalous conditions.

Diving into the code

Finding security flaws can involve more subtle issues. For example, there is danger associated with areas of "dead" code that could be activated by a hacker or obscure events in the system for malicious purposes. Although it is ideal to start implementing security from the ground up, most projects include pre-existing code that may not have been subjected to the same rigorous testing as the current project. Used together, static and dynamic analysis can reveal areas of dead code, which can be a source of danger or may take up needed space.

The ability to distinguish between truly dead code and seldom-used code is yet another reason why bidirectional requirements traceability is important; to be able to check that requirements are met by code in the application, but also to trace code back to actual requirements from the actual code. If neither of those routes shows a connection, the code definitely does not belong there.

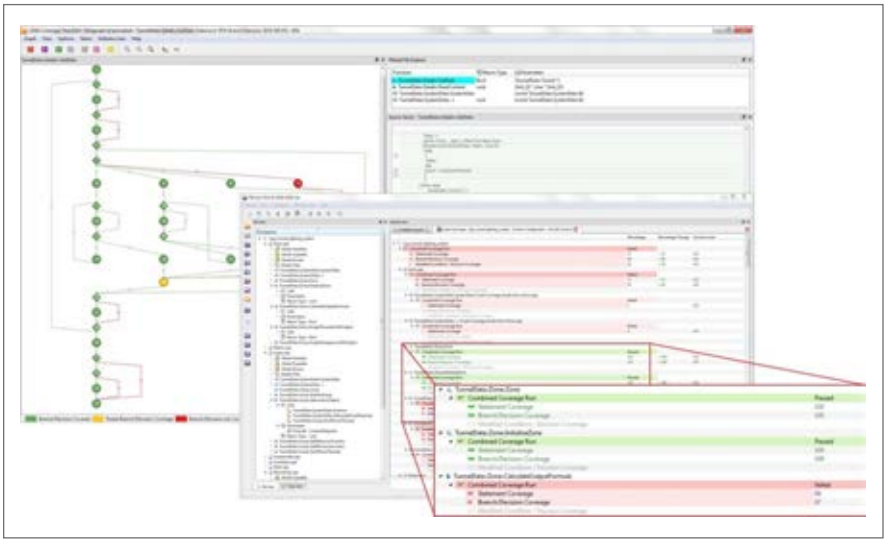


Figure 1 | The dynamic-analysis capabilities of the LDRA tool suite produce reports of variable and parameter usage that are based on the current test run. The report highlights the file and location within the file where the variable was used, with custom filters that allow more refined testing.

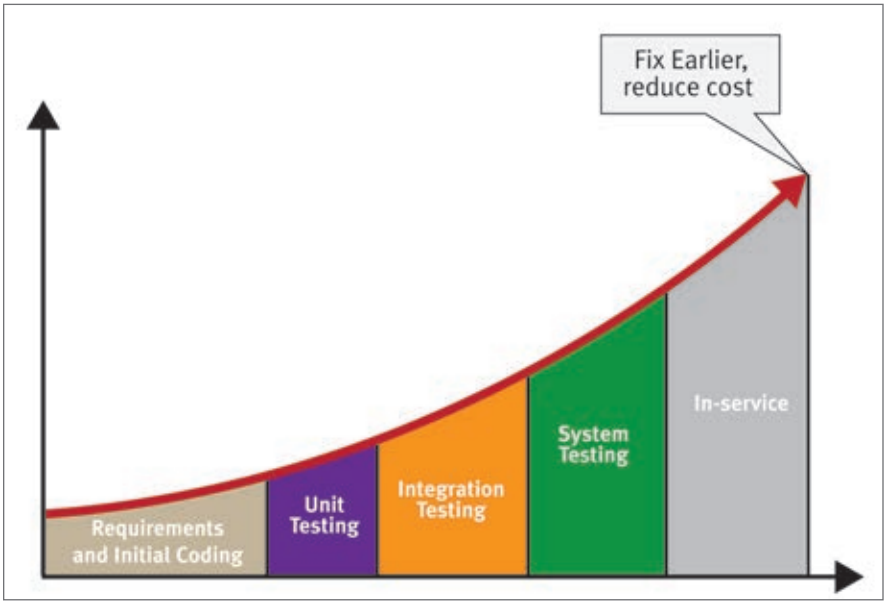


Figure 2 | The cost of fixing defects increases dramatically the later in the development cycle they are addressed.

Static analysis, therefore, functions to analyze source code for proper programming practices and also to help dynamic analysis set up for coverage testing, functional testing, control, and data-flow analysis. The latter is essential in order to highlight and correct potential problem areas and produce software quality metrics.

Companies developing to meet stringent security requirements in airborne or combat systems may be required to demonstrate analysis of data flow and control flow for software certification. In the case of certifying airborne software and systems under DO-178C, verification is required at the object level. This involves the ability to relate code coverage at the source-code level with that achieved at the object-code level. In some cases, it may also be necessary to provide the mechanism to extend the code coverage at the assembler level. This extension can be especially helpful for certification at DO-178C Level A, where software failure could result in loss of aircraft and/or loss of life.

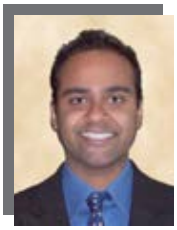
Start with unit testing and grow the project

Thinking about and developing for security from the ground up doesn't help much unless testing can occur from the ground up – and that includes testing on a host development system before target hardware is available. At this phase, nobody is talking about the stage of a project nearing completion, so it's often possible to do early unit testing and then integration testing as assignments come together from different teams or developers.

This approach also applies to parts of code that may be written from scratch, brought in from other projects, purchased as commercial products, or obtained as open source. Even in-house code needs to be checked because it may not have been originally subjected to the same analysis. The decision to use unit-test tools comes down to a commercial decision: The later a defect is found in the product development, the more costly it is to fix (Figure 2).

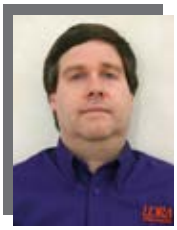
Functional testing on the host can be done without consideration for hardware timing and in some cases can be performed on a host-based virtual target with simulated connected peripherals. The same tests executed on the host must also be executed on the target hardware to ensure proper functional testing.

Applying a comprehensive test and analysis framework to the development process of an organization greatly improves the thoroughness and accuracy of security measures to protect vital systems. **MES**



Jay Thomas, *a technical development manager for LDRA Technology, has been working on embedded software applications in aerospace systems since the year 2000. He specializes in embedded verification implementation and has helped clients on projects including the Lockheed Martin JSF and Boeing 787, as well as medical and industrial applications.*

Chris Tapp *is a field applications engineer at LDRA, with more than 20 years of experience in embedded software development. He graduated from the University of Durham in 1987 and has spent most of his career working within the automotive, industrial control, and information technology industries. He serves in the MISRA C working group, and is currently chairman of the MISRA C++ working group.*



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Managing COTS obsolescence for military systems

By Sally Cole

The short life cycles of commercial components create many obsolescence headaches for military electronic-system designers as they try to integrate these high-performance devices into air, ground, and sea platforms that must last for decades, have long system development cycles, and require time-consuming testing procedures. As the military looks to leverage more open architectures and commercial off-the-shelf (COTS) technology, the challenge of managing the obsolescence that comes with COTS will only become more difficult.

Obsolescence is often hailed as "the dark side of COTS procurement" for the U.S. Department of Defense (DoD). Military platforms – many of which are expected to survive for at least 50 years – are becoming dependent upon commercial technology as a way to decrease costs.

But there are serious downsides to tapping COTS components that can become obsolete within 18 months – particularly when it comes to managing obsolescence issues. It poses numerous challenges for integrators, embedded suppliers, distributors, and aftermarket suppliers alike.

Can long life cycle military platforms coexist with COTS?

How are long life cycle military platforms able to coexist with COTS components that can become obsolete within 18 months?

This reality is a significant challenge, according to Christopher Bruns, director of component application engineering for Rockwell Collins in Cedar Rapids, Iowa. To deal with it, the company is "aligning itself with preferred suppliers that provide extended product life cycles," he says. "And we augment this with product road maps that include block update strategies to allow us to minimize the impact of obsolescence by making shorter duration buys when components go 'end-of-life.'"

Flexibility is another key piece of coexistence: "Customers want the flexibility to choose what's right for their program," says Richard Kirk, product manager for Abaco Systems in Huntsville, Alabama. "The first approach is committing to making a product available for a minimum of seven years. Then we can offer long-term support services, which means that the product is available as long as the customer needs it."

An alternative is to "design a series of 'technology-insertion' steps so customers can slot in new products with minimum integration effort," Kirk adds. "It will have the same pinout and specific new hardware features can be masked by the software."

Customers who bought a single-board computer (SBC) from Abaco in 1998 can obtain "essentially the same board nearly 20 years later, but with significantly more performance," Kirk points out. "This type of technology insertion strategy is popular with many customers because it's common for military platform capabilities to be upgraded during their lifetime. This is something that Abaco's customers factor in at a platform's outset, and our strategy

is to allow them to do that with minimum cost and disruption – in effect a straight swap."

Not everyone believes COTS belong within military platforms, however. "The biggest problem is that the military is using commercial products, which aren't designed for longevity," says Dale Lillard, president of Lansdale Semiconductor in Tempe, Arizona. "Roughly one percent of semiconductor revenue comes from the military, so they're not exactly driving semiconductor manufacturers to keep producing their products. And life cycles are much shorter now, so the aftermarket is having a difficult time maintaining newer technologies."

Another issue is that "during the past 18 months, we've seen significant delays within our airspace in the Americas due to glitches and shutdowns of airline systems," says Rich Fitzgerald, vice president of business operations for Avnet in Phoenix, Arizona. "The suggestion that perhaps these glitches are not simple outages but the result of using COTS solutions in complex secured networks is concerning … and a problem that must be addressed. Government

"COMPONENT AND INTEGRATION DESIGNERS "ARE INCREASINGLY MOVING TOWARD COTS IN THEIR DESIGNS, BUT WITH PROPER PLANNING – INCLUDING LIFE CYCLE REQUIREMENTS – THEY CAN BE DESIGNED INTO MILITARY SOLUTIONS."
– RICH FITZGERALD, VP OF BUSINESS OPERATIONS, AVNET

agencies, designers, OEMs, distributors, and integrators can't simply put their heads in the sand. Everyone is accountable for the actions and outcomes of designing COTS solutions into technology, and the military space isn't a place for it to play a significant role."

Fitzgerald acknowledges a need to reduce overall costs, but points out that oversight – in which checks and balances are required – could use some improvement. "Bills of materials, labor, overhead, and costs must all be managed," he elaborates. "Private business could never get away with the lack of discipline and controls that our government shows in its oversight of costs. This is driving the discussion of going to COTS and, frankly, it's a root cause of the issue."

Component and integration designers "are increasingly moving toward COTS in their designs, but with proper planning and requirements – including life cycle requirements – they can be designed into military solutions," Fitzgerald continues.

"Inventory is a 'dirty word,' because companies don't want those costs on their balance sheet. Avnet manages these services and can play a significant role in end-of-life (EOL), life cycle management, and EOL buys to protect our government agencies and their contractors. This involves serialization management tracking, buying lifetime buys for such components, working closely with our supplier partners and customers, as well as mitigating parts so that 'tin whiskers' won't create issues with ROHS (Restriction of Hazardous Substances) parts."

Supply-chain/risk-management challenge

Obsolescence is a huge supply-chain challenge, which is essentially risk management.

"It's very much about risk management and understanding the supply chain," says Abaco's Kirk. "The organizations with whom we work are anxious to mitigate risk throughout the program life cycle – from initial concept through development and testing to deployment. They want to eliminate or at least minimize the impact of risk, whether it's to on-time delivery or cost overrun, and also the risk and impact of component obsolescence is something relatively easy to do."

From Avnet's perspective, "inventory is an asset, not a liability, and provides critical counsel to the military agencies and their primes," Fitzgerald says. "Our approach is to look at requirements and then design upfront solutions that are managed throughout the life cycle so agencies aren't surprised by obsolescence."

Avoiding obsolescence management missteps

Are COTS vendors who are new to the military market making avoidable obsolescence management mistakes?

"When COTS suppliers obsolete a product, it's extremely important for them to provide a next-generation device that will drop into our designs and that they notify us prior to discontinuance," says Rockwell Collins' Bruns. "The two primary issues we've

seen are that some suppliers are unable to provide drop-ins, or when they do we find subtle differences that prevent us from being able to use them."

Avnet's Fitzgerald says he believes that obsolescence management for COTS providers is "counterproductive" because they're "focusing on reducing costs, high rates of flexibility and change, as well as ensuring inventory is available in the channel. The world is moving to the Internet of Things, and 70 percent of the world's market is now focused on COTS solutions, for which clients increasingly lead with software and cloud solutions – leaving the hardware to COTS and agnostic. This is critical for companies who have zero interest in operationalizing their business."

Companies today "are set up with many software engineers, and one within their operations," Fitzgerald continues. "These companies rely heavily on supply chain partners to manage end-to-end solutions – including inventory. The value is clearly software. Military solutions with long lead times and specific market requirements with minimal change allowable and higher mean-time-between-failure (MTBF) requirements don't play well within the market. COTS may play a bigger role, but when it comes protecting our military, my recommendation is do not play with COTS."

Figure 1 | The Abaco PPC11A is form, fit, and function-compatible with the PPC4A, introduced in 1998.

The biggest mistake for COTS vendors or newcomers to the military market would be "not having a program in place to offer long-term support and obsolescence management," according to Abaco's Kirk. A COTS product offered by Abaco is the PPC11A. Introduced earlier this year, the board is form, fit, and function compatible with the PPC4A, introduced in 1998, providing a straightforward technology insertion. (Figure 1.)

Current DoD procurement environment

Is the current DoD procurement environment, in which the government largely places the burden for research and development (R&D) investment on the integrators, making obsolescence and product life cycle management more challenging? Yes and no, but mostly yes.

"You can buy a component online with lot control and serialization and ship it within a day," says Avnet's Fitzgerald. "But dealing with government agencies requires a significant amount of scrutiny – some of which is required, yet is unnecessary for other areas. Avnet counsels government agencies by getting inside and in front of these challenges to reduce the overall end-to-end supply chain."

Abaco's customers "increasingly prefer to extend existing programs rather than start a new one," points out Kirk. "This makes a lot of sense because startup costs for new programs can be huge."

For customers who factor in extended programs from the outset, "the cost of providing extended support becomes part of the negotiation because they're trying to minimize their overall cost," he adds. "This, in turn, can shift some of the cost to the supplier.

"Recently, for example, one of Abaco's customers wanted to extend a program for as long as five years for an eight-figure investment, but the condition of placing the order was that the chosen supplier would meet him halfway on the cost of long-term support. At the end of the day, it's a business judgment call we're asked to make. Customers recognize the importance of long-term support – and while it can make selling the concept easier, negotiations can become more complex." **MES**

Aftermarket suppliers and today's military industry

What role do aftermarket suppliers play in obsolescence management? "Aftermarket suppliers are supporting products that were designed in the 1970s and 1980s – primarily during the Reagan years' buildup. And approximately 80 percent of those systems are still being used," says Dale Lillard, president of Lansdale Semiconductor in Tempe, Arizona. "The F-16, Patriot missile system, and the Navy's Aegis systems are old designs from the time when original component manufacturers had military product lines, and they're still in use today."

Some of the parts being supplied by Lansdale harken back to the 1960s. "Most of the nuclear reactors in the world are using a 600-Series HTL (high-threshold logic) product that was designed in the 60s," says Lee Mathiesen, operations manager for Lansdale. Nuclear power plants rely on it for its "15-V threshold and because it's noise-immune."

Nuclear reactors tend to "raise hell with electronics, so that's why they're still using HTL," adds Lillard. "They're one of our biggest customers. In fact, Westinghouse is still making new controllers using our logic – the entire product family."

Lansdale and Rochester Electronics (Newburyport, Massachusetts) are the two primary aftermarket suppliers to the military – a crucial part of the supply base that the military uses not only for repairs but also for new systems as well. Many of these new systems are for foreign military sales.

"We're still supporting F-15, F-16, and F-18 radars that were designed in the 1980s," notes Lillard. "If we went out of business they'd redesign the system because they'd have to … but it's much more economical for the military to buy products from us."

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Battling obsolescence in military systems from Earth to space

By Mike Newman and Paul Armijo

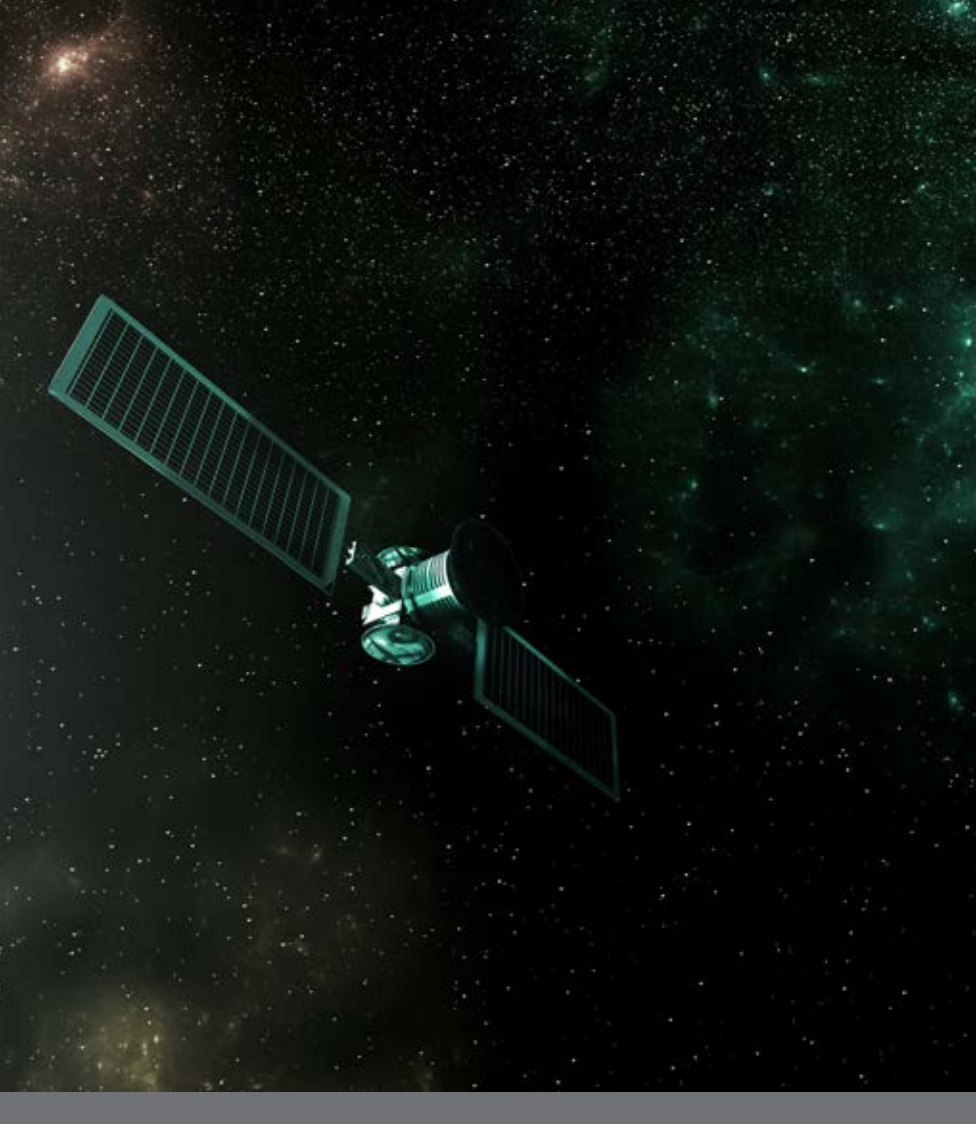
The military no longer drives innovation in electronics, so it must depend on commercial technologies for new capability. However, commercial technology has a dark side – obsolescence. Problems created by obsolete, unreliable, unmaintainable, underperforming, or incapable electronics hardware and software can be resolved via development of advanced technology insertions and applications that help meet Department of Defense (DoD) requirements for quick-reaction capabilities. This response will enable the warfighter to continue to have improved operational readiness, new capabilities, and dramatically enhanced performance through the application of advanced technologies and sophisticated engineering techniques.

The obsolescence challenge

Over the past several decades, the explosion in demand for consumer electronics in computing, feature-laden smartphones, and increased connectivity of anything that contains a microchip has driven an unparalleled shortening of the development lifecycle in the microelectronics industry – commonly known as Moore's law. While Moore's law can be traced back to the early 1970s with the production of early microprocessors, a significant shift to products and designs with substantially shortened technology-refresh targets took place in the mid-2000s.

This shift has proven to be very profitable for commercial technology companies across a variety of industries, including laptops, cellphones, printers, cameras, televisions, and wearables. Also seen: an explosion of new concepts with the idea of connectivity using the Internet of Things (IoT). To illustrate this point, microelectronics production has seen an explosion in demand over the last decade, leading to global semiconductor-market sales of more than $335 billion in 2015.

Consequently, most new technology developments and innovations in microelectronics are now exclusively driven by commercial companies for purely commercial applications. Technology development is now driven by short-turn product refresh rates, because that is where the largest sales volumes with the larger chip manufacturers reside. As a result, the industry is seeing older technology nodes reaching end-of-life (EOL) earlier than previous generations, in order to make room for the next greatest thing. This turn of events also diminishes the need for developing fundamental technologies and designs with extended reliability lifetimes, which, in turn, could also help to reduce product costs for commercial markets. An additional consequence of this



change is that pricing pressure in these markets has led to corporate consolidations and migrations of production so that a majority of microchip production is now being produced outside of the United States.

As this global market force has solidified, it has created many challenges for the DoD. One of the most daunting challenges is how to handle and manage obsolescence of electronics hardware and software for the warfighter. Unlike the commercial electronics market, the DoD will sponsor programs that can range from years to decades. For example, the B-52 bomber was originally awarded in 1946 and is projected to be in service into the 2040s. While this instance may represent an extreme case for program lives, it is not uncommon for larger DoD programs to extend for several decades. As these systems age, the electronic and software systems within them will become obsolete over time and will eventually become unreliable, unmaintainable, unserviceable, underperforming, or nonfunctional, leaving the warfighter at risk of losing superiority on the battlefield.

The lifetime buy

Multiple approaches have been adopted by both the supply-chain community and DoD in battling obsolescence. Each method has its own advantages and risks. Generally, the simplest and most common solution adopted is the lifetime buy. With this approach, lifetime purchases of at-risk electronics are either prepurchased at the beginning of the program or at a future date when the item is at risk of becoming obsolete. While simple in its approach, this methodology carries substantial risk: Can the program estimate the appropriate quantities needed until an appropriate upgrade is required, will there be proper long-term storage of the material to ensure future functionality, and will new technology development damage reliability and accelerate obsolescence? This lifetime-buy methodology requires substantial funding upfront, with the risk that the material may never be used.

Standard platforms and flexible designs

Military and space systems are continually migrating to next-generation architectures to both combat obsolescence and leverage investments in infrastructure from the commercial sector. Examples of this approach are OpenVPX (military), SpaceVPX (satellite), VITA standards, and Controller Area Network (CAN), used in automotive, military, and space applications. The CAN bus standard (Figure 1) is a good example of a DoD system

Figure 1 | The Cobham CAN FD transceiver family is radiation-tolerant and high-reliability, aimed at use in spacecraft sensor, telemetry, and command-and-control applications.

leveraging a commercial bus standard found in all modern automobiles. Adoption of such a broad-use standard will allow the DoD to take advantage of the collective design and development efforts made globally while still allowing for their own customization.

While the initial investment in open standards can challenge budgets, it enables the military and space community to use advanced technologies to meet their ever-changing missions and puts in place a standardized platform for the industry. It enables them to drive companies to those platforms to create more effective competition and utilize more "off-the-shelf" hardware available from a number of sources, which, in general, are available for longer periods of time. This shift helps make systems more affordable and portable in the long run, versus traditional proprietary architectures that are developed by individual contractors.

Field-programmable gate arrays (FPGAs) were originally developed by the Naval Surface Warfare Center in the early 1980s to enable a reprogrammable computer. Since that time, the FPGA market has seen substantial growth due to significant use throughout the telecommunications and networking industries, which has allowed it to achieve scaling similar to the effect of Moore's law in the microprocessor industry. FPGAs have been a key enabler to combat obsolescence in military and space systems, as they enable systems to be procured early and configured along the development cycle with the software/firmware being supported long past the typical commercial product time scale. FPGAs are flexible by design, so they can be adapted in the field or even after being launched in space. The devices also enable rapid prototyping and initial system deployment while an advanced technology node application-specific integrated circuit (ASIC) is being developed on a commercial foundry for long-term system product availability as well as overall program cost savings.

Flexible and fast procurement

Another significant challenge that the DoD faces in battling obsolescence is the procurement process required under the Federal Acquisition Regulation (FAR), a well-established process that is used and understood across the industry for DoD acquisition. The FAR, however, can be time-consuming and expensive. To address these concerns, the government has established programs and indefinite delivery, indefinite quantity (IDIQ) contract vehicles designed to give the DoD and other agencies streamlined access to state-of-the-art technologies and engineering capability for the purpose of research and development and obsolescence mitigation.

One program designed for this purpose is the Defense Microelectronic Activity's (DMEA) Advanced Technology Support Program IV (ATSP4). Cobham Advanced Electronic Solutions (CAES) is the newest awardee on this program, along with seven other leading defense

industry contractors – BAE Systems, Boeing, General Dynamics, Honeywell International, Lockheed Martin, Northrop Grumman, and Raytheon. The eight performers selected for ATSP4 have been prequalified by DMEA, which allows any government agency to have a performer on contract for an IDIQ within four weeks, which can result in as long as 18 months of cycle time reduction. The $7.2 billion ATSP4 mechanism focuses on rapid acquisition for development activities that are going to enable the warfighter to continue to overcome these obsolescence challenges. This contract vehicle enables each of the eight prime contractors to focus on getting next-generation systems developed quickly and economically while also focusing on size, weight, power, and cost (SWaP-C) reductions to help all the branches of the DoD maintain and grow their superiority in all domains of warfare.

Working together

The explosion of the global commercial electronics business over the past 20 to 30 years has led to countless innovations that have been leveraged across all the branches of the DoD that would likely not have been possible without the growth in today's mobile and computing consumer markets. One of the drawbacks to such a relationship is the ever-growing risk of obsolescence mitigation. To tackle this complex dynamic problem, the DoD and the defense community are working together to develop solutions such as standard platforms, flexible designs, and agile procurement vehicles that allow for rapid response to ensure warfighter superiority today, tomorrow, and far into the future. **MES**

WHILE THE INITIAL INVESTMENT IN OPEN STANDARDS CAN CHALLENGE BUDGETS, IT ENABLES THE MILITARY AND SPACE COMMUNITY TO USE ADVANCED TECHNOLOGIES TO MEET THEIR EVER-CHANGING MISSIONS AND PUTS IN PLACE A STANDARDIZED PLATFORM FOR THE INDUSTRY.

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PMC-CIV-COM-ISO

Summary:

- *Cyclone IV EP4CE30 484-fbga package*
- *Cyclone IV FPGA allows a wide range of customization options.*
- *4 Mbyte SRAM*
- *SRAM is dual ported*
- *User Reconfigurable I/O*
- *ISOLATED I/O lines, Up to 155Mbps*
- *Each GPIO line has independent Interrupt Support programmable for Edge trigger*
- *On board Serial configuration device programmable via PMC bus or bit/byte blaster*
- *Local serial EPROM*
- *Internal/External clock*
- *PCI +3.3V/+5V Operation and Logic*
- *32/64 MHz PMC clock support*
- *Front panel I/O access*
- *Windows, Linux and VxWorks Drivers*

FEATURES

- User Programmable Altera Cyclone IV FPGA 484 BGA:
- Stand alone possibility
- Single wide PMC Module
- Opto Isolated 20 LVDS, 2 RS-422,1 RS-232
- Optional User clock oscillator

Custom Designs: In addition, Alphi offers complete Engineering Design Services. Custom hardware, drivers and application software as well as FPGA development, we are ready to help.

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ALPHI Technology Corporation
www.Alphitech.com

Sales@Alphitech.com 480-838-2428

HARTING

Pushing Performance

HARTING PCB Assembly Solutions

High Performance PCB Backplanes

HARTING is a proven supplier to the military embedded market providing the time-tested connector backbone for the durable VME64 standard.

HARTING Integrated Solutions include both standard and customized backplane solutions with particular expertise on VPX/Open VPX systems. Each one is produced in our fully integrated manufacturing plant in Elgin, IL. Prior to shipment, all products undergo comprehensive mechanical testing and electronic performance verification according to widely recognized industry standards and customer specifications.

Our capabilities include the design and manufacture of special chassis assemblies requested by our customers. These chassis are designed for use in rugged industrial and military environments.

Backplane capabilities include a complete range of engineering expertise and design services for unique, custom-built products of any size or configuration.

We provide fast engineering response to inquiries, supplying reliable PCB designs to customer specifications, for any project initiative – large or small.

HARTING's backplane manufacturing capabilities are designed for high product mix and we have the ability to service high speed backplanes to the most demanding customers. These capabilities are identical in three globally located facilities in North America, the United Kingdom and China.

State-of-the-art capabilities

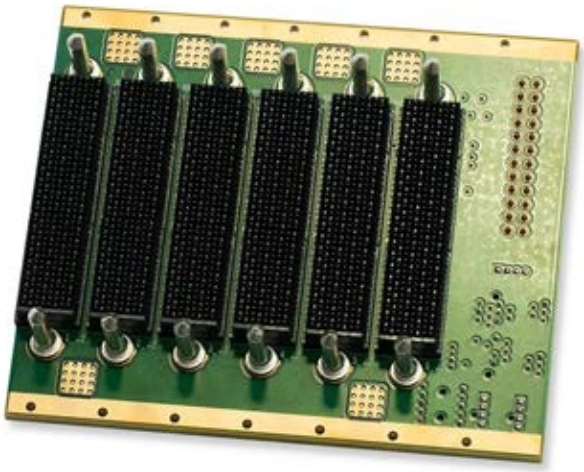
Our equipment is able to handle large PCB's up to 48" x 24" and allows rapid change-over times. In-line inspections control costs and ensure quality. Our vapor phase ovens allow perfect soldering of large backplanes, large layer counts.

High accuracy through fully automated press in machinery

HARTING's automated presses for press-fit backplane components result in far more accurate and repeatable insertion compared to any manual method, even with conformal-coated boards. The result is higher reliability by reducing the chance of latent failures due to cracked barrels and temperature cycling.

Outstanding quality due to sophisticated, well trained staff

To maintain and improve assembler skills at the highest level, we retain an in-house staff of fully qualified IPC trainers. This part of our ContinuousImprovement program is always looking for better ways to conduct operations, increase product performance, and ensure quality at the highest level. As a minimum, we make sure every aspect of your assembly meets high standards of IPC 610, Class III.



FEATURES

- Design and manufacture of custom chassis assemblies
- State-of-the-Art RoBAT Backplane Tester
- Electrical tests check for opens, shorts, proper continuity, and measures parasitic capacitance, which could cause signal distortion
- Cadence Allegro design software
- A complete connector library
- Full differential pair capability
- SPICE and IBIS modeling
- Complete backplane simulation
- Time and frequency domain measurements
- EMC testing
- Time and frequency domain characterization
- Characteristic impedance
- Reflection/standing wave ratio
- Pulse signal rise and fall times
- 4-Port S-parameter analysis
- Return loss, attenuation, crosstalk
- Eye-diagram – compliance tests with chip vendor evaluation modules

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Communications

North Atlantic Industries
Accelerate Your Time-to-Mission

Data Acquisition Systems – DAQ Series

Preconfigured, scalable, application-ready Data Acquisition Systems with no NRE

NAI's new DAQ Systems are COTS-based, preconfigured and tested data acquisition systems designed for air, land and sea environments. These hardware systems support compact, low-power, military/aerospace data acquisition applications that require high-density multi-channel programmable I/O and processing. They are optimized for harsh SWaP-constrained environments. NAI's rugged DAQ systems offer a proven solution for acquiring sensor information in real time and are ruggedized to withstand -40 to +71° C environments.

The DAQ Series is built on NAI's highly adaptive, Custom-On-Standard Architecture™ (COSA™). COSA's modular approach delivers more intelligence and functionality in a smaller footprint – *all at a lower cost.* Built for compact, low-power system requirements, the DAQ systems are "application-ready" for the customer's software.

NAI's DAQ systems are scalable (DAQ-31CP0G, DAQ-33CP0G, DAQ-35CP0G) and offer measurement and acquisition capabilities by using NAI's high-density, multi-channel, programmable, Discrete I/O, Differential I/O, A/D, RTD, Thermocouple, Serial, ARINC 429/575, and CANBus communications function modules. See each DAQ system for the exact module complement.

FEATURES

- A single source mitigating 3rd party integration risks
- No NRE
- Increased design versatility
- Reduced power consumption
- Scalable with three systems to choose from
- Higher package density
- Streamlined development resources
- Overall lower program cost
- Accelerated time-to-mission
- MIL-STD-461F and MIL-STD-810G
- Continuous Background Built-in-Test (BIT)
- COTS/NDI
- COSA™ architecture
- Operating temperature -40°C to +71°C

Made in the USA
Certified Small Business

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North Atlantic Industries, Inc.
www.naii.com/Data-Acquisition-System/PSC71

lmassafra@naii.com 631-567-1100

Electronic Warfare

OMNETICS
CONNECTOR CORPORATION

Omnetics' Hybrid Connector Series

Omnetics' rugged, high reliability mixed-signal and power connectors allow designers the flexibility to select the ideal high density connector configuration to suit almost any specific application design requirement. By using Mil qualified pin and sockets the Hybrid Connector Series from Omnetics meets not only the requirements for shock and vibration but also of SWaP (Size, Weight, and Power) by replacing multiple connectors with one rugged connector solution.

FEATURES

- Rugged and Lightweight
- High Contact Density
- High-speed Data
- Highly Configurable
- Micro and Nano sizes available

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www.linkedin.com/company/omnetics-connector-corporation

ACCES I/O PRODUCTS, INC.

ETH-DIO-48 Ethernet 48-Channel Industrial Strength Digital I/O

Designed for compact control and monitoring applications, this product features 48 or 24 industrial strength TTL digital I/O lines. This Ethernet device is an ideal solution for adding portable, easy-to-install, digital I/O to any Ethernet network, even wirelessly. The ETH-DIO-48 is excellent for use in applications sensing inputs such as switch closures, TTL, LVTTL, CMOS logic, and is ideal for controlling external relays, driving indicator lights, and more. Applications include home, portable, tablet, laboratory, industrial automation, and embedded OEM.

Available accessories include a broad range of ribbon cables, screw terminal boards, optically isolated adapters, electromechanical relay boards, and industry standard solid state module racks. Special order items such as conformal coating, custom software, right angle headers, and more, are also available.

FEATURES

- Ethernet 10/100 RJ45 connector for interfacing to CPU or network
- 48 or 24 channel high-current TTL digital I/O lines
- Compatible with industry standard I/O racks such as Grayhill, Opto 22, Western Reserve Controls, etc.
- Eight-bit ports software selectable for inputs or outputs
- All 48 digital I/O lines buffered with 32 mA source/64mA sink current capabilities
- Jumper selectable I/O pulled up to 5V (via 10KΩ) for contact monitoring, pulled down to ground or floating
- Resettable 0.5A fused +5VDC output per I/O connector
- OEM version (board only), features PC/104 size and mounting compatibility
- Small, (4"x4"x1.7") rugged, steel industrial enclosure
- LVTTL (3.3V) and -40°C to +85°C industrial operating temperature available as factory options

mil-embedded.com/p372692

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Embedded Hardware

ACCES I/O PRODUCTS, INC.

mPCIe-COM Family PCI Express Mini Cards

ACCES I/O Products is pleased to announce the release of a new family of mini PCI Express (mPCIe) multi-port serial communication cards. These small, low-priced, PCI Express Mini cards feature a selection of 4 or 2-ports of software selectable RS-232/422/485 asynchronous serial protocols on a port by port basis. These cards have been designed for use in harsh and rugged environments such as military and defense along with applications such as health and medical, point of sale systems, kiosk design, retail, hospitality, automation, gaming and more. The small size (just 50.95mm x30mm) allows for maximum performance in applications where space is a valuable resource.

Each RS-232 port is simultaneously capable of supporting data communication rates up to 921.6 kbps. RS-422/485 modes support data communication speeds up to 3 Mbps. The cards provide ±15kV ESD protection on all signal pins to protect against costly damage due to electrostatic discharge. Existing serial peripherals can connect directly to industry standard DB9M connectors on the optional breakout cable accessory kits.

The mPCIe-COM cards were designed using type 16C950 UARTs and use 128-byte transmit/receive FIFO buffers to decrease CPU loading and protect against lost data in multitasking systems. New systems can continue to interface with legacy serial peripherals, yet benefit from the use of the high performance PCI Express bus. The cards are fully software compatible with current PCI and PCI Express 16550 type UART applications and allow users to maintain backward compatibility.

FEATURES

- PCI Express Mini Card form-factor (mPCIe) type F1, with latching I/O connectors
- 4 or 2-port serial communication cards with optional DB9M connectivity
- Software selectable RS-232, RS-422, and RS-485 protocols, per port stored in EEPROM
- High performance 16C950 class UARTs with 128-byte FIFO for each TX and RX
- Port-by-port field selectable termination for RS-422/485 applications
- Industrial operating temperature (-40°C to +85°C) and RoHS standard
- Supports data communication rates up to 3Mbps simultaneously, (RS-232 up to 921.6 kbps)
- Custom baud rates easily configured
- ±15kV ESD protection on all signal pins
- CTS, RTS, 9-bit data mode, and RS-485 full-duplex (4 wire) fully supported
- RS-232 only and RS-422/485 versions available

mil-embedded.com/p372691

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Embedded Hardware

ACCES I/O PRODUCTS, INC.

mPCIe-ICM Family PCI Express Mini Cards

The mPCIe-ICM Series isolated serial communication cards measure just 30 x 51 mm and feature a selection of 4 or 2 ports of isolated RS232 serial communications. 1.5kV isolation is provided port-to-computer and 500V isolation port-to-port on ALL signals at the I/O connectors. The mPCIe-ICM cards have been designed for use in harsh and rugged environments such as military and defense along with applications such as health and medical, point of sale systems, kiosk design, retail, hospitality, automation, and gaming.

The RS232 ports provided by the card are 100% compatible with every other industry-standard serial COM device, supporting TX, RX, RTS, and CTS. The card provides ±15kV ESD protection on all signal pins to protect against costly damage to sensitive electronic devices due to electrostatic discharge. In addition, they provide Tru-Iso™ port-to-port and port-to-PC isolation. The serial ports on the device are accessed using a low-profile, latching, 5-pin Hirose connector. Optional breakout cables are available, and bring each port connection to a panel-mountable DB9-M with an industry compatible RS232 pin-out.

The mPCIe-ICM cards were designed using type 16C950 UARTS and use 128-byte transmit/receive FIFO buffers to decrease CPU loading and protect against lost data in multitasking systems. New systems can continue to interface with legacy serial peripherals, yet benefit from the use of the high performance PCI Express bus. The cards are fully software compatible with current PCI 16550 type UART applications and allow for users to maintain backward compatibility.

FEATURES

- PCI Express Mini Card (mPCIe) type F1, with latching I/O connectors
- 4 or 2-port mPCIe RS232 serial communication cards
- Tru-Iso™ 1500V isolation port-to-computer and 500V isolation port-to-port on ALL signals
- High performance 16C950 class UARTs with 128-byte FIFO for each TX and RX
- Industrial operating temperature (-40°C to +85°C) and RoHS standard
- Supports data communication speeds up to 1 Mbps simultaneously
- Custom baud rates easily configured
- ±15kV ESD protection on all signal pins
- 9-bit data mode fully supported
- Supports CTS and RTS handshaking

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Embedded Hardware

ACCES I/O PRODUCTS, INC.

USB-104-HUB – Rugged, Industrial Grade, 4-Port USB Hub

This small industrial/military grade hub features extended temperature operation (-40°C to +85°C), high-retention USB connectors, and an industrial steel enclosure for shock and vibration mitigation. The OEM version (board only) is PC/104 sized and can easily be installed in new or existing PC/104-based systems as well. The USB-104-HUB now makes it easy to add additional USB-based I/O to your embedded system or to connect peripherals such as external hard drives, keyboards, GPS, wireless, and more. Real-world markets include Industrial Automation, Embedded OEM, Laboratory, Kiosk, Transportation/Automotive, and Military/Government.

This versatile four-port hub can be bus powered or self powered. You may choose from three power input connectors: DC power input jack, screw terminals, or 3.5" drive power connector (Berg). Mounting provisions include DIN rail, 3.5" front panel drive bay mounting, and various panel mounting plates.

FEATURES

- Rugged, industrialized, four-port USB hub
- High-speed USB 2.0 device, USB 3.0, and 1.1 compatible
- Extended temperature operation (-40°C to +85°C)
- Data transfer rates up to 480 Mbps
- Supports bus-powered and self-powered modes
- Three power input connectors (power jack, screw terminals, or 3.5" drive Berg power connector)
- LED status indicators for power and overcurrent fault conditions for each downstream port
- USB/104 form factor for OEM embedded applications
- OEM version (board only) features PC/104 module size and mounting
- Includes micro-fit embedded USB header connectors in parallel with all standard USB connectors
- Industrial grade USB connectors feature high-retention design
- Small (4" x 4" x 1"), low profile, steel enclosure
- 3.5" front panel drive bay mounting provision

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ADLINK TECHNOLOGY INC.

CM2-BT2 Extreme Rugged PC/104-*Plus* Single Board Computer

Our versatile CM2-BT2 is a PC/104-*Plus* single board computer (SBC) with the latest Intel® Atom™ Processor System-on-Chip (SoC); a PC/104 (CM1-BT1) variant for ISA bus-only support and PCI-104 (CM3-BT1 or CM3-BT4-8G) variants for PCI bus-only support are also offered to service diverse design and budget requirements. The CMx-BTx SBCs support up to 4GB-1066/1333 MHz DDR3L SODIMM memory and feature interfaces for DisplayPort and LVDS, GbE, 1x SATA 3Gb/s, 1x USB 3.0 + 2x USB 2.0, and 8x GPIO.

The CM2-BT2 is designed to withstand intense shock and vibration and supports operating temperatures from -40°C to +85°C. ADLINK's Smart Embedded Management Agent (SEMA), designed into all of our SBCs, helps users optimize system performance and lower power consumption through remote device management.

FEATURES

- Dual-core Intel® Atom™ Processor System-on-Chip
- Up to 4GB DDR3L at 1333MHz
- Supports VGA and LVDS
- GbE (optional 2x GbE)
- 1x SATA 3Gb/s (optional 2x SATA), 3x USB 2.0, 8x GPIO
- Extreme Rugged operating temperature: -40°C to +85°C
- Supports Smart Embedded Management Agent (SEMA) functions

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Embedded Hardware

ADLINK TECHNOLOGY INC.

XMC-G745 Rugged XMC Module

ADLINK recognizes the trend towards implementing General Purpose computing on Graphics Processing Units (GPGPU) for parallel computing and increased processing performance, and the XMC-G745M targets a variety of high-performance computing applications that can take advantage of this technology.

The rugged XMC-G745M module is equipped with the CUDA-enabled 384-core NVIDIA GeForce GT 745M GPU, utilizing NVIDIA Kepler architecture and yielding unprecedented levels of graphics processing performance for defense and aerospace applications. The GeForce GT 745M features 2048MB of GDDR5 memory, ensuring high-capacity and high-bandwidth access to data during massively parallel GPGPU algorithm processing.

The XMC module incorporates the VITA 42.0 XMC switched mezzanine card auxiliary standard and the VITA 46.9 PMC/XMC/Ethernet signal mapping on 3U/6U VPX module standard and supports both Windows and Linux operating systems. The GPU also supports OpenGL 4.4, OpenCL 1.2 and DirectX 11, as well as High-bandwith Digital Content Protection (HDCP).

FEATURES

- NVIDIA GeForce GT 745M GPU (Kepler refresh)
- CUDA compute capability 3.0 for parallel computation and graphics processing
- Dual channel GDDR5 soldered memory, 2GB
- PCIe x8 Gen3 on P15
- High-resolution, high-performance platform for rugged video I/O and GPGPU applications
- Ideal for defense, radar, sonar, UAV and ground vehicles

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Embedded Hardware

Advanced Micro Peripherals
THE EMBEDDED VIDEO EXPERTS

XStream-SD4 – Low Latency Standalone H.264 Video Streamer

The **XStream-SD4** is an intelligent, stand-alone, ultra low latency H.264 Streaming solution that accepts 4x NTSC/PAL/RS-170 composite video sources and records and streams them over 100/1000MBit Ethernet. This SWaP optimized solution is ideal for rapid deployment in demanding applications in Military, Communications, Transportation, Mining and Energy industries.

The XStream-SD4 features a dedicated hardware compression engine capable of encoding all 4 video channels at full size and full frame-rate with Ultra Low Latency (under 40ms). The flexible streaming engine can stream each channel direct from the on-board Ethernet port as well as save direct to locally attached storage for later retrieval. The XStream-SD4 also supports 4 channels of audio that can be captured and streamed with the video data.

The XStream-SD4 is an intelligent stand-alone device with its own on-board CPU and does not require a host CPU or any driver or OS software. For mechanical convenience the module can be mounted on a PC/104 stack without consuming host CPU resources.

FEATURES

- 4x PAL/NTSC/RS-170 composite video inputs
- Real-time 4x D1 H.264 encode at full frame rate
- Ultra Low Latency technology with video latency below 40ms
- 4 channels of audio encoding
- Single, rugged, real-time video streaming solution
- SATA support for extended local storage
- Standard PC/104 mechanical form factor

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Advanced Micro Peripherals
www.amp-usa.com/stand-alone/h264/xstream-sd4.php

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Embedded Hardware

LUMINEQ®
DISPLAYS BY beneq

Lumineq – Displays for Extreme Conditions

Lumineq displays are an easy choice for small information graphic and segmented displays. Rugged, transparent and customized Lumineq displays tolerate cold, pressure, shock and vibrations better than any other display type. Lumineq TASEL displays are the most transparent displays on the market.

FEATURES

- **Pass your environmental requirements:** Instant on from -60°C (-76 °F) to +105°C (221 °F)
- **Stop chasing EOL parts:** Long term availability and 10+ years product life without fading
- **Unique see-through experience:** Can be laminated in windshields and other glass panels
- **Excellent readability:** High contrast, wide viewing angle and instant pixel response
- **Custom display service:** Contact Beneq for your custom product with low MOQ requirements

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Beneq
www.lumineq.com

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Aitech Defense Systems, Inc.

Embedded Computing *without* Compromise

A191 COTS HPEC with upgraded GPGPU

Aitech Defense Systems Inc. upgraded the GPGPU in its A191, a rugged, compact COTS HPEC (High Performance Embedded Computer).

The new, fully integrated subsystem combines a multi-core CPU to efficiently process overhead functions with an advanced NVIDIA GeForce GTX 965M GPGPU that focuses on executing heavy-duty system requirements. This nearly doubles the performance and FLOPS per Watt of the previous A191, with the same power dissipation.

Requiring zero NRE, the compact, lightweight A191 is a fully tested system, with the operating system and drivers pre-installed, so it is ready to boot upon power up. Its rugged design easily withstands severe elements found in a number of critical military environments, and its efficient use of power makes it ideal for manned and unmanned applications, alike.

From C4ISR, SIGINT, COMINT/ELINT, guidance and autonomous flight control to electro-optic visual, IR and SAR sensor fusion, static and moving target recognition, on-board weapons management and fire control, the new A191 continually provides exceptional processing.

The new RediBuilt rugged HPEC features a balanced heat/power vs performance as well as a 4th Generation Intel Core i7 processor on Aitech's C873 SBC or Freescale's latest QorIQ multi-core SOC processors on the C912 SBC. An embedded frame grabber provides video input capture, coupled with a large, internal solid state SATA disk.

Extensive I/O includes numerous video formats, Ethernet, serial and USB ports, and the on-board 1 TB of Flash-based SATA mass storage eliminates the need for external storage or mechanical/rotating media drives.

Finned for ambient free-air cooling or a cold plate, the unit measures 155 mm (6.1" W) x 260 mm (10.26" D) x 126 mm (4.96" H) and weighs less than 6.8 kg (15 lbs) complete. Internally, the A191 uses conduction cooling.

A two-slot 3U VPX backplane and a PWB-based front panel I/O board provide all system interconnections and power filtering circuitry. The high-efficiency modular power supply ensures reliable operation over a wide range of input voltages. Predefined interconnect and power cables are readily available to connect to industry-defined, commercial standard I/O – just plug into a 28 VDC power source and start running your application.

FEATURES

The new A191 RediBuilt meets the needs of manned and unmanned aircraft, including these UAV classifications:

- NATO-type 10,000 ft (3,000 m) altitude, up to 50 km range
- Tactical 18,000 ft (5,500 m) altitude, about 160 km range
- MALE (medium altitude, long endurance) up to 30,000 ft (9,000 m) and range over 200 km
- HALE (high altitude, long endurance) over 30,000 ft (9,100 m) and indefinite range
- Hypersonic high-speed, supersonic (Mach 1-5) or hypersonic (Mach 5+) 50,000+ ft (15,200 m) or suborbital altitude, range over 200 km
- CACGS (computer assisted carrier guidance systems)

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Annapolis is famous for the high quality of our products and for our unparalleled dedication to ensuring that the customer's applications succeed.

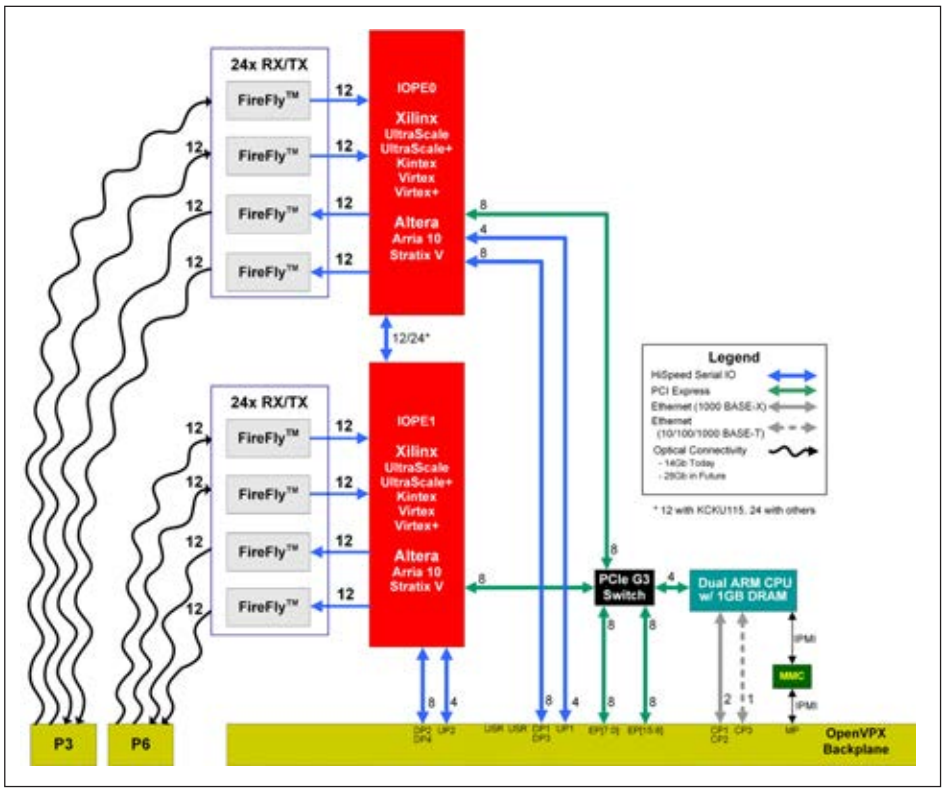
We offer training and exceptional special application development support, as well as more conventional support.

High-Speed Fiber Optics in Wild40/100 EcoSystem

Annapolis Micro Systems, Inc. is now building powerful FPGA boards with optical 48x connectivity. This VITA 66/67 architecture delivers 5X the bandwidth of copper. It is designed for super-high-performance data acquisition and processing, as is required in phased array radars and other applications where digital-to-analog or analog-to-digital converters are located close to the sensor. In addition, this fiber optic capability will now allow Annapolis Wild 40GbE systems to work at 100GbE.

FEATURES

- On a 6U card, have the capability for 5X the bandwidth of copper VPX
- 24 fibers in and out of every mezzanine card (48 fibers per 6U slot)
- Supports 14Gbps signaling rates, with 28Gbps to come
- Front panel MPO or VITA 66 backplane blindmate I/O
- Commercial & industrial temp
- Air and conduction cooled



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Annapolis Micro Systems

Ruggedized Systems and High Temperatures

Ruggedized COTS systems from Annapolis Micro Systems are designed to withstand the harshest environments. From the bitter cold of an Antarctic radar station to the hottest deserts of the Middle East, AMS equipment is real-world deployed for the most demanding embedded applications.

Cooling Options

Depending on the application, AMS chassis are robustly designed using Air, Conduction, or Liquid cooling. During the design process, every board and system is simulated for thermal performance, then subjected to hours of grueling operation to verify its ability to withstand temperature stresses.

Independently Verified

AMS verifies environmental conformance of its equipment to various stringent standards such as MIL-STD-810 and RTCA/DO-160 (for airborne equipment). This independent testing proves the ability to withstand:

- *Temperature extremes & thermal shock*
- *Liquid & dust ingress*
- *Humidity, fungus & corrosion*
- *Vibration & shock*
- *Other application-specific stressors*

FEATURES

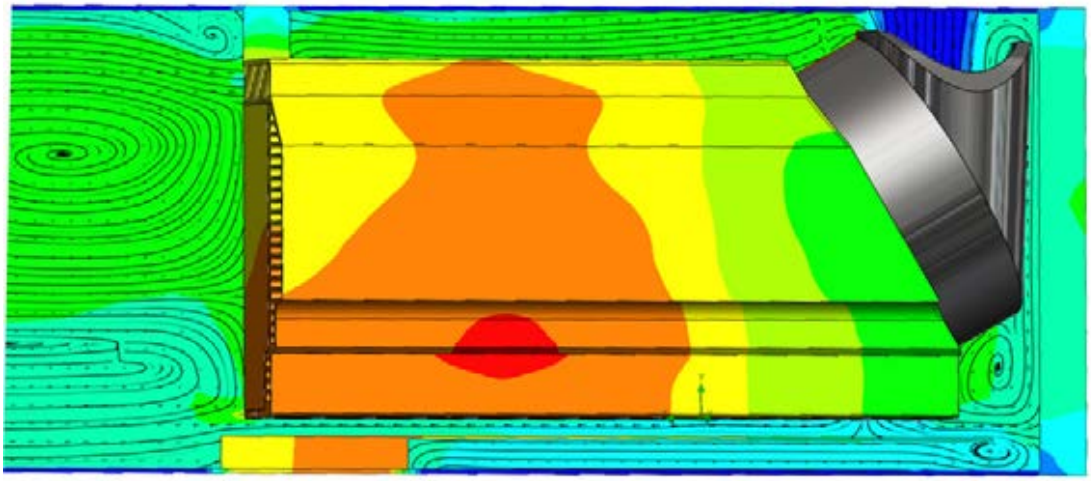
› Designed from the ground-up to fit into the smallest spaces without compromising performance

› Withstands a scorching 70°C ambient air temperature with a full payload of working Annapolis WILDSTAR boards

› Contains 5 high-bandwidth 3U OpenVPX payload slots and one VITA 62 power supply slot

Designed & Manufactured in USA

All AMS products are engineered and manufactured under one roof in the United States. This co-location of engineering and manufacturing allows for more aggressive design, and better quality control and production flexibility.



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Annapolis Micro Systems, Inc.
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WILDSTAR UltraKVP for OpenVPX 6U & 3U

Annapolis Xilinx FPGA boards are engineered for superior performance and maximum bandwidth. WILDSTAR UltraKVP FPGA boards utilize Xilinx Kintex FPGAs, which feature the most multipliers currently deployable, or UltraScale+ FPGAs, which feature 28Gb signaling capability!

These FPGA cards are hot-swappable and paired with Annapolis OpenVPX compliant 6U/3U backplanes, enable even the most bandwidth-intensive applications.

All Annapolis COTS boards are rugged, open, deployable, and offer different cooling options, making them the most cutting-edge Xilinx-based products on the market.

Optional, Annapolis is now building powerful Xilinx FPGA boards with optical 48x connectivity. This VITA 66/67 architecture delivers 5X the bandwidth of copper.

Annapolis is famous for the high quality of our products and for our unparalleled dedication to ensuring that the customer's applications succeed.

We offer training and exceptional special application development support, as well as more conventional support.

FEATURES

› **General Features**
- Up to three Xilinx® Kintex® UltraScale™ XCKU115, Virtex® UltraScale™ XCVU125/XCVU190 or Virtex® UltraScale+™ XCVU5P/XCVU9P FPGAs
  - *Hard 4x (3U) or 8x (6U) PCIe Gen3 endpoint for DMA and register access*
  - *FPGAs programmable from attached flash or Annapolis-provided software API*
  - *16 or 20-nm copper CMOS process*
  - *Available with DDR4 DRAM ports on all FPGAs*
    - 6U board has optional QDR-IV SRAM ports on IOPEs
- Dual core ARM Cortex-A9 Processor (Zynq SoC)
  - *Host Software: Linux API and Device Drivers*
- A Full Board Support Package using Open Project Builder for fast and easy Application Development
- System Management

› **OpenVPX Backplane I/O**
- Two PCIe Gen3 4x (3U) or 8x (6U) Connections to VPX Backplane
- 6 Backplane Protocol Agnostic connections support 10/40Gb Ethernet, IB capable, AnnapMicro protocol and user-designed protocols. Optional optical VITA 66/67 connectivity.
- Radial Backplane Clock Support for OpenVPX backplane signals AUXCLK and REFCLK
  - *Allows reference clock and trigger from backplane to synchronize and clock compatible ADC/DAC mezzanine cards without front panel connections needed*

› **Front Panel I/O**
- Wild FMC+ (WFMC+) next generation IO site based on FMC+ specification
  - *Accepts standard FMC and FMC+ cards (complies to FMC+ specification)*
- Up to 32 High Speed Serial and 100 LVDS connections to FPGA

› **Mechanical and Environmental**
- Available in Extended Temperature Grades
- Air or Conduction Cooled Path
- RTM available for additional I/O

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Annapolis Micro Systems, Inc.
www.annapmicro.com

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410-841-2514

Atrenne Integrated Solutions

Atrenne is your lab development chassis partner and offers everything you need when the time comes to design a fully ruggedized, deployable chassis.

VPX Lab Development Systems

Atrenne provides the industry's widest array of desktop, tower, open frame, and ATR lab development systems for usage in the lab environment. Chassis are available that support both 3U and 6U module form factors, and both air and forced-air conduction cooling methodologies. Atrenne offers lab chassis in a range of slot counts, power supply configurations, orientations and backplane topologies. The horizontally oriented DT-CC and DT-XC chassis provide over 300W per slot in a desktop or rackmountable enclosure. From the small 849-S145 (2-slot, 3U, 200W) to the large RME13XC (6U, 16-slots, 3300W), and many options in-between, Atrenne can provide a development platform that will support the success of your program development.

Atrenne's lab development offerings include:

- ***849-S145 –*** *Desktop, 3U, 2-slot, Air*
- ***COOL-CC3 –*** *Desktop, 3U, 6-slot, Conduction*
- ***COOL-XC3 –*** *Desktop, 3U, 6-slot, Air*
- ***COOL-CC6 –*** *Desktop, 6U, 6-slot, Conduction*
- ***COOL-XC6 –*** *Desktop, 6U, 6-slot, Air*
- ***585-9U –*** *Rackmount, 6U, 8-slot, Air*
- ***708/728 –*** *3U-9U, Rackmount, 6U, 5-12 slots*
- ***DT-CC –*** *Horizontal, 6U, 6-slot, High Power, Conduction*
- ***DT-XC –*** *Horizontal, 6U, 6-slot, High Power, Air*
- ***RME13CC –*** *13U, Desk/Rackmount, 6U, 16-slot, Conduction*
- ***RME13XC –*** *13U, Desk/Rackmount, 6U, 16-slot, Air*
- ***RME9CC –*** *9U, Desk/Rackmount, 3U, 12-slot, Conduction*
- ***RME9XC –*** *9U, Desk/Rackmount, 3U, 12-slot, Air*
- ***522 –*** *Open Frame, 3U/6U, 10-slot*
- ***OF-SMART3 –*** *Open Frame, 3U, 6-slot*
- ***OF-SMART6 –*** *Open Frame, 6U, 6-slot*

Atrenne also offers the industry's widest selection of VPX backplanes including pass-through backplanes which can be configured to meet an application-specific interconnect specification with VPX compatible cabling. Off-the-shelf backplanes support central switched, distributed, daisy chained, partial mesh, full mesh, and pass-through topologies.

Transmission rates start at 3.125 Gbaud with many 3U and 6U backplanes that operate at 10 Gbaud using the standard VPX connector. These new Gen-3, 10 Gbaud backplanes enable the utilization of high-speed serial interconnects including 40 Gb Ethernet, PCI Express Gen 3, Infiniband QDR and FDR10 and USB 3.1 in a VPX system.

Atrenne also offers ¾ ATR chassis that are as comfortable in the lab as they are deployed in the field. The D2D series has been designed to bridge the transition from development to demonstration to deployment with upgradable and expandable internal components. During the deployment phase, power supplies, fans, IO and the backplane is upgradable to rugged components, enhancing the ruggedness of the chassis.

FEATURES

- 3U and 6U Modules, Air and Conduction Cooled
- VPX, OpenVPX, VME64x, Hybrid
- Tower, Desktop, Open Frame, Rackmount, Horizontal and ATR
- 3rd-Party Agnostic
- 25+ Standard VPX Backplanes
- 10 Gbaud, Gen-3 Signaling for 40Gb Ethernet, PCIe V3 and more
- 2-16 Slots
- Wide Range of Power Supplies from 200W to 3750W
- 110 VAC, ATX, 200 VAC, Upgradable
- +5V and +12V-Centric Power Supplies
- Custom Variants and Integration

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Embedded Hardware

CONCURRENT TECHNOLOGIES

TR C4x/msd

TR C4x/msd is a 3U VPX™ board featuring the Intel® Xeon® Processor D-1500 family and up to 32GB of DDR4 ECC DRAM for high performance embedded server applications. Concurrent Technologies offers variants based on 8, 12 and 16-core processors to suit application profiles. TR C4x/msd has four SATA600 interfaces for external drives plus two SATA600 connections for on-board solid state disk options. For high speed networking applications, two 10 Gigabit Ethernet data plane ports can be used either as a system ingress/egress point or for local data connectivity within the chassis. Two Gigabit Ethernet control plane ports are available on the backplane and two optional Gigabit Ethernet ports are available on the front panel of air cooled boards.

TR C4x/msd can also provide up to x16 PCI Express® (PCIe®) lanes on the expansion plane of the backplane with a theoretical bandwidth of 15.6GB/s. These PCIe lanes enable point to point and small mesh configurations for high speed applications.

FEATURES

- Intel® Xeon® processor D-1500 Family
- Up to 32 Gbytes of DDR4 DRAM
- On-board solid state drive (SSD) options
- 2 x 10GBASE-KR Data Plane
- Up to x16 PCI Express® Gen 3 Expansion Plane
- Air cooled and rugged conduction cooled variants
- Compliant with VITA 46.11 management

mil-embedded.com/p373709

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www.cct.co.uk/sheets/TR/trc4xmsd.htm

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Embedded Hardware

Connect Tech Inc.
Embedded Computing Experts

36-port Switch/Router from Connect Tech

Connect Tech's **Xtreme/10G Managed Ethernet Switch/Router** targets managed Layer 2 and Layer 3 equipment in SMB, SME, and industrial applications where high port count 1G switching with 10G aggregation/uplinks are required.

This Managed 10G Ethernet Switch/Router is designed to act as a module allowing it to be mated to a Connect Tech off the shelf breakout board or with a custom designed breakout board to meet your exact application requirements.

Xtreme/10G Managed Ethernet Switch/Router provides a total of 36 switchable ports, with 4 x 10G, 8 x 1GbE (SGMII), and 24 x 1GbE (Copper 10/100/1000Mbps) ports in an extremely small form factor 85mm x 85mm.

FEATURES

- 36 switchable ports (4x 10G; 8x 1GbE [SGMI]; 24x 1GbE)
- High-density board-to-board connector
- +4V to 14V input range
- 85mm x 85mm module
- Extended Temperature Range -40°C to +85°C

mil-embedded.com/p373752

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Connect Tech Inc.
Embedded Computing Experts

Compact and Rugged Solutions for NVIDIA® Jetson™ TX1

Connect Tech offers small form factor, field deployable solutions for the NVIDIA® Jetson™ TX1 module.

The **Astro Carrier for NVIDIA® Jetson™ TX1** provides access to the NVIDIA® Jetson™ TX1 module at an 87mm x 57mm footprint, using a COTS or custom breakout board.

The **Elroy Carrier** is 87mm x 50mm and offers a low profile solution. Elroy's design includes Dual x2 MIPI CSI-2 Video Inputs, Mini-PCIe/mSATA expansion, HDMI Video, USB 3.0 and 2.0, and two Serial Ports for RS-232/485.

The **Orbitty Carrier** is our lowest priced carrier, with 1x GbE, USB 3.0, USB 2.0, 1x HDMI, 1x MicroSD, 2x 3.3V UART, I2C, 4x GPIO, it's also 87mm x 50mm.

Rosie is a small form factor, rugged embedded system based on the NVIDIA® Jetson™ TX1. Rosie is designed to MIL-STD-610g and DO-160 for shock and vibration and is rated IP68.

FEATURES

- **Astro:** A two board solution that includes an application agnostic carrier board mated to either a COTS breakout board or a custom breakout board that is designed to your specific requirements.
- **Elroy:** A single carrier board solution offering low profile, locking pin header connectors and expansion via dual head to head Mini PCIe slots. Our lowest profile offering.
- **Orbitty:** Low cost, small form factor carrier board with PC style connectors. The quickest and most economical method for field deployment of your Jetson™ TX1 module.

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CRYSTAL™

RE1312

The compact **RE1312** offers a small package with big capabilities. This unit is designed for space and weight constrained deployments; optimized for remote applications requiring powerful processing in the harshest of environments – MIL-STD-461, CE102, RE102 compliant. The RE1312 offers advanced compute power with the Intel™ Core® i7, up to 32GB unbuffered, non ECC DDR4 1.2V 50-DIMM memory and 18-36VDC power.

Innovative packaging techniques and our attention to the details make our product run cooler and operate over wider temperature ranges. We demand un-throttled CPU performance at specified temperature extremes, unlike many of our competitors. Our design approach limits chassis deflection to extend the solder joint life of our circuit boards. We provide incredible processing power in the RE1312 package with exceptional life at a fraction of the cost of our competition.

FEATURES

- Compact composite construction (4.5"H x 12" W x 9"D) provides low SWaP
- Unit weighs 7.52 lbs.
- Extended temperature range: -40°C to +60°C
- Dual and Quad Core i7® CPU options
- Two 15mm SSD or three 9mm SSD storage options, removable drives
- Bulk head or tray mounted options

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Crystal Group Inc.

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www.crystalrugged.com/products/embedded-systems/rugged-embedded-computer/RE1312/

Dawn VME Products®

PSC-6265

VITA 62 compliant 6U power supply for conduction cooled systems.

Dawn's VITA 62 compliant 6U **PSC-6265** can operate continuously in diverse environments over a wide range of temperatures at high power levels. The standard model is conduction to wedge lock cooled with an operating temperature range of -40C to +85C and a non-operating range of -55C to +105C.

The PSC-6265 operates continuously at a power level of 580 watts. For systems that require higher power levels, up to three supplies may be operated in parallel.

Fault monitoring and control circuits protect the system from over-voltage, over-current, and over-temperature conditions.

Power supply operational or fault status is displayed using colored LED's on front panel.

FEATURES

- Continuous 580W output over temperature range of -40C to +85C
- True 6 Channel supply provides full Open VPX support
- Secondary Side Wedge lock conduction cooled
- 6U, 1 inch pitch form factor
- Compatible with Dawn's HLD-6262 Holdup Module
- Fault monitoring and control
- Output over-voltage, over-current, and over-temperature shutdown protection
- Current/Load share compatible with up to 3 PSC-6265 units
- Standard INHIBIT*, ENABLE*, FAIL* and SYSRESET* control signals
- VBAT for support of VPX memory backup power bus
- Front I/O panel includes LED status indicator, and VBAT battery access
- VITA 48.2 Compliant Inject/Eject levers for easy installation

mil-embedded.com/p372930

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www.dawnvme.com

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Embedded Hardware

DDC®
Connectivity Power Control

Your Solution Provider for ... Connectivity, Power and Control

DDC is a world leader in the design and manufacture of high-reliability Connectivity, Power and Control solutions *(Data Networking; Power Distribution, Control and Conversion; Motor Control and Motion Feedback)* for aerospace, defense, and industrial applications. With awards for quality, delivery, and support, DDC has served industry as a trusted resource for more than 50 years ... providing proven solutions that are optimized for efficiency, reliability and performance. Data Device Corporation brands include DDC, Beta Transformer Technology Corporation, National Hybrid Inc., Pascall Electronics Ltd., and XCEL Power Systems Ltd. DDC is headquartered in Bohemia, NY and has manufacturing operations in New York, California, Mexico, and the United Kingdom.

DDC designs boards, hybrids, and multi-chip modules (MCM) to meet ruggedness and reliability levels for performance in demanding environments:

- **Ruggedization**
  - Flyable boards for conduction or air-cooled applications
  - Extended temperature operation
  - MIL-STD-810/VITA 47 shock and vibration
- **Life Cycle**
  - Uninterrupted product availability, backwards hardware and software compatibility, and configuration control

Leader in standard and custom electronic solutions for commercial aerospace, defense and space ...

- **Connectivity**
  High reliability data bus solutions ...
  - MIL-STD-1553/1760, ARINC 429, ARINC 629, Fibre Channel, Ethernet, CANbus & serial I/O
  - Optimized avionics computers, modules, boards & components maximize system performance
  - Radiation tolerant single board computers, hybrids, and ASIC components
  - Cross domain solutions that enable secure "red/black" data communications
- **Power**
  High reliability power solutions ...
  - Power supplies
  - Solid-state power controllers with over 800,000 nodes installed
  - Transformer and magnetic solutions
- **Control**
  High reliability motion control solutions ...
  - *When off-the-shelf won't do ... DDC custom motor controllers and drives.* DDC has a proven track record of solving the most complex and technically challenging motor control requirements
  - Synchro/Resolver-to-Digital and LVDT converters for precision motor & actuator positioning for demanding applications – Rugged & reliable motion feedback solutions engineered for dust, fluid, shock, vibration, extreme temps (-55°C to +200°C) with precision performance – Accuracy (1 arc-min), resolution (16 bit), repeatability (1 LSB)

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www.twitter.com/datadevicecorp

Embedded Hardware

ELMA
Your Solution Partner

High Capacity Embedded Storage Arrays

Today's high performance embedded computing systems require storage capacity that keeps up with the volume and pace of data collection in many applications. High definition video, radar, infrared and signals intelligence data captured over high port count systems can rapidly overwhelm a system deficient in storage capacity. To address those concerns, Elma offers the most complete line of storage modules in the embedded computing industry.

Elegant and straightforward board designs enable fast SATA III connectivity in 3U, 6U, VPX, VME and, cPCI standard form factors. Standard and extended temperature options include front or rear I/O. Including 2.5" SSDs from our top tier drive suppliers, each board undergoes complete thermal cycle testing to ensure flawless operation in scorching hot environments.

As designers and builders of storage products and systems for the embedded computing industry for over the 30 years, Elma has the unparalleled experience necessary to ensure your storage system is durable, reliable and versatile.

Also consider Elma for complete integrated systems including compute, networking and application specific I/O elements as well as data storage. For board level solutions or fully tested and qualified integrated systems, Elma has the industry know how and design experience to move your project forward quickly.

FEATURES

- Multi-terabyte capacity per slot
- Extensible design allows expansion out to N slots to accommodate capacity increases
- Front removable options for easy data download and transfer plus fixed drive solutions
- Easily build RAID arrays using s/w RAID options or mezzanine mounted controllers
- Conduction and convection cooled models
- Extended temperature, shock and vibration versions
- SSD or rotating drives with SSD options in MLC and SLC plus secure erase and data protection options

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Embedded Hardware

ELMA
Your Solution Partner

Network Switching and Routing Product Family

If proven performance in demanding applications is what you look for in an Ethernet switch, Elma has the answer. Our Ethernet switches and routing engines perform in a wide range of applications. Address your networking requirements with the broadest and most technologically advanced family of networking products on the embedded market. Elma offers solutions for high speed networking in defense, industrial, medical and telecommunication systems. Based on the latest silicon available from Marvell, our Interface Concept line of products have been serving critical roles in defense programs as well as key industrial installations for over twelve years. Models support basic switching up to the latest layer 3 routing protocols. Our Switchware™ graphical user interface (GUI) makes network management simple with an easy to use interface enabling network optimization, analytics and troubleshooting. All Ethernet switching products are supported through our Pennsylvania office by one of the most experienced staffs in the industry. Customization is available at low volumes. We also provide custom packaging and backplane designs along with thermal analysis for system platforms as well as complete integration and system design support. Look to Elma's Interface Concept line of networking products for the speed, scalability, reliability and security your systems require.

FEATURES

- 12 year track record of solid performance, reliability and longevity in defense applications
- 3U, 6U, mezzanine and custom chassis solutions including SFF and 19" rackmount
- VPX, VME, cPCI, cPCI serial, mezzanine and PCI/104 versions
- 1Gig, 10 Gig and 40Gig links with copper and fiber port options
- Front or rear I/O for up to 28 ports on a 6U board plus low volume customization
- Air and conduction cooled models, -45°C to +85°C with optional conformal coating
- Low volume customs including port location, count, type and GUI enhancements

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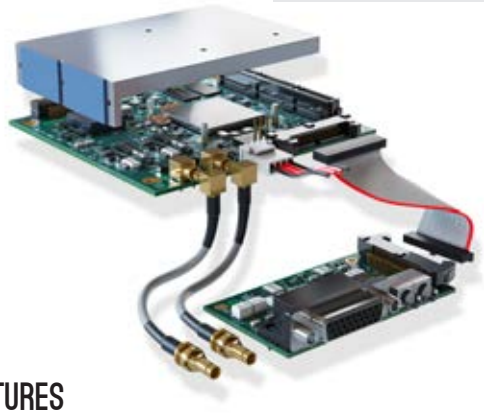
Embedded Hardware

EURESYS™
Excellence in vision

Coaxlink Duo PCIe/104



Transmission and acquisition of high-definition video over long coaxial cables

CoaXPress is a recent powerful standard providing a high speed interface between the camera and the PC frame grabber. High frequency real time triggering and exposure time adjustment to the low light situations can be accommodated.

Airborne ISR

Vision systems often integrate high resolution and high speed CoaXPress cameras for airborne Intelligence, surveillance and reconnaissance missions.

Transport, security

Thanks to a high resistance to extreme temperatures, shocks, vibrations and humidity, the Coaxlink Duo PCIe/104 board is particularly well suited for embedded security systems for rail and road transportation, police vehicles equipment or any mobile or outdoor video-surveillance applications.

Camera turrets for airborne surveillance or gun turrets

CoaXPress cameras can easily be integrated in 360°C rotating stations with slip rings to allow continuous panning. High resolution video provides sharper images and a larger viewing area thereby potentially reducing the number of cameras required.

Unmanned applications, vehicle-based video capture

The CoaXPress standard allows video transfer to the PC in a few milliseconds. The very low latency of the system will allow the control of land vehicles or remote control of UAVs.

FEATURES

- Ruggedized COTS board for industrial and military embedded applications
- Small stackable PCIe/104 form factor
- Extended temperature range: -40 to +85°C / -40 to +185°F with conduction cooling (ambient temperature measured inside the enclosure)
- Sustained shock: 20 g/11ms (all axes – half-sine and saw tooth)
- Optional conformal coating
- Two CoaXPress CXP-6 connections: 1,250 MB/s camera bandwidth
- Feature-rich set of 10 digital I/O lines

mil-embedded.com/p373650

Euresys
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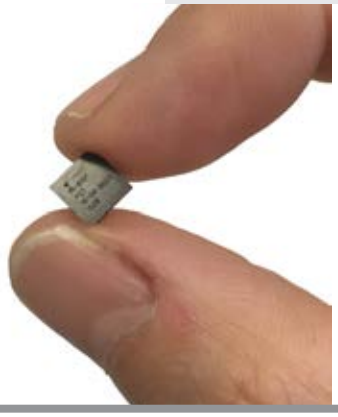
Embedded Hardware

HOLT INC.
INTEGRATED CIRCUITS

MAMBA™: World's Smallest MIL-STD-1553 Integrated Circuit Solution



Holt's 3.3V MIL-STD-1553 MAMBA™ family provides a complete single- or multi-function interface between a host microprocessor and MIL-STD-1553B bus. The family provides fully compliant Bus Controller (BC), Bus Monitor Terminal (MT) and Remote Terminal (RT) functions. Four device options are available; BC/RT/MT, BC/RT, RT/MT and RT only, with the ability to enable any combination of the included MIL-STD-1553 functions for concurrent operation.

The user allocates 8K x 17-bit words of on-chip static RAM between devices to suit application requirements, communicating with the host MCU via a 40 MHz Serial Peripheral Interface (SPI). Up to 32 programmable interrupts may be stored in a 64-Word Interrupt Log Buffer, providing terminal status to the host processor.

Each device may be configured for automatic self-initialization after reset. A dedicated SPI port reads data from an external serial EEPROM to fully configure registers and RAM and optionally start execution for any subset of terminal devices. In addition, a MIL-STD-1760 Boot Pin may be used to initialize the RT with Busy Bit set without host intervention.

All devices have integrated dual MIL-STD-1553 transceivers and are available in 48-pin plastic QFP or 6mm x 6mm QFN packages.

FEATURES

- World's smallest MIL-STD-1553 terminal: QFN package measures just 6mm x 6mm
- 4 product variants: RT, RT/MT, BC/RT and BC/RT/MT with concurrent multi-terminal operation possible
- Integrated dual transceivers on all product variants
- 40 MHz Serial Peripheral Host Interface (SPI)
- MIL-STD-1760 Boot Pin to initialize RT with Busy Bit set without host intervention
- Two temperature ranges: -40°C to +85°C, or -55°C to +125°C with optional burn-in
- DO-254 certifiable

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Holt Integrated Circuits
www.holtic.com/category/406-mil-std-1553-protocol-ics.aspx

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GENERAL MICRO SYSTEMS, INC.

S2U "King Cobra" Rugged, 2U LRU Server

The **S2U "King Cobra"** is a major breakthrough in **server/switch/Cisco router technology**. It is the smallest, fastest server on the market, with more I/O performance and storage functionality than any other server. It replaces up to 8U of 1U/2U servers, switches/routers, RAID controllers, and Auxiliary Power Units (APU) with a single 2U, 17-inch deep (short) rack-mountable (or free-standing) enclosure.

One hundred percent of the "King Cobra" electronics are Line Replaceable Units (LRU) specifically designed for field replacement and upgrading. This 100% LRU functionality allows the user to replace any function of the system in the field within ***seconds***, thus providing ultimate flexibility and economy while minimizing down time. S2U also easily evolves as program needs change.

The S2U features a state-of-the-art rugged and proven OpenVPX architecture. Unlike PC motherboards, which virtually all servers use, the OpenVPX design allows much higher shock, vibration, and temperatures than standard servers. S2U's reliable, field-proven 100% LRU architecture also takes full advantage of commercial-off-the shelf (COTS) PCIe boards, such as high-end video boards, RAID controllers, and DSP modules, which may be quickly plugged and unplugged into the system within seconds. A complete Cisco Embedded Services Router is an optional part of S2U.

FEATURES

- Supports Dual Xeon® E5 processors, 20-port managed switch, 48TB RAID storage and Quad NVIDIA® GPU
- 100% Line Replacement Unit (LRU) for ultra fast service, upgradability and sparing
- 23 Gigabit Ethernet ports (8 with PoE); 4 10Gigabit Ethernet ports
- Supports two 6U OpenVPX, modules, three 3U OpenVPX modules and four full-length/height PCIe modules
- Supports twelve 2.5" removable storage devices such as x4 PCIe NVMe SSD and SAS/SATA III drives
- Operates at standard temperature 0°C to +50°C or extended temperature -20°C to +75°C
- Ultra-low SWaP, only 17" x17" x 3.25" @ 30 lb. and as low as 300W. Optional Auxiliary Power Unit for graceful shutdown

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Embedded Hardware

TRUSTED AND DEPLOYED SINCE 1979

SB2002-SW "Blackhawk" Xeon D Mini-Server with Storage

The **SB2002-SW "Blackhawk"** is an ultra-rugged, small, lightweight server system with up to 16 CPU Intel®Xeon® processor D cores and up to four removable drives. It is designed to provide a 20-port intelligent hardware switch/router system supporting Layer 2/3 routing functions with customizable rules while providing the highest level of workstation performance possible in a fully ruggedized, conduction-cooled, sealed system, operating from -40°C to +85°C. This system is designed for applications that require a very high performance server, low-cost router in a small, ultra-rugged enclosure with the highest possible performance per dollar and per watt while utilizing rugged interconnects to provide a fully sealed system.

The Blackhawk supports the latest, most power-efficient Intel® Xeon® processor D with Hyper-Threading for a total of up to 16 logical cores, each operating up to 1.5GHz and having the ability to TurboBoost up to 2.1GHz. To harvest this incredible CPU performance, the CPU is coupled with up to 64GB of DDR4 RAM organized in two banks with support for Error Correcting Code (ECC). The ECC RAM provides 2-bit error detection and 1-bit error correction.

FEATURES

- Supports Intel® Xeon processor D (D-15xx) with up to 16 Cores; up to 64GB of DDR4 memory with ECC
- Up to 16 Gigabit Ethernet ports; 4 10 Gigabit Ethernet ports
- Up to four removable, 2.5" SATA SSD (optional encrypt/secure-erase/write-protect)
- Optional fixed mSATA SSD for OS boot (optional encrypt/secure-erase/write-protect)
- Support for one Enterprise Class PCIe x4 NVMe (SATA Express) SSD with up to 2.4GB/s Read/1.2GB/s Write
- Intel® Virtualization Technology (VT-x/VT-d2) and Trusted Execution Technology (TXT)
- Greatest computing density, most number of embedded cores and RAM, highest number of Ethernet ports with PoE in the industry

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Innovative Integration
a molex company

K706 Rugged Miniature Digital Transceiver

The **K706 Digital Transceiver** supports one FMC-1000 plug-in module providing two antenna inputs and four independent channels of DDC, two channels of DUC, and one spectrum analyzer embedded in a Xilinx Kintex-7 FPGA. It supports monitoring and/or recording of wide- or narrow-band spectra or channelized IF band data. The transceiver supports contiguous recording at 160 MByte/s until running out of disk space.

Each DDC has its own programmable tuner, programmable low-pass filtering, gain control, and decimation settings, supporting output bandwidth up-to 100 MHz.

Perfect for Surveillance, Arbitrary Waveform Generator/Player, and Digital Receiver.

Download datasheets and pricing now!

FEATURES

- Two 14-bit, 1 GHz ADCs; analog bandwidth 1 GHz (AC Coupled) Two 16-bit, 1 GHz DACs; analog bandwidth 1 GHz (AC Coupled)
- Xilinx Kintex-7 K410T2 FPGA Intel Atom Quad Core, 8 GB RAM, 1GbE Sustained logging rate up-to 300 MByte/s
- Embedded power meter Optional GPS 10 MHz ref clock/PPS
- Digital Down-Converter (DDC) Four independent 16-bit DDC channels
- Digital Up-Converter (DUC) Two independent 16-bit DUC channels
- Real-Time Spectrum Analyzer FFT length: 32,768; 50% overlapped Real-time bandwidth: 100 MHz

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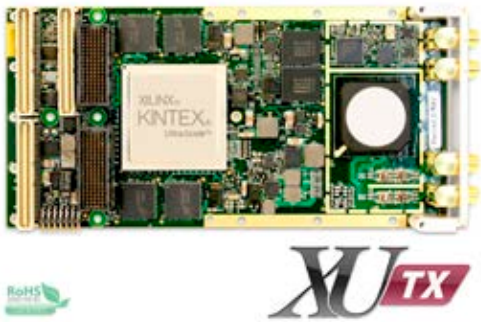
XU-TX xmc Two 5.1 GSPS 16-bit DACs Xilinx UltraScale

The **XU-TX** is an XMC module which features two AC-coupled single-ended 16-bit DAC outputs with programmable DC bias. The DAC devices employed support synchronization, interpolation, and their unique output circuits allow improved frequency synthesis in the 2nd and 3rd Nyquist zones. This can shift the Nyquist null frequency in the output spectrum to two times the typical Nyquist null frequency. The maximum sample rate of the DAC IC is 10.2 GSPS, the maximum external direct clocking rate is 5.1 GSPS and the on board PLL can generate clocks up to 4.8 GHz. The DACs' JESD 204B interfaces can stream data with transfer rates up to 5.1 Gsps.

A Xilinx Kintex UltraScale XCVU060/085 FPGA with 4GB DDR4 RAM memory provides a very high performance DSP core for demanding applications such as RADAR and wireless IF generation.

Download datasheets and pricing now!



FEATURES

- Two 16-bit, > 5.1 GSPS DAC channels: Single ended AC coupled outputs with programmable DC bias Differential DC model option
- >2 GHz analog bandwidth (1X) Digital inverse sinc filter Enhanced 2nd and 3rd Nyquist modes "Frequency doubling" 2X mode Interpolation filters: 1X(bypassed)-64x
- 48 bit NCO and 31 32bit fast hop NCOs Up to 7800 MB/s streaming via PCIe or Aurora Internal or external clocking Internal 0.3 to 4.8 GHz PLL each DAC
- Internal or external triggering Fixed latency, multi-board synchronization Xilinx Kintex UltraScale FPGA XCKU060/085:
- 4 GB DDR4 DRAM in 2 banks each with 64 bit interface Up to 38.4GB/s total bandwidth (based on 100% data buss efficiency)
- 4 MB QDR SRAM in 1 bank with 32 bit interface 12x faster than DDR for random access applications (like FFTs)

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iveia™

Zynq UltraScale+ 3U OpenVPX Single Board Computer

Reduce your VPX slot count with VPX-1, a high-performance heterogeneous computing module from iVeia. This All-In-1 module can fufill all of your SBC, FPGA, and I/O requirements in a single slot. Featuring the Zynq® UltraScale+™ Multi-Programmable System-on-a-Chip (MPSoC) from Xilinx®, the VPX-1 boasts a 1.5 GHz quad-core 64-bit ARM® architecture with 8GB of DDR4-2400 memory integrated with over 1 milltion programmable logic cells and up to 3500 DSP blocks.

The flexible architecture enables the VPX-1 to support over a dozen OpenVPX slot profiles, including popular SBC profiles. Sixteen high-speed transceivers can be soft-configured for multiple PCIe or 10G/1G Ethernet (and more) configurations, and can be connected to the ARM system, the programmable logic, or to the I/O modules. Options are available for coaxial (VITA 67.1) and fiber-optic connections (VITA 66.4) to the VPX backplane.

The flexible Mini-Flex I/O architecture allows the user to combine a number of different mixed-signal and video I/O interfaces, or the option to develop their own.

FEATURES

- Zynq UltraScale+ ZU11EG, ZU15EG, or ZU19EG
- Quad-core ARM® Cortex™-A53 64-bit processors up to 1.5 GHz
- Up to 1.1 million logic cells and 3500 DSP blocks
- 8GB of DDR4-2400 available to the processing system
- 8GB of DDR4-2667 dedicated to the programmable logic
- Operating system support for Linux and VxWorks®
- Flexible I/O options for ADC, DAC, and industrial video
- Options for VITA 67.1 and VITA 66.4
- Convection-cooled and conduction-cooled options

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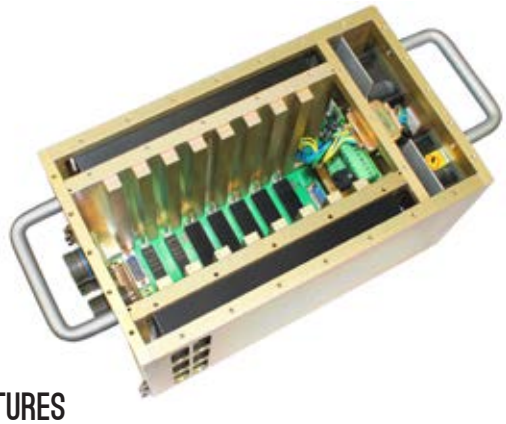
LCR™ EMBEDDED SYSTEMS, INC.

3U VPX ARINC 404 Rack

The VITA 46.0 and 48.2-compliant 3U VPX ARINC 404 Rack provides a highly customizable, modular solution offering superior cooling, ideal for small form factor needs such as tracked vehicles and aircraft.

The chassis offers a sealed exterior for harsh computing environments, ARINC 404/600 hold-down hooks in front, and interface for hold-down pins in rear. It is also available as a fully populated integrated system.

Within its sealed exterior, the chassis uses convection-over-conduction cooling, with 4 fans moving air from front to back, allowing for 100W of cooling per slot. It uses a bolted machined and gasketed aluminum frame and weighs 24lbs.



FEATURES

- Superior cooling (100W per slot)
- Shock and vibe MIL-STD-810
- EMI to MIL-STD-461F
- IP67 against dust and immersion
- Altitude: 15,000ft
- Optional intelligent power available
- Fully customizable

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LCR EMBEDDED SYSTEMS, INC.™

A New Family of Affordable Enclosures

LCR Embedded Systems' new family of customizable, rugged industrial NEBS enclosures provide our telecom, datacom, and military customers with an affordable open-standard ecosystem for application solutions development.

Processor options include Intel Core i5/i7 Quad-Core Processors, drive bays for a slim DVD, and two locking, removable 2.5" SATA drives.

Our affordable family of 2U, 3U, and 4U Universal development chassis is an ideal solution for open-standards-based application development and supports VPX, VME, CompactPCI, or custom backplanes.

FEATURES

- Form Factor: VPX, VME, CompactPCI, or Custom
- 2U, 3U, and 4U vertical sizes available with 3, 4, or 8 slots
- 6U card size, horizontally mounted
- Left to right, push configuration cooling, fan tray easily removed for service
- Locking removable or hinged front door
- Shock and vibe tested
- Fully customizable

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Embedded Hardware

LCR EMBEDDED SYSTEMS, INC.™

Rugged 6-Slot AdvancedTCA Chassis

Designed in accordance with PICMG 3.0 Rev3, and featuring a variety of power options, this chassis is sturdy, efficient, and ready to support your most environmentally demanding mission-critical military applications.

This rack-mountable chassis accepts two shelf managers for redundancy and is constructed with a steel outer shell and machined card guides housing a machined aluminum frame. It is highly configurable and customizable for your specific program needs.

The chassis employs side-to-side convection cooling of 300W per slot, with six redundant 189 CFM fans, with monitoring and control via PWM.

FEATURES

- Superior cooling (300W per slot)
- Six slots (2 Hub, 4 Node)
- Shock and vibe MIL-STD-810
- Altitude: 15,000ft
- Three 110/220 VAC inputs, 1500W per power supply, N+1 redundant
- Backplane fabric/profile full mesh bussed UPMB
- Fully customizable

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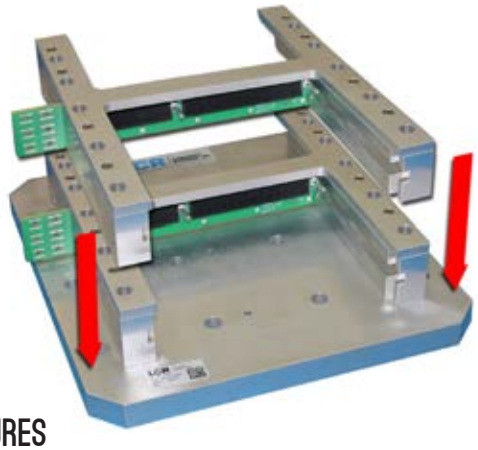
Embedded Hardware

LCR EMBEDDED SYSTEMS, INC.™

Stackable Single-Slot Test Fixture

The VITA 48.2-compliant Stackable Single Slot Test Fixture can be used for development, validation, and environmental testing. In the vertical configuration, the fixture can be used on the benchtop or desktop for development and validation. In the horizontal configuration, it can be used for operational/non-operational environmental testing.

The fixture is compliant with VITA 46.0 (VPX base), with options for VITA 66 (optical interconnect) and VITA 67 (coax interconnect). Rear connectors for cables or RTMs are included, with optional support for VITA 46.10 RTMs.



FEATURES

- Form Factor: VPX, VME, CompactPCI, or Custom
- 6U Card size, 3U optional
- Conduction cooling
- Bolted machined aluminum construction
- Can be vertically mounted as well
- Ideal for testing, development, and validation
- Fully customizable and stackable

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Embedded Hardware

MPL
High-Tech • Made in Switzerland

Rugged Fanless Embedded Computers up to i7 Quad Core

The **PIP Family** is a powerful, highly integrated, robust, and fanless rugged embedded Computer Solution. Selection of the parts are purely made on the subject for long-term availability (Embedded Roadmap). The systems can be expanded in a very modular way and represent a unique solution for today's demanding defense requirements. The products are designed to operate under extreme and normal conditions without the need of fans. MPL solutions are designed and produced in Switzerland to meet MIL STD-810F as well as other standards.

The systems include features like wide DC input power, reverse polarity protection and more. Additional GPS, WLAN, CAN, Sound, and UPS modules are available.

FEATURES

- Soldered CPU, Chipset, and ECCRAM
- Up to 5 Gbit Ethernet, 7 USB (3.0/2.0), 4 serial ports
- Internal & external PCIe expansion
- PCIe, PMC, XMC, mPCIe, PCI-104 expansion
- Extreme low power consumption
- Availability 10+ years (repairable 20+ years)
- Optional -40°C to 85°C environment temperature

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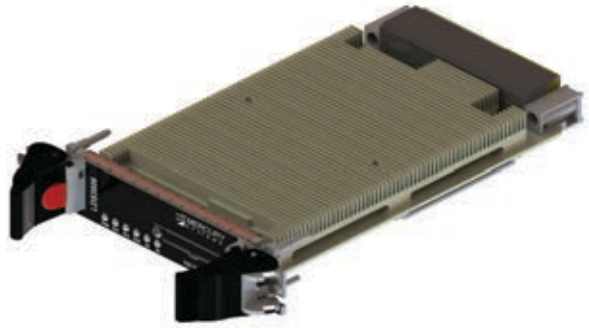
Embedded Hardware

MERCURY SYSTEMS™

INNOVATION THAT MATTERS™



LDS3506

Mercury's OpenVPX™ Ensemble® LDS3506 processing module seamlessly integrates Intel's Xeon® D-series processor (formerly codenamed "Broadwell DE") with Xilinx's UltraScale™ FPGA in a SWaP-constrained 3U package. This dense union of best available commercial-item general processing and FPGA resources produces a highly versatile, affordable and interoperable building block for embedded, high-performance compute applications with additional low-latency, refresh and mission capabilities.

The module's latest Xilinx FPGA hosts Mercury's Protocol Offload Engine Technology (POET™) to give each module the ability to refresh its mission capability, provide information assurance abilities, or even refresh or upgrade its switch fabric itself without affecting any hardware.

FEATURES

- 3U OpenVPX™ compliant VITA 65/46/48 (VPX-REDI) module
- 8-core Broadwell DE Intel® Xeon® D family server-class processor
- Xilinx® UltraScale™ FPGA with dual x4 PCIe data plane and Ethernet control plane
- 256 GFLOPS peak processing power in a single slot
- Dual 10 Gigabit Ethernet interfaces for sensor I/O or inter-processor communication
- x8 PCIe expansion plane for additional I/O or offload
- Mercury MultiCore Plus® software infrastructure support

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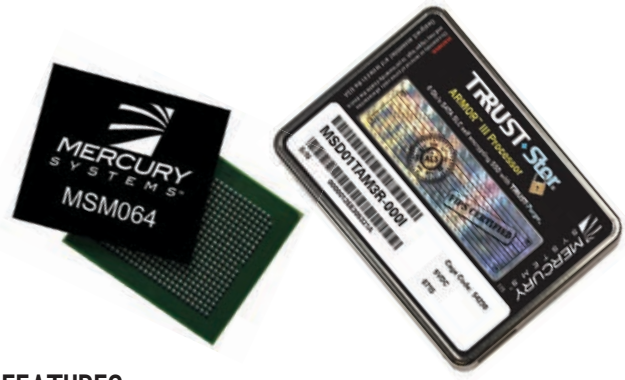

Secure Solid State Drives

Innovation that Protects

Mercury's Solid State Drives (SSDs) provide superior data at rest protection against intruders as well as harsh environments. Our SSDs come in BGA, 2.5", XMC, mSATA 52-pin and custom form factors.

Engineered and manufactured in a DMEA Trusted Facility, these SSDs offer a secure supply chain critical for defense applications. They are built to withstand high shock and vibration environments. And the controller is owned by Mercury which provides long term product support and removes obsolescence risk.

Learn more at mrcy.com/SSD

FEATURES

- Densities from 32GB to 1TB
- AES 256 XTS encryption
- FIPS 197 certified encryption
- Support for customized security features and packaging options
- High speed purge with validation
- Meets all Military purge protocols
- Ruggedized connector options

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North Atlantic Industries
Accelerate Your Time-to-Mission

Fire Control & Targeting Systems – FCT Series

Preconfigured, scalable, application-ready Fire Control & Targeting Systems with no NRE

NAI's new FCT Systems are COTS-based, preconfigured and tested fire control and targeting systems designed for air, land and sea environments. These systems can be applied to a broad spectrum of applications where a multitude of sensor and command interfaces need to be maintained to ensure steady on-target aim and control. Critical air, land or sea positioning platforms such as on-the-move targeting or line-of-sight communications, radar and laser guidance can all benefit from the efficient and programmable NAI FCT Systems.

The FCT Series is built on NAI's highly adaptive, Custom-On-Standard Architecture™ (COSA™). COSA's modular approach delivers more intelligence and functionality in a smaller footprint – *all at a lower cost.* Built for compact, low-power system requirements, the FCT systems are "application-ready" for the customer's software.

NAI's fire control and targeting systems (FCT-31CP0D, FCT-33CP0D, FCT-35CP0D) support a multitude of military/aerospace applications that require high-density, multi-channel, programmable, A/D, Discrete I/O, Differential I/O, Synchro/Resolver measurement and simulation, Serial and CANBus Communications function modules. See each FCT system for exact module complement.

FEATURES

- Single source mitigating 3rd party integration risks
- No NRE
- Increased design versatility
- Reduced power consumption
- Scalable with three systems to choose from
- Higher package density
- Streamlined development resources
- Overall lower program cost
- Accelerated time-to-mission
- MIL-STD-461F and MIL-STD-810G
- Continuous Background Built-in-Test (BIT)
- COSA™ architecture
- Operating temperature -40° C to +71° C

Made in the USA
Certified Small Business

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Embedded Hardware

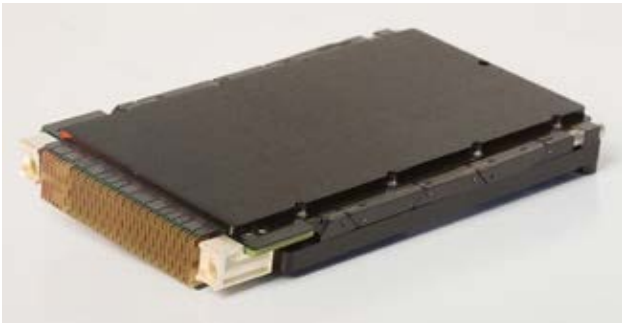
ORION TECHNOLOGIES

3U VPX Intel® Xeon® D Single Board Computer (Air or Conduction Cooled) – VPX7668

Orion Technologies introduces its newest multi-core single board computer. Utilizing the power of the **Intel® Xeon® D-1500** family processors, the VPX7668 can hold up to 16 cores in a single, power-efficient SoC package.

Orion Technologies understands the importance of security in todays evolving industries. This is why the VPX7668 uses a **Trusted Platform Module** to provide platform integrity, disk encryption, and password protection. With **anti-tamper features** also available, this single board computer enables customers full control of some of the most advanced security capabilities in todays market.

The VPX7668 is available in 6 levels of ruggedization from commercial temperature air-cooled (0.8" pitch) to extended temperature REDI (Vite 48.2, 1" pitch) making it ideal for practically any military, industrial or commercial application.



FEATURES

- Intel® Xeon® D-1500 Family Processor up to 16 core
- Up to 16GB of soldered DDR3 SDRAM with ECC and Up to 64GB of on-board NAND Flash
- Trusted Platform Module
- Anti-Tamper features available
- Two 4-lane PCIe v3.0 ports on VPX P1 (Vita 46.4)
- Two 10GbE Base-KR ports
- PCIe non-transparent port and DMA capabilities

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Embedded Hardware

Opal Kelly

XEM7350

The **XEM7350** is a perfect match for all three of the company's target markets: *Integration, Evaluation, and Acceleration*. System integrators can build fully-operational prototype and production designs with off-the-shelf FMC peripherals. Manufacturers of high-speed devices such as JESD-204B data acquisition chips can launch evaluation boards as FMC peripherals. The XEM7350 is an ideal platform for demonstrating these devices to customers with a capable, compact system, and custom evaluation software built on the well-supported FrontPanel SDK.

With ample logic resources, the Kintex-7 is also suited to signal processing and image processing for acceleration tasks when mated to image capture or data acquisition hardware.

Celebrating 10 years of USB FPGA connectivity, Opal Kelly's Front-Panel SDK fully supports the XEM7350 for real-world transfer rates in excess of 340 MiB/s. FrontPanel includes a multi-platform (Windows, Mac, Linux) API, binary firmware for the on-board Cypress FX3 USB controller, and atomic HDL modules to integrate into your design. FrontPanel is the industry's most full-featured, high-performance, turnkey solution for professional grade USB connectivity.

FEATURES

- Xilinx Kintex-7 XC7K70T, XC7K160T, or XC7K410T
- Small form-factor: 80mm x 70mm x 15.1mm
- VITA 57.1 FMC-HPC connector
- 512 MiB DDR3
- Up to 170 user I/O + 8 Gigabit Transceivers
- Low-jitter 200 MHz and 100 MHz clock oscillators
- Integrated voltage, current, and temperature monitoring

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Embedded Hardware

Opal Kelly

XEM7360

The **XEM7360** Kintex-7 based FPGA module offers a turnkey SuperSpeed USB 3.0 host interface using Opal Kelly's FrontPanel SDK. System integrators can build fully-operational prototype and production designs quickly by integrating this device into their product. Manufacturers of high-speed devices such as JESD-204B data acquisition devices can launch fully-functional evaluation systems without the costly design and maintenance of an evaluation platform.

With ample logic resources, the Kintex-7 is well-suited to signal processing, image processing, and other logic-heavy acceleration tasks. Memory-hungry applications enjoy access to 2 GiB of on-board DDR3 memory with a 32-bit wide data bus.

Celebrating over 10 years of USB FPGA connectivity, Opal Kelly's Front-Panel SDK fully supports the XEM7360 for real-world transfer rates in excess of 340 MiB/s. FrontPanel includes a multi-platform (Windows, Mac, Linux) API, binary firmware for the on-board Cypress FX3 USB controller, and atomic HDL modules to integrate into your design. FrontPanel is the industry's most full-featured, high-performance, turnkey solution for professional grade USB connectivity.

FEATURES

- Xilinx Kintex-7 XC7K160T or XC7K410T
- 2 GiB DDR3, 2x 16 MiB serial flash
- Two Samtec QSH-090 expansion connectors
- Up to 193 user I/O + 8 Gigabit Transceivers
- Low-jitter 200 MHz and 100 MHz clock oscillators
- Integrated voltage, current, and temperature monitoring
- Small form-factor: 100mm x 70mm x 19.65mm

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PENTEK

3U VPX Board Multichannel, High-Speed Data Converter

Model 5973-313 is a member of the Flexor® family of high-performance 3U VPX boards based on the Xilinx Virtex-7 FPGA. As a FlexorSetTM integrated solution, the Model 3312 FMC is factory-installed on the 5973 FMC carrier. The required FPGA IP is installed and the board-set is delivered ready for immediate use.

The delivered FlexorSet is a multichannel, high-speed data converter with programmable DDCs. Its built-in data capture and playback features offer an ideal turnkey solution as well as a platform for developing and deploying custom FPGA-processing IP.

It includes four 250 MHz, 16-bit A/Ds, one digital upconverter, two 800 MHz, 16-bit D/As, DDCs and four banks of memory. In addition to supporting PCIe Gen. 3 as a native interface, it includes optional copper and optical connections to the FPGA for custom I/O.

The Flexor Architecture

Based on the proven design of the Onyx family of Virtex-7 products, the 5973 FMC carrier retains all the key features of that family. As a central foundation of the board architecture, the FPGA has access to all data and control paths of both the carrier board and the FMC module, enabling factory-installed functions that include data multiplexing, channel selection, data packing, gating, triggering and memory control.

When delivered as an assembled board set, the 5973-313 includes factory-installed applications ideally matched to the board's analog interfaces. The functions include four A/D acquisition IP modules for simplifying data capture and data transfer. Each of the four acquisition IP modules contains a powerful DDC core.

The 5973-313 features a sophisticated D/A waveform playback IP module. A linked-list controller allows users to easily play back to the D/As waveforms stored in either on-board or off-board host memory. Parameters including length of waveform, delay from playback trigger, waveform repetition, etc. can be programmed for each waveform.

Up to 64 individual link entries can be chained together to create complex waveforms with a minimum of programming.

A controller for all data clocking and synchronization functions, a test signal generator, and a PCIe interface complete the factory-installed functions and enable the 5973-313 to operate as a turnkey solution without the need to develop any FPGA IP.

Extendable IP Design

For applications that require specialized functions, users can install their own custom IP for data processing. Pentek GateFlow® FPGA Design Kits include all of the factory-installed modules as documented source code.

FEATURES

- Supports Xilinx Virtex-7 VXT FPGAs
- GateXpress supports dynamic FPGA reconfiguration across PCIe
- Four 250 MHz 16-bit A/Ds
- Four multiband DDCs
- One digital upconverter
- Two 800 MHz 16-bit D/As
- Extended Interpolation
- Sample clock synchronization to an external system reference
- PCI Express (Gen. 1, 2 & 3) interface up to x8
- User-configurable gigabit serial interface
- Optional optical Interface for backplane gigabit serial interboard communication
- Also available in PCIe as the Model 7070-313

Flexor

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Red Rapids

SigStream and SigFPGA Product Families

Red Rapids offers a catalog of signal acquisition and generation hardware products that target communication, telemetry, radar, spectrum monitoring, and instrumentation applications. The products are available in multiple form factors for seamless integration into an embedded chassis or traditional server/desktop environment.

Embedded products conform to the VITA conduction cooled XMC (CCXMC) specification. The CCXMC products can plug into any compliant host platform with no modification to the conduction frame. Temperature monitors distributed across each board provide in-system thermal performance measurements. Power monitors on each primary supply voltage also contribute to a comprehensive view of the operating environment.

All Red Rapids products include an on-board frequency synthesizer to produce a low phase noise clock source. The frequency synthesizer can be phase locked to the local 10 MHz TCXO or an external reference can be supplied to achieve system-wide phase coherence. An external sample clock input is also available to bypass the synthesizer.

A unified code base allows application developers to transition between products and across operating systems with a common API. Demonstration code exercises all of the API functions in a simple application example that includes high performance DMA scatter-gather operations. Windows and Linux drivers are provided at no additional cost to the product.

FEATURES

Plug and Play ADC/DAC

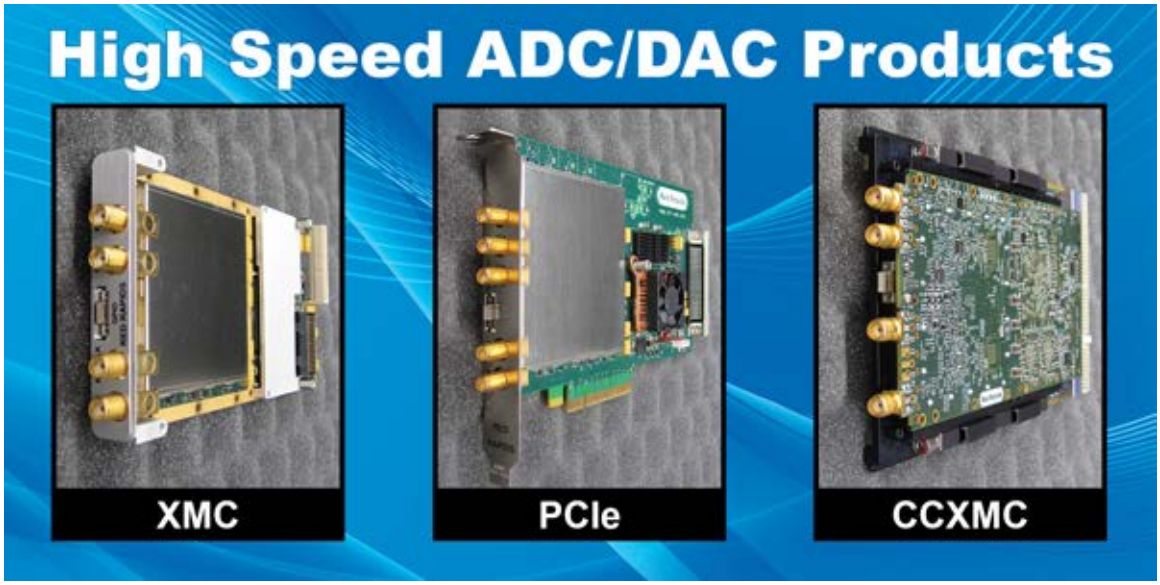
The **SigStream product family** instantly transforms a general pur-pose computer into a high speed signal acquisition platform. The hardware incorporates a rich set of software programmable features that include selectable operating modes (continuous, snapshot, periodic), external or timed event triggers, timestamped data samples, and flexible data formatting. Each channel can stream raw samples or data packets defined by the VITA 49 specification.

- **Model 271** Dual Channel Receiver (16-bit/250 Msps)
- **Model 273** Dual Channel Receiver (16-bit/310 Msps)
- **Model 276** Single Channel Receiver (12-bit/1.5 Gsps)
- **Model 277** Quad Channel Receiver (16-bit/250 Msps)

Xilinx FPGA Based DSP Accelerators

The **SigFPGA product family** provides an ideal platform to rapidly field application specific signal acquisition and generation functions minus the expense of custom hardware development. The products share a common Kintex-7 based FPGA processing architecture that features high performance QDR II+ SRAM storage.

- **Model 371** Dual Channel Receiver (16-bit/250 Msps)
- **Model 372** Dual Channel Transceiver (16-bit/310 Msps)
- **Model 373** Dual Channel Receiver (16-bit/310 Msps)
- **Model 376** Dual Channel Receiver (12-bit/1.6 Gsps)
- **Model 377** Quad Channel Receiver (16-bit/250 Msps)



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Embedded Hardware

OpenVPX Backplanes, Systems, & Components

Pixus is a leader in OpenVPX backplanes with a wide range of 3U and 6U configurations off-the-shelf. We specialize in high-speed designs to 40GbE and beyond. The company also develops customized versions with lower NRE in any volume. With virtually unlimited rackmount configurations and a vast array of conduction cooled enclosures, Pixus has a solution for you.

The Pixus rugged injector/ejector handle for OpenVPX boards has a metal engagement claw that won't wear down or break. Thick, rugged horizontal rails are also available to prevent bowing or cracking in high insertion force systems.

From components to backplanes to full system platforms, Pixus has an OpenVPX solution for you.

FEATURES

- 3U and 6U backplane high-speed expertise, 40GbE, PCIe Gen3, and more
- Rugged ATR and SFF enclosures for OpenVPX, conduction-cooled
- Virtually unlimited standard rackmount configurations
- Low-cost development systems for 3U or 6U boards
- ITAR compliant, ISO9001 registered
- Customization in any volume
- Proven, high-reliability designs

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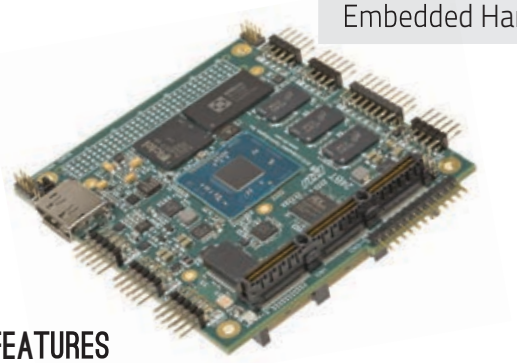
Pixus Technologies
www.pixustechnologies.com

sales@pixustechnologies.com

Embedded Hardware

Intel Atom E3800-based SBC



The CML24BT is an advanced PC/104 single board computer and controller with a PCI/104-Express stackable bus structure. This Intel Atom E3800-based CPU is exceptionally suited for intelligent systems requiring low power consumption in harsh thermal conditions. The CML24BT-series CPUs are available in quad-core, dual-core, and single-core configurations. Surface-mount Type 2 PCI Express connectors enable users to stack multiple peripheral modules above and below the CPU. All models include 4GB surface-mount single-channel ECC DDR3 SDRAM and a 32GB industrial-grade surface-mount SATA flash drive.

FEATURES

- PCI/104-Express stackable bus structure
- Available in modular, rugged enclosures and eBuild systems
- Intel Atom E3800 Series Processor
  - *Clock Speed: 1.33 GHz, 1.46 GHz, and 1.91 GHz options*
  - *Max. Core Temperature: 110°C*
- 4GB Single-Channel DDR3 SDRAM (Surface-Mounted)
  - *Robust Error Code Correction (ECC)*
- 32GB Surface-mounted industrial-grade SATA flash drive
- 4 PCIe x1 Links, One SATA Port, 4 Serial Ports, 7 USB ports, Gigabit Ethernet, Analog VGA, Embedded DisplayPort (eDP) 1.3 with Audio, on-board advanced Digital I/O
- -40 to +85°C standard operating temperature
- Thermal-optimized passive heat sink included

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RTD Embedded Technologies, Inc.
www.rtd.com/atom

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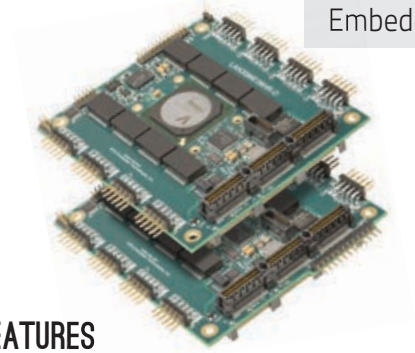
814-234-8087

Embedded Hardware



Managed Scalable GigE Switch

The LAN35MH08HR is an 8-port 10/100/1000 Managed Ethernet switch. This switch module has a total of 10 ports: eight ports are provided to I/O connectors, one port is available to the host CPU through a x1 PCI Express GigE controller, and one port is used as a stacking switch expansion port allowing full compatibility with RTD's managed and unmanaged StackNET™ Ethernet switch family. Additionally, this allows the CPU to use the switch without the need for external cables. The LAN35MH08HR can also be used as an expandable, standalone 8-port Ethernet switch.

The onboard CEServices Carrier Ethernet switching software provides a rich Layer 2 switching solution with Layer 3-aware packet processing. All of the industry-standard Managed Ethernet Switch features found in an enterprise rackmount switch are provided, such as VLANs, Spanning Tree, QoS, and SNMP. Additionally, the CEServices software provides features for carrier and timing-critical networks such as OAM, Synchronous Ethernet, and IEEE 1588. The switch may be configured via a web GUI interface, or a command-line console via USB, Telnet, or SSH.

FEATURES

- -40 to +85°C operation, passively cooled
- PCIe/104 stackable bus structure
- Eight 1000/100/10 Mbps Ethernet ports plus one host port and one stacking switch expansion port
- Onboard tri-color LED for each Ethernet Port
- RJ-45 jacks or 10-pin right-angle headers
- Fully-managed Layer 2 Ethernet Switch with Layer 3-aware packet processing
  - *Support for all major Enterprise switching features such as VLANs, Spanning Tree, QoS, and SNMP*
  - *Manageable via web GUI interface, SSH, Telnet, and Serial Console*
  - *Industry-standard CLI interface*
- Onboard PCI Express Ethernet Controller for interface to host cpuModule
- USB Device Port for Serial Console command-line interface
- Passive heat sink included ▪ Available in stackable, rugged enclosures

mil-embedded.com/p373422

RTD Embedded Technologies, Inc.
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Embedded Hardware

RTD Off-the-Shelf Mission Computer

RTD's standard HiDANplus® embedded computer system provides a robust Commercial-Off-the-Shelf (COTS) solution enabling rapid uptime for mission-critical applications. The system includes a rugged single board computer, power supply, SATA card carrier, and room for an additional peripheral module. Without increasing the enclosure size, functional upgrades can include high-performance data acquisition, versatile networking options, or enhanced capabilities from a variety of special-purpose add-in modules. Additional configuration options include a removable SATA drawer.

The milled aluminum enclosure with advanced heat sinking delivers passively-cooled performance from -40 to +85°C. Integrated tongue-and-groove architecture with EMI gaskets create a watertight solution with excellent environmental isolation. Keyed cylindrical connectors offer easy cable connections while maintaining the integrity of the environmental seal.

FEATURES

- -40 to +85°C standard operating temperature
- Designed for high ingress protection in harsh environments
- Milled aluminum enclosure with integrated heat sinks and heat fins
- Rugged Intel and AMD-based Single Board Computers
- High-performance, synchronized power supply
- 2.5 inch SATA card carrier
- Designed to include an additional PCIe/104, PCI/104-Express or PCI-104 peripheral module without increasing overall enclosure size

mil-embedded.com/p373424

RTD Embedded Technologies, Inc.
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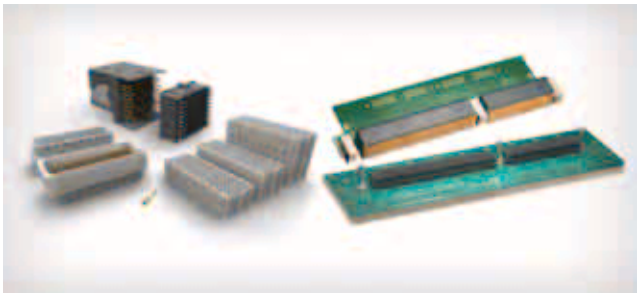
Rugged to the Core

On the outside, today's aerospace designs are sleek and elegant machines. But on the inside, extreme temperatures and vibration demand the most rugged equipment. TE Connectivity's (TE) rugged modular connector systems for backplane applications were specifically constructed for high speed aerospace and military projects that require design flexibility, incorporate power and signal and provide rugged reliability.

Connect with TE to learn more about our rugged, high speed backplane connectors for aerospace and military applications at te.com/highspeed.



HIGH SPEED CONNECTORS

- CeeLok FAS-T Connector
- CeeLok FAS-T Nano Circular Connector
- CeeLok FAS-X Connector
- Mezalok Connector (VITA 61)
- MULTIGIG RT 2 Connector (VITA 46)
- MULTIGIG RT 2-R Connector (VITA 72)
- Fortis Zd Connector
- Fortis Zd LRM Connector
- Quadrax Product Family

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TE Connectivity
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OpenSystems Media works with industry leaders to develop and publish content that educates our readers.

AXIS Software Development Tools

By Abaco Systems

The AXIS modular architecture enables the designer to significantly optimize communications between processors. It provides flexibility of transports, including InfiniBand, RoCE, TCP, UDP, Posix shared memory, KNEM shared memory, and GPU IPC. It uniquely supports heterogeneous architectures including multiple processor architectures and operating systems.

This white paper details how AXIS creates a layer of abstraction between the application and the hardware and operating system.

Check out our white papers at http://whitepapers.opensystemsmedia.com/

http://mil-embedded.com/white-papers/white-software-development-tools/

Tektronix

MDO4000C

The **MDO4000C** mixed domain oscilloscope includes up to six built-in instruments, each with exceptional performance to address tough design challenges. Featuring a spectrum analyzer, function generator, and more, they are the only scopes that come with the instruments you use most. Every MDO4000C features powerful triggering, search and analysis, and these are the only scopes to offer synchronized analog, digital, and RF signal analysis at the same time, which is ideal for wireless communications in IoT and EMI troubleshooting. The MDO4000C is completely customizable and fully upgradable, allowing you to add the instruments and functionality as your needs and situation changes.

For a limited time, you can get even more value to a MDO4000C oscilloscope purchase with FREE instrument upgrades. When you purchase a new MDO4000C oscilloscope, you can choose a free arbitrary/function generator option, or a free digital channels (MSO) option, or a free protocol analysis bundle – that's up to a $3,900 value. ***But hurry – supplies are limited and this offer won't last.***

FEATURES

- **Upgradeability:** Upgrades are available to analog bandwidth, spectrum analyzer, arbitrary function generator, digital channels (MSO), serial trigger and analysis packages, and more
- **Serial bus triggering and analysis:** Automates triggering and decode on up to three serial buses at once. Save time locating events of interest and avoid hand-translating bits
- **Fast waveform capture:** Identify glitches and other infrequent transient signals quickly with more than 340,000 waveforms/s. Understand events of interest with the color-graded display
- **20 Mpoint record length:** Acquire more time while maintaining resolution to zoom in on fine signal details
- **Advanced RF analysis with SignalVu-PC Vector Signal Analysis Software:** Enables Bluetooth and WLAN (IEEE 802.11 a/b/g/n/p/ac) signal quality analysis, pulse analysis, audio measurements, AM/FM/PM modulation analysis, general purpose digital modulation and more

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VECTOR ELECTRONICS & TECHNOLOGY, INC.

cPCI, PXI, VME, Custom Packaging Solutions

VME and VME64x, CompactPCI, or PXI chassis are available in many configurations from 1U to 12U, 2 to 21 slots, with many power options up to 1,200 watts. Dual hot-swap is available in AC or DC versions. We have in-house design, manufacturing capabilities, and in-process controls. All Vector chassis and backplanes are manufactured in the USA and are available with custom modifications and the shortest lead times in the industry.

Series 2370 chassis offer the lowest profile per slot. Cards are inserted horizontally from the front, and 80mm rear I/O backplane slot configuration is also available. Chassis are available from 1U, 2 slots up to 7U, 12 slots for VME, CompactPCI, or PXI. All chassis are IEEE 1101.10/11 compliant with hot-swap, plug-in AC or DC power options.

Our Series 400 enclosures feature side-filtered air intake and rear exhaust for up to 21 vertical cards. Options include hot-swap, plug-in AC or DC power, and system voltage/temperature monitor. Embedded power supplies are available up to 1,200 watts.

Series 790 is MIL-STD-461D/E compliant and certified, economical, and lighter weight than most enclosures available today. It is available in 3U, 4U, and 5U models up to 7 horizontal slots.

All Vector chassis are available for custom modification in the shortest time frame. Many factory paint colors are available and can be specified with Federal Standard or RAL numbers.

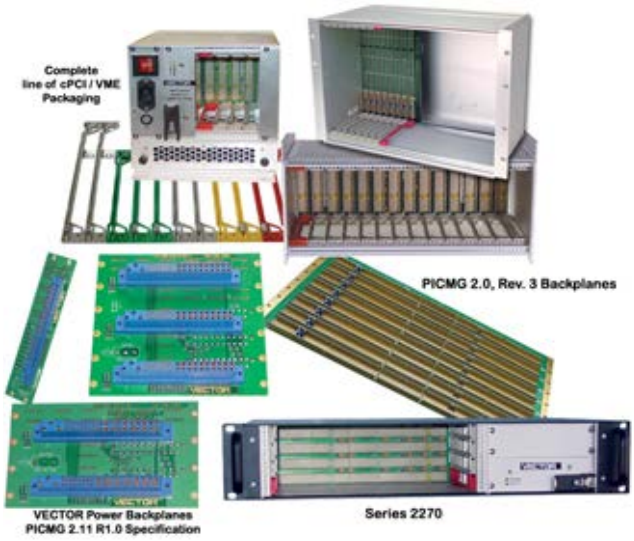
For more detailed product information,

please visit **www.vectorelect.com**

or call

1-800-423-5659 and discuss your application

with a Vector representative.



FEATURES

- Made in the USA
- Most rack accessories ship from stock
- Modified 'standards' and customization are our specialty
- Card sizes from 3U x 160mm to 9U x 400mm
- System monitoring option (CMM)
- AC or DC power input
- Power options up to 1,200 watts

mil-embedded.com/p371649

Vector Electronics & Technology, Inc.
www.vectorelect.com

inquire@vectorelect.com
800-423-5659

VERSALOGIC CORPORATION

BayCat (VL-EPM-31)

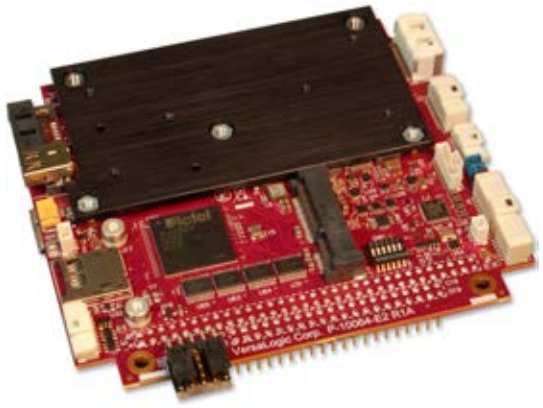
PC/104-*Plus* "Bay Trail" Embedded Computer

BayCat is a rugged PC/104-*Plus*™ single board computer (SBC) with on-board Trusted Platform Module (TPM) for enhanced security. BayCat combines high performance, low power consumption, and backwards compatibility with systems using PC/104-*Plus* ISA or PCI expansion. Built for extreme environments, the BayCat is designed and tested for industrial temperature (-40° to +85°C) operation and meets MIL-STD-202G specifications to withstand high impact and vibration.

BayCat is available in single-, dual-, and quad-core processor options to meet a variety of price/performance/application requirements.

The BayCat's on-board TPM security chip can lock out unauthorized hardware and software access providing a secure processing environment for applications in applications that require hardware-level security functions.

The BayCat is backed by VersaLogic's 5-year warranty and product life extension programs that can continue delivery well past the year 2025.



FEATURES

- -40°C to +85°C operation
- TPM hardware security
- High shock and vibe
- Latching connectors
- 4th Generation Bay Trail processor
- Quad-, dual-, and single-core models
- PC/104-*Plus* expansion site (ISA + PCI)

mil-embedded.com/p373589

VersaLogic Corporation
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503-747-2261
@versalogic

Embedded Hardware

VERSALOGIC CORPORATION

Osprey (VL-EPU-3311)

This next generation of the VersaLogic Embedded Processing Unit (EPU) format combines processor, memory, video, and system I/O into an extremely compact full function embedded computer. The computer has a footprint just slightly larger than a credit card!

The **Osprey** was engineered to meet the military, avionics, and medical industries' evolving requirements for smaller, lighter, and more powerful embedded systems. Roughly the size of a credit card and less than 1.08 inches thick, the Osprey is a highly-integrated embedded computer. It combines the new 4th generation Intel® Atom™ "Bay Trail" processor, with newer system interfaces, in a form factor designed to withstand extreme temperature, impact, and vibration.

Osprey is available in single-, dual-, and quad-core models. The single-core is suitable for lower power systems, while the quad-core is ideal for UAV video and control applications where higher performance and light lower weight are important.

The Osprey is backed by VersaLogic's 5-year warranty and product life extension programs that can continue delivery well past the year 2025.

FEATURES

- Size: 55 x 95 x 27 mm; Weight: 140 grams (< 5 oz.)
- Quad-, dual-, and single-core models
- 4th Generation "Bay Trail" processor
- -40°C to +85°C operation
- Wide input voltage (8V – 17V)
- Soldered-on RAM; Soldered-on Flash
- Mini PCIe/mSATA expansion socket

mil-embedded.com/p373590

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@versalogic

X-ES

Extreme Engineering Solutions

XPand6052

The **XPand6052** is a Small Form Factor (SFF) system featuring an XPedite5205, which runs Cisco IOS® Software with Cisco® Mobile Ready Net capabilities, and an XPedite7450 for general processing. XPand6052 can be utilized as a development platform or a deployed system.

XPedite5205 uses the same Cisco IOS® that IT staffs in the military, energy, public safety, and other industries are already trained on, enabling organizations to expand their network to personnel, equipment, facilities, and vehicles at the edge of the network – warfighters on the battlefield, mines and drilling platforms, natural disaster mobile command centers – without any additional training. The XPand6052 can be connected to UHF, VHF, Wi-Fi, and other IP-based radio platforms to create the network nodes used to form mobile ad hoc networks (MANETs).

The router offers four Gigabit Ethernet interfaces and a rich Cisco IOS® Software feature set for the most Size, Weight, and Power (SWaP)-constrained applications. To meet the needs of demanding mobile and embedded networking applications, the XPand6052 provides hardware encryption, radio aware routing (RAR) with support for the latest Dynamic Link Exchange Protocol (DLEP), support for IPv6, integrated threat control with integrated Cisco IOS® firewalls and Intrusion Prevention System (IPS), and Quality of Service (QoS).

FEATURES

- Integrated XPedite5205: NIST FIPS 140-2 Overall Level 1 validated and NIAP Common Criteria Certified
- Runs Cisco IOS® software
- Cisco® Unified Communications Manager Express (CME) support
- Cisco® Mobile Ready Net, which allows for mobile ad hoc networking and radio aware routing
- Hardware acceleration and encryption
- Integrated threat control using Cisco IOS® Firewall, Cisco IOS® Zone-based Firewall, Cisco IOS® Intrusion Prevention System (IPS), and Cisco IOS® Content Filtering
- Identity management using authentication, authorization, and accounting (AAA) and public key infrastructure

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Extreme Engineering Solutions (X-ES)
www.xes-inc.com

sales@xes-inc.com 608-833-1155 @XES_INC
www.linkedin.com/company/extreme-engineering-solutions

Embedded Hardware

X-ES

Extreme Engineering Solutions

XPedite7672

The **XPedite7672** is a secure, 3U VPX-REDI, single board computer based on the Intel® Xeon® D-1500 family processors, which provide up to 16 Xeon®-class cores in a single, power-efficient System-on-Chip (SoC) package.

The XPedite7672 integrates SecureCOTS™ technology with a SmartFusion®2 security SoC for hosting custom functions to protect data from being modified or observed and provides an ideal solution when stringent security capabilities are required. The SmartFusion®2 can control, intercept, and monitor the Xeon® D subsystem, implement penalties, and interface to the system through single-ended and differential I/O directly connected to the VPX backplane. Circuit board enhancements and optimized Two-Level Maintenance (2LM) metalwork provide additional protection.

The XPedite7672 accommodates up to 16 GB of DDR4-2133 ECC SDRAM in two channels, up to 32 GB of onboard SATA NAND flash, and numerous I/O ports, including two 10 Gigabit 10GBASE-KR Ethernet ports, two 10/100/1000BASE-T Gigabit Ethernet ports, USB, SATA, and RS-232/422/485 through the backplane connectors. An integrated XMC site supports a x8 PCIe connection to the Intel® Xeon® D processor and X12d I/O mapped directly to the VPX backplane connectors.

FEATURES

- Supports Intel® Xeon® D-1500 family processors (formerly Broadwell-DE) with up to 16 Xeon®-class cores in a single, power-efficient SoC package
- 4, 8, or 12 core SKUs available with native extended temperature support
- SecureCOTS™ for secure and trusted processing
- Microsemi SmartFusion®2 SoC with 1 GB DDR3-667 ECC SDRAM and 32 MB SPI flash
- Up to 16 GB of DDR4-2133 ECC SDRAM in two channels
- Two 10 Gigabit Ethernet ports and two Gigabit Ethernet ports
- Four SATA ports capable of 6 Gb/s and two USB 2.0 ports

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LynxSecure ▪ LynxOS 7.0 ▪ LynxOS-178

RTOS and Secure Virtualization Software from Lynx Software Technologies

LynxSecure

LynxSecure provides one of the most flexible secure virtualization solutions for use in Intel® architecture based embedded and computer systems, including the new 4th generation Intel® Core™ i7 and Core™ i5 processors. LynxSecure is based on separation kernel technology and was designed from the ground up with security as a key design goal. Adding virtualization to the separation kernel allows for multiple different guest Operating Systems (OSs), both real-time and general purpose, to run in secure domains on a single embedded system. LynxSecure 5.2 is the latest version of this established product and adds a new feature that offers real-time detection of stealthy advanced persistent threats such as rootkits.

LynxOS 7.0

LynxOS 7.0 is a deterministic, hard real-time operating system that provides POSIX-conformant APIs in a small-footprint embedded kernel. LynxOS provides symmetric multi-processing support to fully take advantage of multi-core/multi-threaded processors. LynxOS 7.0 contains new security functionality designed for M2M devices. LynxOS 7.0 supports the most popular reference targets in the ARM and Intel PowerPC architectures, including the new 4th generation Intel® Core™ i7 and Core™ i5 processors.

LynxOS-178

LynxOS-178 is a safety-critical COTS RTOS that fully satisfies the objectives of the FAA DO-178B level A specification and meets requirements for Integrated Modular Avionics developers. LynxOS-178 delivers the security and real-time responsiveness needed for safety-critical systems and provides a low-risk path to DO-178B certification for developers to meet the technical requirements in the production of software for airborne systems.

FEATURES

LynxSecure

- LynxSecure runs fully virtualized guest OSs such as Windows®, Solaris, Linux®, Android, and Chromium OS, requiring no changes to the guest OS
- LynxSecure offers the ability to run guest OSs that have Symmetric Multi-processing (SMP) capabilities
- Designed to maintain the highest levels of military security offering a MILS architectural approach

LynxOS 7.0

- LynxOS 7.0 provides the ability for developers to embed military-grade security directly into their devices
- LynxOS contains networking support for long haul networks with TCP/IPV4, IPV6, 2G/3G/4G cellular and WiMax communication stacks. It also supports the short-haul networks common with M2M applications such as 802.11 WiFi, ZigBee wireless mesh and Bluetooth
- LynxOS is a true fully preemptive hard real-time OS with a POSIX application interface

LynxOS-178

- LynxOS-178 provides full POSIX conformance, enabling developers to take advantage of the time-to-market and investment-protection benefits of open standards-based development
- Supported standards include ARINC 653 as well as support for the Future Airborne Capability Environment (FACE) standard currently under development
- LynxOS-178 is the only time- and space-partitioned RTOS that has been awarded the FAA Reusable Software Component (RSC) for DO-178B certifications

mil-embedded.com/p372827

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www.facebook.com/lynxsoftwaretechnologies
800-255-5969
@LynxSoftware

XMC Removable CFast Module

The **XMC Removable CFast Module** is a mezzanine storage module with a dual-channel PCI Express SATA 3 controller rated for temperature range of -40C to +85C.

Provides boot drive and/or disk storage for VPX, VME, cPCI, and ATCA SBCs with XMC slot.

CFast is same form factor as Compact Flash but with SATA interface thus providing faster throughput. The CFast connectors are rated for 10,000 mating cycles to support frequent insertions/removals.

FEATURES

- Adds removable SSD to your VPX, VME, ATCA, cPCI SBC
- Boot or Storage
- XMC PCIe Gen2 x1 interface per VITA 42.3
- Air or conduction cooled
- Uses COTS CFast up to 120GB
- CFast secured by rugged retainer clip
- 10,000 mating cycles
- 1.8" SATA version available with up to 2TB capacity
- PMC versions also available
- Drivers for Windows, Linux and VxWorks

mil-embedded.com/p372671

Red Rock Technologies
www.redrocktech.com

info@redrocktech.com 1-800-808-7837

NanoSWITCH

NanoSWITCH is a SWAP-C optimized rugged multi-layer gigabit Ethernet switch with an embedded x86 PC. The NanoSWITCH brings enterprise level layer 2/3 switching to rugged environments including military ground, air and sea vehicles, and unforgiving industrial environments. Typical applications include vehicle network switching, distributed architecture vehicle controller, VICTORY compliant switch, router, timing, and control, WAN/LAN interconnectivity and firewall, and shared processing and peripheral communications.

NanoSWITCH provides 16x or 10x external Gigabit Ethernet ports that operate at rates of 10, 100, and 1000 Mbps. A full management suite is included, as well as a Command Line Interface (CLI) for controlling switch and routing operations. The NanoSWITCH supports sophisticated IPv4 and IPv6 routing, including tunneling and IP Multicast, VLANs, and IETF, IEEE, and DSL Forum standards.

The NanoSWITCH includes numerous Quality of Service (QoS) features to ensure that traffic is prioritized to deliver the superior performance for real-time applications including system management, voice, video, and bandwidth-intensive file uploads and downloads.

NanoSWITCH is available in a VICTORY software configuration. The VICTORY open standard, or "Vehicular Integration for C4ISR/EW Interoperability" standard (http://victory-standards.org/), provides a common data-bus centric approach to sharing services and hardware components, eliminating redundancy and reducing SWAP in Army ground vehicles.

FEATURES

- Layer 2/3 Enterprise non-blocking network switch for demanding SWAP-C environments
- 16x GigE Ethernet ports with auto tri-speed 10/100/1000Mbps and MDIX
- MIL-STD-1275E – Ground vehicle power; MIL-STD-704F – Aircraft power (with no hold up); MIL-STD-461F – EMI; MIL-STD-810G – Environmental
- 10 or 16 port versions
- Full featured AMD Fusion APU for VICTORY or user applications
- 1GB DRAM, 64GB SSD
- Operating temperature: -40°C to 71°C

mil-embedded.com/p373404

Themis Computer
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innodisk

Innodisk's 3MG2-P SSD with AES engine – Enhances data security

Data security is critical for many industries in a need of protecting their personal information as well as corporate and national security. The US government protects the classified data by adopting AES (Advanced Encryption Standard) function. AES offers an effective way to protect all types of classified data, which is widely used for securing sensitive information throughout various industries, especially in military application. To support the requirements and demands of market, Innodisk developed the 3MG2-P SSD equipped with an AES 256-bit engine. This product combines a reliable and rugged design with superior performance.

How does Innodisk 3MG2-P AES encryption work?

After the 3MG2-P receives the data package from the host, the AES engine encrypts the data packets and saves the encrypted data into a NAND flash. This action ensures that there's no unauthorized access to the data in the NAND flash. The 3MG2-P with AES encryption and an ATA security-authorized key can provide advanced security protection for your data with the encryption key being stored in a secured data of SSDs. You can quickly destroy the data on the drive by simply destroying the AES key. That's because without the AES key, the data cannot be unencrypted, which is faster than a software-based encryption and takes less than 1 second to perform.

3MG2-P PRODUCT SERIES FEATURES

- Equipped with hardware-based AES 256 bits key
- Instant data erase when destroying the AES key
- TCG OPAL 2.0: independent access control to read/write/erase
- iData Guard™ technology for abnormal power failure
- Innodisk's exclusive L^2 architecture
- DEVSP supported for low power consumption
- Supports wide temperature from -40 to 85
- Up to 2TB capacity

About Innodisk –

Innodisk is a service-driven provider of industrial embedded flash and DRAM modules, Server DRAM, embedded peripherals products and technologies, with a focus on the enterprise, industrial, cloud, and aerospace and defense applications.

mil-embedded.com/p373754

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Address: 5F., No. 237, Sec. 1, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan

Mass Storage

PHOENIX INTERNATIONAL

RPC24 Rugged RAID Storage Array

Phoenix International's **RPC24** is a high performance Fibre/SAS/iSCSI Host, SAS/SATA 3 Solid State/Hard Disk Drive RAID subsystem that delivers a level of operational environmental capability not previously available in COTS Data Storage Systems.

The RPC24 features two 12 drive removable magazines housed in a rugged 2U panel height chassis providing up to eight 16Gb FC, 12Gb SAS or 10GigE iSCSI host interfaces to high performance 6/12Gb SAS and/or SATA HDDs or SSDs.

Incorporating aluminium and steel in its rugged construction, the RPC24 weighs only 51 lbs with a full complement of 24 SSDs, is less than 20" deep and has been tested and certified to military specifications MIL-STD-810G and MIL-STD-461E.

FEATURES

- Single or Dual Active Redundant RAID Controllers
- MIL-STD-810G and 461E Certified
- Two each 12 Drive (24 drives total) Removable Magazines
- Solid State or Hard Disk Drives
- Magazines are Enclosed and Electrically Isolated
- Sustained Read/Write Data Rates over 6000MB/sec
- Battery Free Cache Backup
- Operational Altitude to 45,000 ft
- Operational Temperature -20 to 70 C
- 40 to 440Hz, 90/240 VAC Input Operation
- Management GUI and Failover Software
- AES 256/FIPS 140-2 Encryption
- **Made in USA**

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Mass Storage

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VP1-250X VPX Solid State Data Storage Module

The **VP1-250X** Serial Attached SCSI (SAS)/Serial ATA (SATA) based VPX blade delivers high capacity, high performance data storage for military, aerospace and industrial applications requiring rugged, secure and durable mass data storage.

The VP1-250X is a 3U VPX storage module and is available in air cooled and conduction cooled configurations. It integrates MLC, eMLC and SLC NAND SSDs and can be direct connected as a SAS/SATA Drive or via the PCIe interface. When used with supporting media, the VP1-250X supports the purge input to destroy media or the Zeroize that will erase the media.

The Phoenix VP1-250X's outstanding performance and versatility are enabled by Phoenix International's state-of-the-art technology, which provides high transfer and I/O rates, endurance and data integrity.

FEATURES

- Conduction, REDI Conduction (pictured) or Air Cooled
- Supports SATA, SAS and PCI Express interfaces
- Up to 80,000 Feet Operational Altitude
- Operational Temperature from -40° to +85° C
- Can be Configured to work from Fat Pipe A or B from the VPX bus
- Integrated SLC, eMLC or MLC NAND SSDs
- Meets Military and IRIG 106-07 Declassification Standards
- Optional AES 256/FIPS 140-2 Encryptionn
- Advanced NAND Flash Management for Enhanced Reliability and Durability
- **Made in USA**

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INTERCONNECT SOLUTIONS

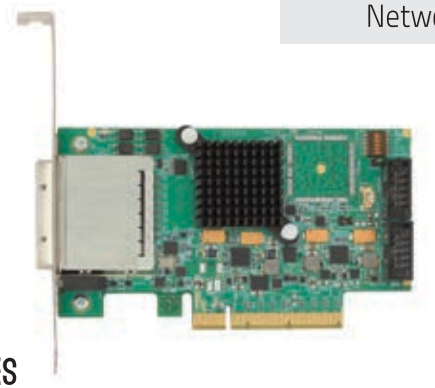
PCI Express Gen 3 Host adapter/PXH810

The **PXH810 Gen3 PCI Express Host Adapter** is our high performance cabled interface for distributed processor subsystems and I/O expansion applications. The host adapter extends PCI Express over cables to external systems. Based on PLX Gen3 PCI Express switch architecture, the PXH810 host adapter includes advanced features for non-transparent bridging (NTB) and clock isolation.

For high performance application developers, the PXH810 host adapter combines 64 Gbit/s performance with less than one microsecond latency, significantly improving overall inter-system communication. Inter-processor communication benefits from the high throughput and low latency.

The PXH810 performs both Remote Direct Memory Access (RDMA) and Programmed IO (PIO) transfers, effectively supporting both large and small data packets. RDMA transfers result in efficient larger packet transfers and processor off-load. PIO transfers optimize small packet transfers at the lowest latency. The combination of RDMA and PIO creates a highly potent data transfer system.

Dolphin's software suite takes advantage of PCI Express' RDMA and PIO data transfer scheme, delivering a complete deployment environment for customized and standardized applications.



FEATURES

- PCI Express® 3 compliant – 8.0 Gbps per lane
- Link compliant with Gen1, Gen2, and Gen3 PCI Express
- PCI Express iPass Connectors ▪ One x8 PCI Express port
- RDMA support through PIO and DMA
- Copper connection up to 2 meters, fiber-optic cable connection up to 100 meters
- Clock isolation support, CFC or SSC on cable
- Transparent host and target operations along with non-transparent bridging to cabled PCI Express systems
- Low Profile PCI Express form factor
- EEPROM for custom system configuration
- Link status LEDs through face plate

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Proprietary FPGA-based technology provides maximum capability with a wide range of SCSI systems.

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FEATURES

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ORBIT POWER GROUP
Behlman Electronics

VP*Xtra*™ Power Supplies (3U and 6U)

Behlman announces the reconfigured Open VPX VITA 62 compatible 3U VP*Xtra*™ 500M1 Power Supply, and the VP*Xtra*™ Reconfiguration Program.

VPXtra™ 500M1

3U Open VPX VITA 63 compatible
High Power Multi-output Power Supply

Working within its new VP*Xtra*™ Reconfiguration Program, Behlman has modified the VP*Xtra*™ 500M to create the new VP*Xtra*™ 500M1, with 80 amps of 5 VDC output. This unit, in conjunction with the standard VP*Xtra*™ 500M, can supply 120 Amps of 5 VDC along with the customer-required 12 VDC and 3.3 VDC.

- **Open VPX VITA 62 compliant**
- **Wide input range**
- **High power DC output**
- **Efficiency of 90% typical**
- **Conduction cooled at card edge**
- **Conformal coating on PWA**

The Behlman VP*Xtra*™ 500M1 COTS DC to DC power supply is a rugged, highly reliable, conduction cooled, switch mode unit built for high-end industrial and military applications. It delivers 460 Watts of DC power via six outputs. The main outputs can be paralleled for higher power.

VP*Xtra*™ 500M1 can accept a 28 VDC input, IAW MIL-STD-704, and can supply a high-power DC output at various power levels. This power supply has no minimum load requirement and has over-voltage and short circuit protection as well as over current and thermal protection. The power supply is designed to support the rigors of mission critical airborne, shipboard, vehicle and mobile applications.

Designed and manufactured with *Xtra*-Cooling™, *Xtra*-Reliable™ Design and *Xtra*-Rugged™ Construction.

The new **Behlman VP*Xtra*™ Reconfiguration Program** addresses the needs of system designers for non-standard features on VITA 62 compatible VPX power supplies that can vary significantly from system to system. Variables can run from different power levels of the standard voltages, to mechanical configurations, such as connectors, user-defined pins, and general interfaces. EMI filtering and hold-up requirements, as well as transient and lightning protection are other possible considerations. This program has already resulted in an impressive list of new, non-typical, COTS VPX power supply models (3U 3-phase AC to DC; High Voltage Hold-up card, Low Voltage Hold-up card; PS with extra 5 VDC, 6U 3-phase and single-phase AC to DC, PS with extra 12 VDC, PS with extra 5 VDC). But that is only the beginning. Behlman now invites all system designer to request additional system-specific VP*Xtra*™ reconfigurations, without the cost of full-custom development.

VPX POWER RECONFIGURED WITHOUT FULL-CUSTOM COST.

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FEATURES

- Board Support for latest Altera & Xilinx FPGAs
- Works from High Level, Data Flow Concept
- Intelligent Wizard for HDL Users
- GUI Design Entry and Debug Tools
- Tested & Optimized Open Project Builder IP Cores
- Modules Automatically Handle Synchronization
- Supports Multiple Data Types
- Integrates with Matlab™ Simulation Flow
- Standard Avalon and AXI IP interfaces

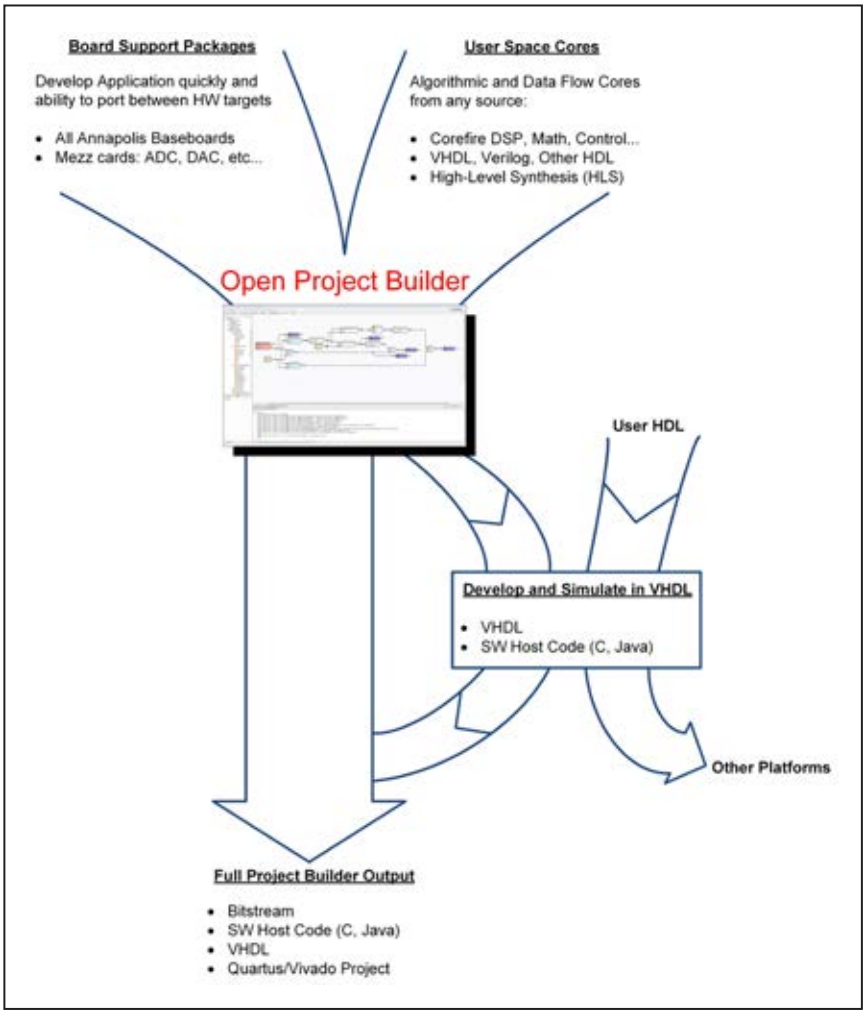
Open Project Builder

Open Project Builder™ is an innovative FPGA application development tool that simplifies and speeds programming, providing a remarkably short and efficient programming experience.

Open Project Builder users have the capability to use FPGA IP from any source, such as VHDL, High-Level Synthesis (HLS), Verilog, or other HDL. Open Project Builder can also port IP to/from other platforms. It uses standard Avalon and AXI IP interfaces. Open Project Builder provides fast portability of applications between Altera and Xilinx and to newer FPGA families.

Annapolis is famous for the high quality of our products and for our unparalleled dedication to ensuring that the customer's applications succeed.

We offer training and exceptional special application development support, as well as more conventional support.



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Quantum LeaPs®

QP™ Active Object Frameworks

Embedded software developers are independently re-discovering patterns for building concurrent software that is **safer**, more responsive and easier to understand than naked threads of a Real-Time Operating System (RTOS). These best practices universally favor non-blocking, asynchronous, event-driven, encapsulated state machines (a.k.a. active objects) instead of naked, blocking RTOS threads.

The QP™ family of active object frameworks from Quantum Leaps provides a lightweight, **reusable architecture** that inherently supports and automatically enforces the best practices of concurrent programming. The QP™ family consists of QP/C, QP/C++, and QP-nano frameworks, which are all strictly quality controlled and thoroughly documented. The frameworks are licensed as GPL open source as well as commercially.

The behavior of active objects is specified in QP by means of hierarchical state machines (UML statecharts). The frameworks support manual coding of UML state machines in C or C++ as well as fully automatic code generation by means of the free QM™ graphical modeling tool.

All QP frameworks contain a selection of built-in real-time kernels and can run on bare-metal MCUs, completely replacing a conventional RTOS. Native QP ports and ready-to-use examples are provided for major CPU families, such as ARM Cortex-M. QP/C and QP/C++ frameworks can also be used with many traditional RTOSs and desktop OSs (such as Windows and Linux).

Welcome to the 21st century!

FEATURES

- Reusable architecture based on active objects (actors) and hierarchical state machines
- Efficient, thread-safe event-driven mechanisms for active objects to communicate, such as direct event passing and publish-subscribe
- Built-in RTOS kernels to run QP applications, such as cooperative QV kernel, preemptive non-blocking QK kernel, and preemptive blocking QXK kernel
- Compliant with MISRA-C:2004 (QP/C and QP-nano) and MISRA-C++:2008 (QP/C++)
- Free, graphical QM™ modeling tool for designing UML statecharts and automatic code generation based on QP frameworks
- Book "Practical UML Statecharts in C/C" with detailed design study of the QP frameworks, application notes, articles, manuals and videos

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AdaCore

Build software that matters.

GNAT Pro Safety-Critical

GNAT Pro Safety-Critical is an enhanced version of AdaCore's robust and flexible GNAT Pro Ada development environment; it is particularly suited for applications where safety certification is required. GNAT Pro Safety-Critical has been used by industry and government customers worldwide in domains such as space systems, commercial avionics, military systems, air traffic management/control, railway systems, and medical devices.

The product's specially designed run-time libraries and comprehensive tool suite help reduce the cost of developing and certifying systems that have to meet industry standards including:

- *Avionics – DO-178B/C*
- *Air Traffic Management – DO-278/DO-278A*
- *Rail – EN 50128*
- *Space – ECSS-E-ST-40C and ECSS-Q-ST-80C*

GNAT Pro Safety-Critical is available on both native and embedded platforms.

Key Features

Configurable Run-Time Library

Using GNAT Pro Safety-Critical's configurable run-time capability, you can specify any level of support for Ada's dynamic features, from none at all to the full Ada 95, Ada 2005, Ada 2012 language versions. The units included in the library may be either a subset of the standard units provided with GNAT Pro, or they may be specially tailored to the application. This capability is useful, for example, if one of the predefined profiles provides almost all the features needed to adapt an existing system to new safety-critical requirements, and where the costs of adaptation without the additional features are considered prohibitive.

Full Ada Implementation

GNAT Pro Safety-Critical implements all versions of Ada, up to and including Ada 2012 – the latest revision of the language. With features such as contract-based programming, **Ada 2012** helps reduce system life cycle costs by allowing low-level requirements to be expressed directly in the source code where they can be verified either at run time or statically.

Simplification of Certification Effort

You can restrict language features that, although not requiring a run-time library, could nevertheless complicate test coverage analysis. For example, you can prohibit the use of constructs that would result in code with implicit loops and conditionals (such as a slice assignment).

Traceability

Through a compiler switch you can generate a low-level version of the source program that reveals implementation decisions but stays basically machine independent. This helps meet traceability requirements, and may be used as a reference point for verifying that the object code matches the source code. Another compiler switch produces details of data representation (sizes, record layout, etc.), which is also helpful in traceability.

Advanced Static Analysis

The **GNATstack** static analysis tool is supplied with GNAT Pro Safety-Critical. GNATstack statically calculates the maximum stack space required by each task in an application. The computed bounds can be used to ensure that sufficient space is reserved, thus guaranteeing safe, predictable execution with respect to stack usage. GNATstack uses conservative analysis to deal with complexities such as subprogram recursion, while avoiding unnecessarily pessimistic estimates. The tool's output data can be used directly to satisfy DO-178B / DO-178C requirements.

AdaCore's **CodePeer** advanced static analysis tool is a useful complement to GNAT Pro Safety-Critical. It's an Ada source code analyzer that detects run-time and logic errors that would otherwise only be found through labor-intensive debugging. Assessing potential bugs and vulnerabilities before program execution. CodePeer helps find errors early in the development life-cycle, when they are least expensive to repair, and it can also perform impact analysis when existing code is modified. CodePeer has been registered as CWE-Compatible for its ability to detect several of the Top 25 Most Dangerous Errors in the CWE (Common Weakness Enumeration) including CWE-120 (Classic Buffer Overflow). CodePeer has been qualified as a Verification Tool for DO-178B and as a T2 tool for EN 50128.

Supplementary Material and Tools

Certification material for several safety standards is available for particular run-time libraries, as well as qualification material for a number of tools.

For more information, please visit:
http://www.adacore.com/products

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Unmanned Systems

Dawn VME Products®

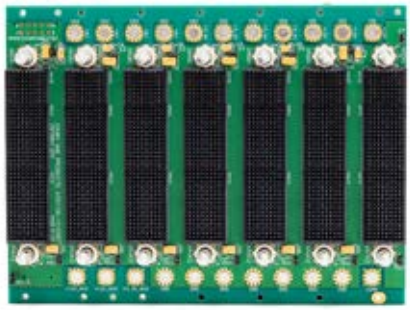
VPX-5987

Gen3 3U OpenVPX Backplanes – Delivering true signal integrity at Gen3 bandwidths.

Shown is Dawn's **VPX-5987** 3U OpenVPX backplane designed to deliver robust signal integrity at Gen3 bandwidths. When your systems are built around interconnects operating with Gen3 signaling rates, you need a backplane you can rely on to support the most advanced module configurations.

Dawn's 598x Series VPX backplanes are designed to be compliant with the following released standards and December 2015 state of draft specifications: VITA 46.0, VITA 46.1, VITA 46.3, VITA 46.4, VITA 46.6, VITA 46.7, VITA 46.9, VITA 46.10, VITA 46.11, VITA 48.0 (REDI), VITA 48.1 (REDI Air Cooling), Vita 48.2 (REDI Conduction Cooling), VITA65.0 (OpenVPX) ready. VITA 68 backplane models are available on request for system simulation.

Dawn's Gen3 3U OpenVPX backplanes are designed for true signal integrity at up to 10.3 Gbaud performance (per VITA 68 backplane simulation models). Supporting PCIe Gen 3 and 10 GbE (XAUI) and the most advanced Gen3 bandwidth module configurations, Dawn Gen3 backplanes offer multiple connector choices, including a high vibration option.



FEATURES

- 7-Slot – BKP3-CEN07 (6 Payload + 1 Switch)
- 3U OpenVPX compliant, 1" pitch
- Supporting PCIe Gen3 and 10 GbE (XAUI)
- Designed for signal integrity at up to 10.3 Gbaud performance
- Multiple connector choices, including a high vibration option
- Terminal block and bus bars to facilitate any desired power supply

Ordering Information:

- P/N 06-1115987: Fully loaded, VPX connectors in all 7 slots, front and rear.
- P/N 06-1115987-01: VPX connectors in all 7 slots, front only. Rear is not loaded.

Note: For all other options, including conformal coating and Meritec frames, consult factory for details and part numbers.

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Insight: Real-Time Video Enhancement System

Stand-alone product designed to reside in an existing architecture's video stream.

Improve Visual Clarity in Live Video

ZMicro's **Insight** is a video processing system that significantly improves visual clarity in real-time video, providing an operator with more information to support better decisions. The Insight improves visibility in fog, rain, dust, smoke, underwater, low-light, bright-light and other degraded visual environments. Utilizing ZMicro's patented video enhancement technology, Insight is a stand-alone system that provides immediate value to any system where video is used.

FEATURES

- Video and imagery enhancement for any environment including; underwater, fog, sand, snow, smoke and more
- Advanced algorithm operations without added latency
- Intuitive controls for on-the-fly enhancement adjustment
- H.264 decoding of IP video streams
- Apply chroma-key overlays such as GPS data

Highlights:

- Plug and play installation
- Intuitive user operation
- Rugged and compact design
- Easy to incorporate with existing equipment

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DIGITAL VOICE SYSTEMS, INC.

The Speech Compression Specialists

AMBE-4020 Half-Duplex Vocoder Chip

Digital Voice Systems, Inc. (DVSI) the recognized leader in the development of low-data-rate speech compression technology announces the availability of the AMBE-4020™ Vocoder Chip. This new addition to DVSI's family of high performance vocoder chips is ideal for half-duplex communication systems. The AMBE-4020™ Vocoder Chip combines a small footprint design with minimal power requirements, at a low cost, to make it a logical choice for commercial, consumer, and military mobile radio communication applications.

The AMBE-4020™ Vocoder Chip uses the proven technology of an ARM Cortex-M4 32-bit MCU that is based on the ARMv7 architecture and Thumb®-2 ISA to deliver a level of performance and reliability typically associated only with customized ASICs, but without the associated risks and high development costs. The AMBE-4020™ Vocoder Chip implements DVSI's patented AMBE+2™ Voice Compression Algorithm that can operate at virtually any data rate from 2.0 to 9.6 kbps. With this high degree of flexibility, the user can optimize speech and FEC rates to provide excellent voice quality with superior robustness to bit errors and acoustic background noise. The unparalleled performance of this vocoder technology has resulted in it being recognized as the standard for voice quality in Land Mobile Radio and Satellite Communications systems around the world.

FEATURES

- **Low-cost**
- **High-quality voice**
- **Noise suppression**

High Quality Performance

› Superior voice quality, DVSI's latest generation half duplex AMBE+2™ Vocoder Technology
› Maximizes channel bandwidth efficiency and supports data-rates from 2.0 kbps to 9.6 kbps
› The **AMBE-4020™ Full-Duplex** model supports echo cancellation
› User selectable forward error correction rates – 50 bps to 7.2 kbps
› Excellent performance at low data rates and harsh environments
› Robustness to acoustic background noise and channel bit errors
› Advanced features like Noise Suppression, Improved Error Mitigation, and Soft Decision FEC Decoding
› Supports a-law and u-law companding via I2S interface
› DTMF detection and regeneration with North American call progress tones

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› Also can be interfaced with most low-cost A/D-D/A codecs
› Input Interfaces include: internal ADC or digital mic or I2S
› Output interfaces include: internal DAC or I2S
› Interface for low-cost digital microphone
› Very low power consumption – Ideal for portable mobile devices
› Small compact footprint design
› No licensing fees or royalties
› Off-the-shelf availability for quick delivery

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Developing effective hardware and software COTS security technologies

By Steve Edwards, Director, Curtiss-Wright Controls Embedded Computing

The armed forces of the United States and its allies around the world rely on critical military technology that is under constant threat. These threats range from the reverse-engineering of systems lost on the battlefield to the accidental introduction of counterfeit components on the factory floor. In response, commercial off-the-shelf (COTS) suppliers are more frequently being called upon to help users address rapidly expanding requirements for anti-tamper (AT) and cybersecurity or information assurance (IA) capabilities.

Effective mitigation of threats to critical systems requires the development and implementation of advanced, industry-leading technologies and techniques, which for obvious reasons, the specifics of these security strategies and techniques cannot be described in detail. In order to provide the reader with a useful introduction and high-level overview to contemporary AT and IA techniques, it is possible to discuss, at an appropriately high level, some of the ways in which COTS hardware might come under attack and provide an outline of some of the methods that are available for protecting against such intrusions.

Defense in depth

The most effective approach for implementing AT and IA technologies to protect deployed COTS systems with a "defense in depth" strategy implements multiple layers of security to protect CPI (critical program information) at the module and component level. It also ensures that manufacturing is performed in a trusted manner. Today, there are a variety of options for protecting hardware at the device and module level.

Some of these approaches involve techniques that make it possible for the user, at their discretion, to add their own protective measures into the system hardware. To help mitigate against the introduction of counterfeit parts into their system hardware, it's imperative that users ensure their COTS module supplier's supply chain is capable of taking an active role in preventing against the presence of counterfeit parts on their modules. The COTS vendor's supply-chain management should be performed with an approved vendors list, and all suppliers should be subject to audits and able to comply with quality clauses. Also important: ensuring that the COTS vendor's quality management system (QMS) is appropriately certified.

The unique attributes of secure COTS products demand that when a module is in need of repair or is no longer serviceable, it be handled in a manner that ensures the proper disposition of any CPI on that module. Methods for disposing of the CPI include the use of algorithms to securely erase the module's nonvolatile memory so that the CPI is permanently removed. There are also methods for handling special components that might contain critical information.

IN ADDITION TO PROTECTING HARDWARE AT THE MODULE AND CHASSIS LEVEL, A COMPREHENSIVE APPROACH TO DATA PROTECTION ALSO NEEDS TO SECURELY STORE, RETRIEVE, AND MOVE DATA IN A SYSTEM WHILE ENABLING ONLY AUTHORIZED ACCESS TO THIS DATA.

To support any specific and unique customer requirements, the COTS vendor should also be able to support customization in order to add in additional layers of security as needed.

One key element of protecting hardware is being able to identify and then respond effectively to any attack as quickly as possible. Fortunately, a malicious encroachment into the system hardware can result in anomalous conditions that can be identified in real time. Techniques to identify such intrusions may involve the use of integrated sensors, such as temperature and voltage sensors, which are able to recognize any abnormal conditions.

Another malicious technique used to attack system hardware involves the probing of signals that emanate from the module's electrical traces. One technique used to protect against this attempted violation of data involves burying any sensitive traces – especially those that carry critical data, deep within the PCB substrate – to eliminate an adversary's ability to analyze and probe them. A module's input/output (I/O) interfaces can also provide an attractive target for an adversary to attack. Methods have been developed for securing JTAG and serial ports in order to protect a module's I/O.

To protect against remote attacks on hardware based on Intel's Xeon processor family, module designers can implement Intel's Trusted Execution Technology (TXT). This "Measured Boot" technology uses boot code to verify that the correct code is being run on the processor. Security options for Intel, Power Architecture, and ARM

processor-based modules also include support for secure boot. To provide protection for data at the chassis or module level, system designers can implement volume protection technologies that enable a module to be physically "surrounded" so that any attempted intrusion is reported and appropriate responses to that intrusion can be triggered.

In addition to protecting hardware at the module and chassis level, a comprehensive approach to data protection also needs to securely store, retrieve, and move data in a system while enabling only authorized access to this data. This requires secure network routers for data-in-motion solutions as well as secure storage for data-at-rest, with support for Type I, FIPS 140-2, FIPS-197, AES-256, and AES-128 encryption.

A flexible approach to next-generation security

When it comes to the protection of CPI, every program and every user is different; there is no one-size-fits-all approach. Effective mitigation against security breaches requires flexibility. COTS vendors need to actively and closely work with users to build in AT and IA capabilities at the module and subsystem level that meet the particular system's specific requirements. The resulting solution may be based on an existing "building block" approach, or may require a custom module design. For requirements that can't be satisfied with existing building blocks, those interested should seek a vendor able to provide MCOTS (modified COTS) services to develop new or customized products.

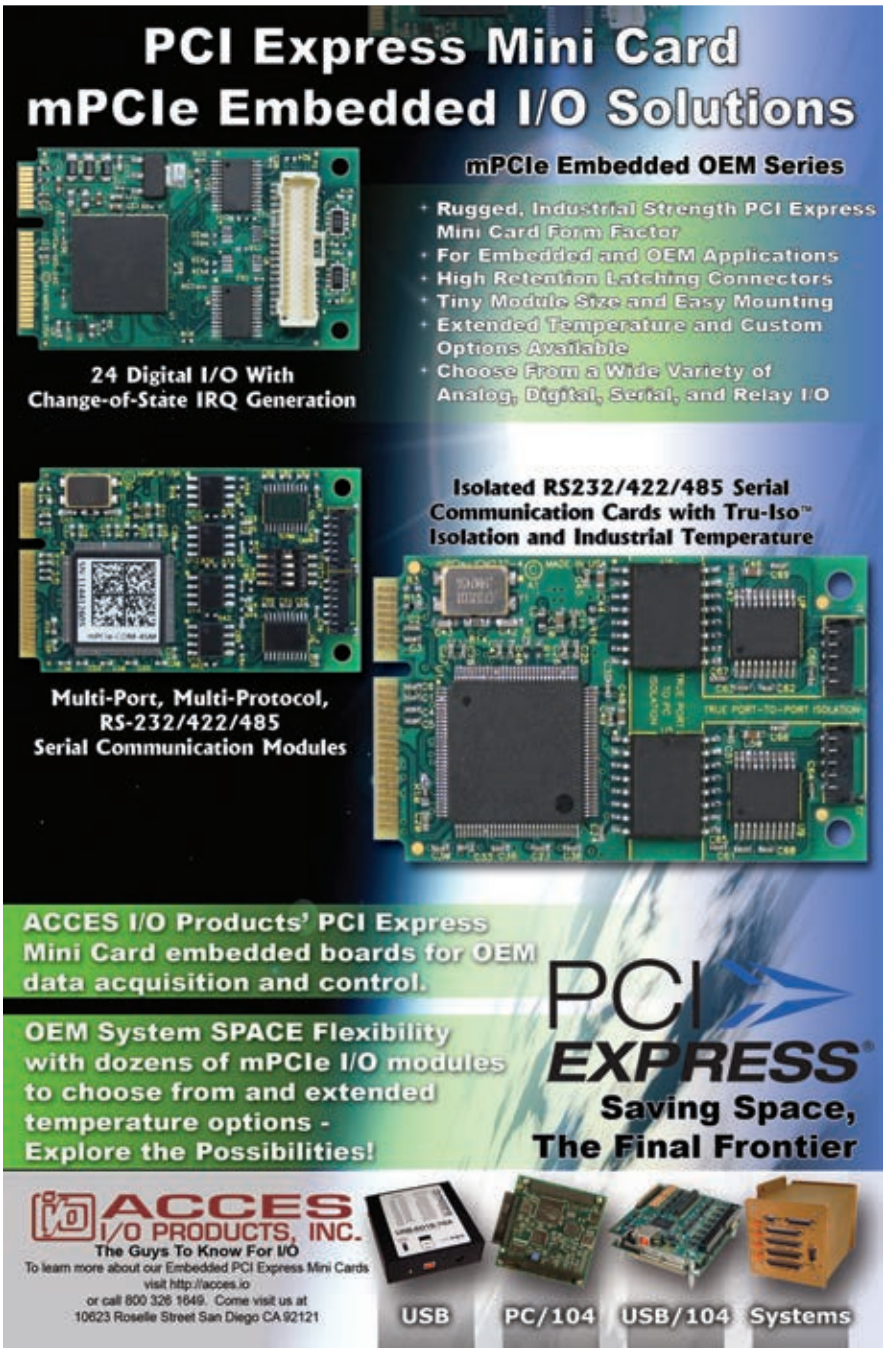
The risk-mitigation techniques described above provide examples of AT and IA strategies we at Curtiss-Wright have implemented via our TrustedCOTS initiative, which takes hardware and software based on standard products then designs in security features that enable those who need protection to implement protection plans for critical technology and data. These products enable users to begin development on standard COTS hardware and software and then move to a secure 100 percent software- and performance-compatible version of the product when they are ready to implement their program-protection requirements.

A moving target

The complex task of protecting CPI against unwanted intrusion presents an engineering challenge that is both ceaseless and ever-evolving. The COTS industry needs to maintain its vigilance and continue the development of sophisticated approaches for protecting critical data from falling into the wrong hands. A multileveled defense in depth strategy enables COTS vendors to provide effective mitigation against malicious attacks by leveraging a combination of cost-effective off-the-shelf technologies, specialized data and hardware IP, and custom design solutions. For peace of mind and the highest possible level of confidence, system designers should undergo serious and detailed discussions with their module suppliers to ensure that the best-possible security techniques are available and can be implemented on their critical systems.

Steve Edwards *is Director, Secure Embedded Solutions for Curtiss-Wright Controls Embedded Computing. He can be contacted at Steve.Edwards@curtisswright.com.*

www.curtisswrightds.com/technologies/secured-embedded-solutions



Phase-change memory: A thousand times faster than silicon

By Sally Cole, Senior Editor

While silicon chips can store data in billionths of a second, phase-change memory may be 1,000 times faster – and require less energy and space. A 19-member group of researchers led by Stanford University reports that phase-change memory, which is based on a new class of semiconductor materials, could both store data permanently and allow certain operations to run as much a thousand times faster than today's memory devices.

The group's work is "fundamental but promising," says Aaron Lindenberg, an associate professor of materials science and engineering at Stanford, and of photon science at the SLAC National Accelerator Laboratory (operated by Stanford University for the U.S. Department of Energy Office of Science). "A thousandfold increase in speed coupled with lower energy use suggests a path toward future memory technologies that could far outperform anything previously demonstrated." Their findings provide new insights into the experimental technology of phase-change memory.

Phase-change materials

Memory chips are typically based on silicon technologies that are capable of efficiently switching electron flows on and off, representing the ones and zeros of digital software. But silicon has its limits, so researchers around the world are on a quest to find new materials and processes requiring less energy and space.

Why phase-change memory? It shows potential as a next-generation technology, thanks to certain materials that boast flexible atomic structures with appealing electronic attributes. Phase-change materials are capable of existing in two different atomic structures, with different electronic states. A crystalline or "ordered atomic structure" enables the flow of electrons, while an amorphous or "disordered structure" prevents their flow.

Researchers have figured out how to flip the structural and electronic states of these materials – changing their phase from "1" to "0" and back again – via short bursts of heat (applied electrically or optically). In terms of being used as a memory technology, phase-change materials are appealing because they retain whichever electronic state conforms to their structure. Once atoms flip to form a "0" or a "1," the data gets stored until another jolt of energy changes it, according to Stanford University. This means that phase-change memory is nonvolatile, like the silicon-based flash memory in smartphones today.

The catch? Any next-generation memory technology must also be capable of performing certain operations much faster than today's chips. To analyze this, the researchers tapped extremely precise measurements and instrumentation to demonstrate the speed and energy potential of phase-change technology.

What they discovered is extremely promising. "Nobody had ever been able to investigate these processes on such fast time scales," Lindenberg says.

Looking at speed

To take on the speed end of things, the researchers focused on the brief interval when an amorphous structure begins to switch to crystalline – a digital "0" flips to a "1." This phase, during which the charge flows through the amorphous material like a crystal, is known as "amorphous on."

By jolting a small sample of amorphous material with an electrical field comparable in strength to a lightning strike, the Stanford researchers' instrumentation detected that the amorphous-on state occurred less than a picosecond after the jolt. This interval means that phase-change materials can be transformed from "0" to "1" by a picosecond excitation, and implies that emerging technology could store data many times faster than silicon random access memory (RAM) for tasks that require memory and processors to work together to perform computations.

Although the researchers weren't able to establish exactly how much time would be required to completely flip an atomic arrangement from amorphous to crystalline or back, their results suggest that phase-change materials could perform superfast memory chores and permanent storage – depending on how long the thermal excitation is engineered to stay inside the material.

While work still remains to turn the group's discovery into functioning memory systems, attaining such speed via a low-energy switching technique on a material that can store more information in less space means that phase-change technology may one day revolutionize data storage. Any new technology that "demonstrates a thousandfold advantage over incumbent technologies is compelling," Lindenberg notes. "We've shown that phase change deserves further attention."

Storage/endurance

Clearly, phase-change memory has attracted researchers' attention. Earlier this year, in another phase-change memory research effort, IBM was able to demonstrate reliably storing three bits of data per cell in a 64k cell array at elevated temperatures after one million endurance cycles via the technology.

Phase-change memory's combination of read/write speed, endurance, nonvolatility, and density prevent data loss when powered off, unlike DRAM, and can endure at least 10 million write cycles, compared to an average USB stick, which maxes out at 3,000 write cycles. IBM expects its phase-change memory storage breakthrough to help speed up machine learning and access to the Internet of Things, mobile phone apps, and cloud storage.

Themis High-Density Computing and Storage Solutions

What is behind the growing demand for high-density server solutions in the defense industry?

Function consolidation, virtualization, and big data analytics are driving more compute capability in a smaller footprint. The DoD requires feature-rich systems that interoperate in multiple applications and allow information sharing between applications. Demand is also driven by "Common Operating Environment" requirements, the use of common components, and "right-sizing" systems to deploy solutions in as many places as possible. To support big data analytics, the DoD utilizes the Map/Reduce function initially developed by Google for search purposes and provided by Apache in Hadoop clusters. The DoD utilizes Hadoop for mining sensor data in the DCGS-A program. The DoD is constrained by size, weight, power consumption, and heat. Themis HD/HDS systems provide robust thermal management and double compute density with a weight savings of nearly 50 percent when compared to a 1U server stack.

How does HD enable enterprise RAS features for embedded mission-critical systems?

Themis HD servers utilize the latest RAS features provided by Intel, including data and address path protection through parity and ECC for CPU and memory. These units incorporate built-in out-of-band management features for accessing system health. Through the KVM function, any network-connected client can access the console for BIOS setup, system boot, or software installation. The fans in each server module are managed locally and are over-provisioned. In the event of fan failure, remaining fans manage the required cooling load until the failed fan is replaced. Server, storage, and power modules are hot-pluggable. Front-mounted air filters protect electronic components and can be easily cleaned or replaced. The Resource Management HD module puts system management at the fingertips of the IT user.

How do Themis HD solutions address DoD requirements?

Themis HD servers deliver increased capability while allowing systems to be built up of standard, modular, lightweight, rack-mount components. Combined with a network switch and a transit case, a complete server solution can be deployed to any service region required. Available in a 2U (four bay) or 3U (six bay) chassis, RES-HD servers provide maximum system configuration flexibility and functionality with hot-pluggable processor, storage, high-speed switch, and system management module options. Additionally, there are both front and rear I/O chassis options. Combining leading-edge components that include Intel® Xeon® E5-2600 v3/v4 Series processors and SuperMicro motherboards, up to 1 TB of memory, dual GbE ports, and a single PCIe slot, RES HD modules feature expansion slots, extensive high-speed front or rear I/O, storage, and enhanced reliability options. Themis HD systems are modular. A 2U Chassis can host up to one HDS8 module plus two HDS8 Storage Expansion modules (2.5 inch SSD or HDD drives) for a total of 24 drives (including eight drives in HDS8 Storage module) or 48 TB. A 3U Chassis can host one HDS8 module plus four HDS8 Storage Expansion modules for a total of 40 drives (including eight drives in HDS8 Storage module) or 80 TB.

Themis
2U HD Storage Chassis

Themis
2U HD Storage Expansion

Themis
3U HD Storage Chassis

What are the Themis server's primary size, weight, and power-cost (SWaP-C) characteristics?

Themis HD systems offer a four-bay 2U (3.5 inches) or six-bay 3U chassis (5.25 inches) height. System depth is 20 inches. The 2U HD system typically weighs 40 pounds, and the 3U system typically weighs 55 pounds when fully populated. The HD system power consumption is -1,300 W and the HDS power consumption is -750 W. HD systems enable customers to double compute density and enable a 50 percent rack space savings with system module weights as low as six pounds. Depending on the configuration, total system weight is reduced by nearly 50 percent.

Do HD designs enable regular technology refresh or technology insertion?

Yes. Themis follows the Intel road map. HD systems are refreshed at the same interval. These systems enable individual module upgrades with the main chassis in place, in the rack.

Where can Themis HD servers be used in applications outside of defense?

HD systems can be used in any application where high compute density and large, local storage are needed. Add in the robust environmental capability and they can easily be deployed in industrial or energy-exploration applications.

THEMIS

Themis Computer
www.themis.com/hd

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CONNECTING WITH MIL EMBEDDED

By Mil-Embedded.com Editorial Staff

CHARITY

Navy SEAL Foundation

Each issue in this section, the editorial staff of *Military Embedded Systems* will highlight a different charity that benefits military veterans and their families. We are honored to cover the technology that protects those who protect us every day. To back that up, our parent company – OpenSystems Media – will make a donation to every charity we showcase on this page.

This issue we are highlighting the Navy SEAL Foundation, a 501(c)(3) nonprofit benevolent organization dedicated to aiding those who serve in the Navy's primary special-operations force, which functions under the Naval Special Warfare (NSW) Command. The Navy SEAL Foundation provides a wide set of programs for U.S. Navy SEALs (an acronym for SEa, Air, and Land teams), Special Warfare combatant-craft crewmembers, NSW support personnel, and their families.

These include warrior- and family-support programs specifically designed to reduce stress and build resiliency; educational opportunities including higher-education scholarships and dependent tuition assistance; tragedy assistance – in addition to those resources provided by the government – in the case of warrior or family-member death; and survivor support in the form of financial and legal counseling, respite child care, and grief support.

The foundation also provides financial support for Navy SEAL memorials and monuments across the country, serves as the co-publisher of "The Blast: Journal of Naval Special Warfare," and supports activities to ensure the legacy of this often-clandestine service. Another of the foundation's ventures is the post-service transition program, under which Navy SEALs and Special Operations community members are offered the tools to adapt and refine their battlefield mission-focused skills to be successful in the business world.

Established in 2000, the Navy SEAL Foundation is a national, nonprofit organization headquartered in Virginia Beach, Virginia. It is also supported by regional organizations in Hawaii and New England.

For more information, visit https://www.navysealfoundation.org.

WHITE PAPER

High-speed switched serial fabrics improve system design

By Rodger Hosking, Pentek

VXS and VPS were developed as evolutionary enhancements to the venerable VMEbus. Both VXS (ANSI/VITA 41) and VPX (ANSI/VITA 46.0-2007) deliver significant improvements as compared with VMEbus in terms of data bandwidth, connectivity, power distribution, and cooling.

When VME was first introduced, its shared bus backplane interboard transfer rates of 30 or 40 Mbytes/s were more than adequate for most applications. As requirements grew for additional speed, however, VME acquired new interfaces such as VSB, RACEway, RACE++, VME64, VME320, and 2eSST. This white paper discusses the growth in the market for such high-speed switched serial interfaces.

Read the white paper:
http://mil-embedded.com/white-papers/white-design-eighth-edition/

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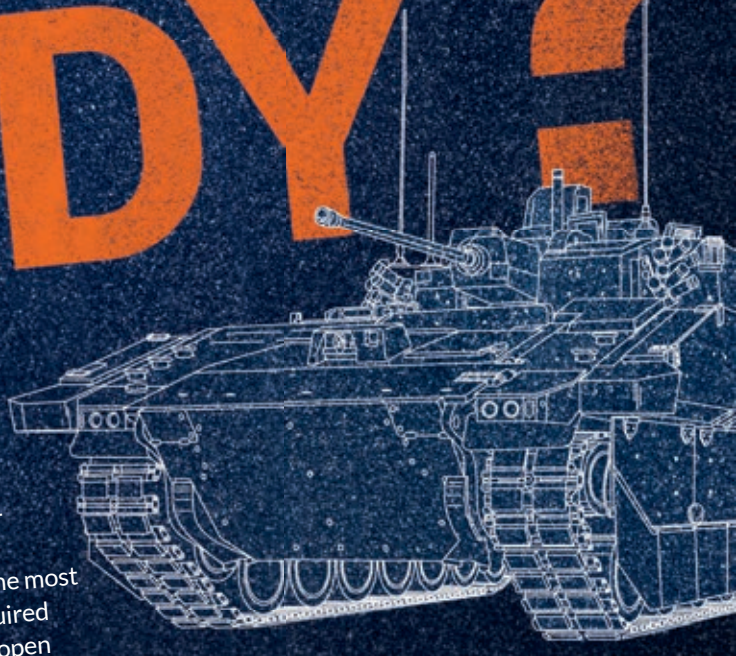
WHAT MAKES IT MISSION READY?



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