MAY 2015

Military & Aerospace Electronics

ENABLING TECHNOLOGIES FOR NATIONAL DEFENSE

Rad-hard electronics

The need for reliable components in space and other harsh environments pushes industry state of the art. PAGE 20

Fighters to drones

Retired F-16 jet fighters escape the boneyard to become sophisticated target drones. PAGE 34

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Sensor networking

Sensor data from land vehicles is becoming Internet content on the digital battlefield. PAGE 8

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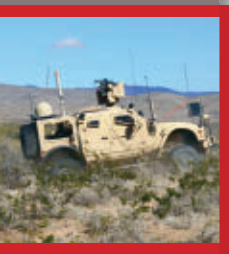

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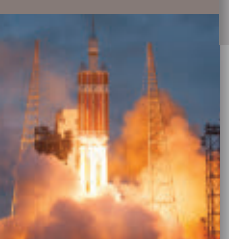

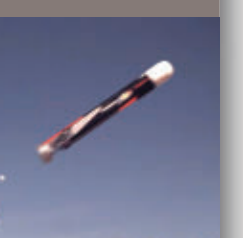

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BY **JOHN KELLER**, EDITOR IN CHIEF

HD infrared sensors a boon to military ISR and lens manufacturers

One of the biggest trends in military night vision these days involves the transition to high-definition (HD) infrared sensors. The new sensor technology increases sensor resolution typically from 640 by 640 pixels to 1,920 by 1,280 pixels, delivering more imagery data than ever before.

HD infrared sensor technology not only offers quantum-type leap enhancements for the value of intelligence, surveillance, and reconnaissance (ISR) images and video, but also provides big market opportunities for infrared lens manufacturers.

For the most demanding surveillance and intelligence applications, where analysts require the highest resolution possible, the move from standard-resolution to high-resolution infrared sensors requires new lenses that can take advantage of everything the new infrared sensor format offers. These requirements for new lenses to exploit the most from the new HD infrared sensors has lens manufacturers tooling up to meet new demand.

HD infrared was on the minds of many attending last month's SPIE Defense, Security, and Sensing conference and trade show in Baltimore. "Lens manufacturers just can't keep up," said a representative of one HD infrared sensor manufacturer.

At first glance, imagery and video from the latest generation of HD infrared sensors doesn't look like much. For long- and mid-wave infrared, which essentially are heat-seeking sensors, images look like contrasting blobs of warm and cool areas. It's only when sensors start to zoom in that the full effect of HD starts coming out. There's detail in those images that rarely, if ever, have come out in previous generations of infrared sensors. At the SPIE show, for example, the heat signatures from the breadth of attendees was apparent once those sensors zoomed in for a close look. Other details — buttons, creases in clothing, and individual hairs in beards — also were clear.

Users of ISR systems with HD infrared sensors will be able to see more than they ever have before, industry experts say. One likened HD infrared capability to the difference between looking through a paper towel tube, and relatively wide field of view. This new capability has broad implications for reconnaissance and surveillance. Manned and unmanned surveillance aircraft flying at the same altitudes could get roughly twice the information on a reconnaissance pass. Yet if analysts simply need the same amount of information, these aircraft could fly at higher altitudes and take in wider swaths of intelligence data. It could mean a need for fewer surveillance platforms and fewer reconnaissance missions to gather the same data.

These new sensors are being deployed today on weapon systems like the F-35 Joint Strike Fighter. In the future, deployed HD infrared sensors are expected to increase in resolution from 1,920 by 1,280 pixels to 2,000 by 2,000 pixels, or even finer resolution, with each pixel progressively becoming smaller and smaller. These sensors will start out to be large and heavy, but are expected to evolve to sizes to fit medium- and small-sized unmanned aerial vehicles (UAVs) and other manned and unmanned systems. It's only a matter of time before the costs of HD infrared sensors start coming down, too. The trend from low- to high-definition infrared is expected to bring unprecedented capability for infrared sensors of all kinds.

New HD infrared sensors can require new lenses. HD images and video are different dimensions than low-def images; using the same lenses for both would cut off portions of the image and diminish the intelligence value. For sensitive military surveillance applications, new lenses will be a must, and lens manufacturers are rising to the occasion. Some estimate the transition to HD infrared will represent hundreds of millions of dollars over two to three years.

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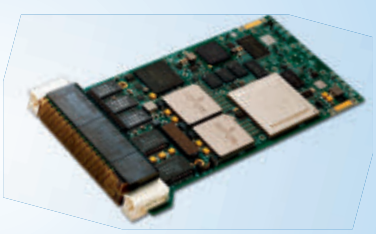

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Air Force seeks to shield military avionics from computer hackers

BY JOHN KELLER

WRIGHT-PATTERSON AFB, Ohio—Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, have issued a notice for the upcoming Avionics Vulnerability Assessment Mitigation and Protection (AVAMP) program, which seeks to find ways of protecting avionics from cyber attack.

A formal solicitation is expected by the end of June. The AVAMP program will involve two or more contractors and will be worth as much as $49.7 million. Contract awards are expected by next November.

AVAMP will investigate and develop methodologies, tools, techniques, and capabilities to identify susceptibilities and mitigate cyber vulnerabilities of avionics systems. Research will focus on embedded system cyber security technologies involving vulnerabilities from physical, remote, and supply chain access.

The program's scope will include manned and remotely piloted vehicles; on-board intelligence, surveillance, and reconnaissance (ISR) systems; munitions; and any equipment, component, or subsystem that could compromise Air Force weapons.

Avionics cyber security technologies developed in the AVAMP program should be able to interface and interoperate with anti-tamper and open avionics system architectures and apply to a wide-range of aircraft that operate in contested environments involving electronic warfare (EW) systems, space systems, and mobile devices.

Air Force researchers are approaching industry for ways to safeguard military avionics from malicious computer hackers.

For this project Air Force researchers want to develop automated tools to support avionics vulnerability assessments; automated reverse engineering, program understanding, and software assurance tools to identify and detect weaknesses in avionics; malware detection tools and countermeasures; and techniques to detect, respond, and adapt to never-before-seen types of cyber attacks.

For technical questions and concerns, contact the Air Force's Lisa Jones, the AVAMP program manager, by email at lisa.jones.6@us.af.mil or by phone at 937-528-8018. For more information, contact Maureen Grandon, the AVAMP contract specialist, by email at maureen.grandon@us.af.mil or by phone at 937-713-9959. ←

MORE INFORMATION IS online at *www.fbo.gov/spg/USAF/AFMC/AFRLWRS/BAA-RQKS-2015-0008/listing.html*.

IN BRIEF

Special Forces look for new combat diver technologies

U.S. military special operations experts are reaching out to industry for new technologies to help combat divers and swimmers maneuver, navigate, communicate, and fight in the water. Officials of the U.S. Special Operations Command (SOCOM) are interested in new technologies for frogman maneuverability, weapons use, communications, navigational accuracy, and diver situational awareness in and out of the water column. This request for information is in preparation for at-sea experiments scheduled for 3 to 7 Aug. 2015 at the Coronado Naval Amphibious Base in San Diego.

Marine Corps avionics computers to receive next-gen Ethernet

U.S. Navy avionics experts are sponsoring a project to upgrade mission computers in U.S. Marine Corps AV-8B Harrier II jump jets with next-generation Ethernet capability. The Naval Air Systems Command is awarding a sole-source contract modification to General Dynamics Advanced Information Systems in Minneapolis to upgrade the second Open System Processor-Generation 3 to function with future Ethernet cards and to update the data requirement. ←

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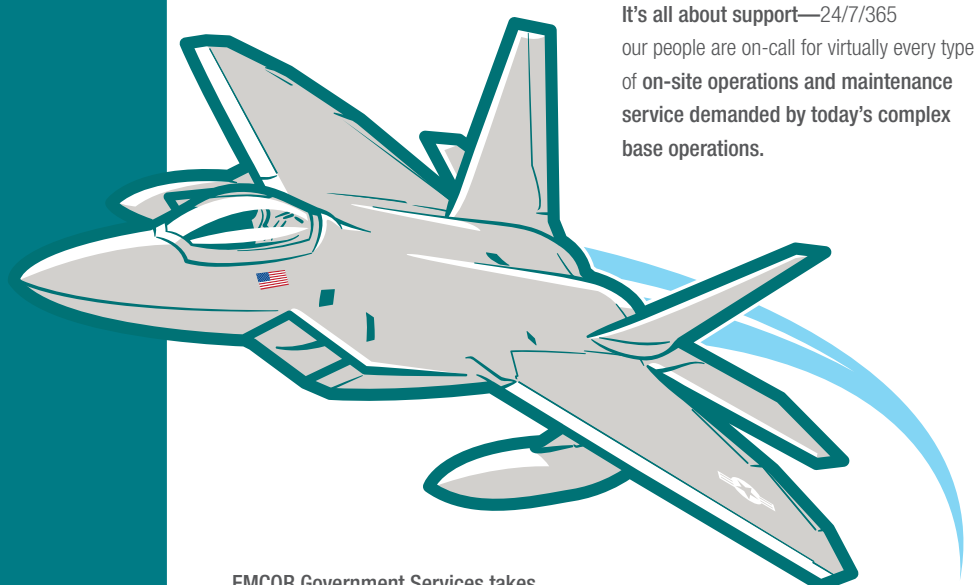

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VPX standard tailored for space applications ratified by ANSI and VITA

BY JOHN KELLER

FOUNTAIN HILLS, Ariz.—A new embedded computing open-systems industry standard for creating high-performance, fault-tolerant interoperable backplanes and modules for spacecraft electronics and other high-availability applications has been ratified.

The VITA 78 SpaceVPX Systems standard capitalizes on the OpenVPX standards family, and has been ratified by the VITA Open Systems and Open Markets trade group in Fountain Hills, Ariz., as well as the American National Standards Institute (ANSI).

The ANSI/VITA 78.00-2015 specification has completed the VITA and ANSI processes reaching full recognition under guidance of the VITA Standards Organization (VSO).

SpaceVPX Systems seeks to achieve an acceptable level of fault tolerance while maintaining reasonable compatibility with OpenVPX components, including connector pin assignments. It seeks to create standard electronic architectures for satellites and manned spacecraft in an effort to reduce costs and ease systems upgrades and technology insertion.

The standard defines standard interfaces, data paths, connectors, and other building blocks for space electronics, which historically have been custom legacy designs that are difficult and expensive to replicate and upgrade.

Legacy space systems often are point solutions with proprietary and application-specific internal interfaces, where re-use is not a priority, says Patrick Collier, senior electrical research engineer and deputy program manager at the Air Force Research Laboratory at Kirtland Air Force Base, N.M., and chairman of the VITA 78 Working Group.

Industry is starting to embrace a new embedded computing open-systems industry standard for spacecraft electronics and other high-availability applications.

VITA 78 SpaceVPX, instead, seeks to use open-systems architecture guidelines and open standards to achieve loose coupling between software and hardware in space electronics designs.

SpaceVPX is intended to reduce risks and costs tied to reintegration of interfaces to make software and hardware reuse more attractive and affordable. Use of industry-consensus interfaces will provide more vendor based options from a broader market, with more regular sustained competition.

The standard defines payload, switch, controller, and backplane module profiles to meet the needs of space applications, and adds features to the utility plane for fault tolerance. Space VPX calls out point-to-point data paths, not bused paths, to help space systems tolerate faults and avoid module failures that affect the entire system.

NASA is evaluating 6U and 3U SpaceVPX form factors, and prototype products should be available by next fall or winter.

Those interested can buy copies of the VITA 78 SpaceVPX specification for $100 online at http://shop.vita.com/searchquick-submit.sc?keywords=SpaceVPX.

FOR ADDITIONAL INFORMATION visit **VITA** online at *www.vita.com.*

L-3 Chesapeake Sciences to build next-generation towed-array sonars for attack submarines

BY JOHN KELLER

WASHINGTON—Sonar designers at L-3 Chesapeake Sciences Corp. in Millersville, Md., are building the U.S. Navy's next-generation towed-array sonar for submarines and unmanned surface vessels (USVs) to detect, track, and classify quiet, modern submarines in open-ocean and shallow coastal waters.

L-3 Chesapeake Sciences Corp. is designing the U.S. Navy's next-generation towed-array sonar system for submarines and surface vessels.

Officials of the Naval Sea Systems Command announced a $20.8 million contract to L-3 Chesapeake to build six TB-29A Compact Towed Array (CTA) towed-array sonar systems for Navy Virginia-class fast-attack submarines. The TB-29A CTA represents the next generation of sonar array technology; it is a reliability improvement array that incorporates CTA telemetry while maintaining TB-29A acoustic performance.

Current towed-array sonar systems, including TB-23, TB-29A, TB-16, and Multi-Function Towed Array (MFTA) provide acoustic performance but are not optimal for deployment from unmanned vehicles.

Towed array sonar uses hydrophones mounted to a cable trailing behind a submarine or a surface ship; it can be miles long. It's designed to keep the array's sensors away from tow vessel noise to improve the sonar's signal-to-noise ratio and ability to detect and track faint contacts like quiet nuclear- and diesel-powered submarines and seismic signals. Effective use of towed array sonar systems limit a vessel's speed, and crews must take care to protect the cable from damage. Current towed-array systems also are complex designs and need to be upgraded to maintain reliability while deployed, while stowed, and while reeling the array in and out of submarines and other marine vessels.

Compared with existing towed arrays, the L-3 Chesapeake TB-29A Compact Towed Array offers significant reduction in sensor power, internal component diameter, bend radius, and production costs.

The TB-29A CTA submarine thinline array is designed to reduce complexity, lower power, and improve robustness to withstand in-situ operations and stresses of handling systems. Its performance telemetry, acoustic sensors, and electronics are designed to provide a ubiquitous solution across the spectrum of submarine, surveillance, and unmanned towed arrays. Multimission commonality for high-volume and unique components provides cost savings from procurement to life cycle support. Further, the common towed array architecture that the TB-29A CTA represents can be used aboard attack, cruise-missile, and ballistic-missile submarines, as well as on unmanned surface vessels.

FOR MORE INFORMATION visit L-3 CSC online at *www.l-3mps.com/csc*.

The evolution of networked sensors

From the dawn of military sensor networking during Vietnam to today's struggle against insurgents and IEDs, military mobile sensor networks strive for ever-higher bandwidth and resolution, and smaller more lightweight platforms.

The WIN-T system is among the first combat vehicle networking technologies to provide reliable data, imagery, video, and voice networking capabilities to combat forces on the move.

BY **J.R. Wilson**

Technology has been the force multiplier giving the U.S. military growing superiority over its adversaries since World War II, and battlespace dominance since the Reagan build-up of the 1980s. Military technological dominance has come at a cost, however, and that cost is asymmetrical warfare.

Much of this shift started during the 1960s in Vietnam. As America gained total air dominance in Southeast Asia, and precision-guided air- and sea-launched weapons decimated traditional enemy military formations. In response, adversaries turned to insurgent warfare with small units, no heavy armor, or even aircraft. Instead they relied on improvised explosive devices (IEDs) as suicide and vehicle bombs.

That, in turn, placed a growing U.S. military emphasis on the equipment and capabilities of small units—even down to the individual warfighter. The lack of a definitive "front line" during the Vietnam War created a critical need for every Army and Marine Corps land vehicle independently to sense, locate, define, and respond to high-, mid-, and low-tech localized weapons.

This is no small feat; it requires significant improvement in sensors to detect dangers, situational awareness to map threat locations, and vehicle networking to ensure all other vehicle crews are aware of the dangers.

Fast-forward to today. The ability to perform technology refresh and

insertion into existing vehicles became part of original design parameters after 9/11, allowing for relatively quick and on-site upgrades in many instances.

Such new technologies, however, rely on continuous research and development, funding for acquisition and fielding, training for users and maintainers, and development of next-generation vehicles, sensors, networking, and related capabilities.

That evolution has been slowed, deferred, or shelved due to declining military budgets, military downsizing, and, most significantly, sequestration. All that comes at a time of increasing geopolitical instability, rising Chinese military technology, a resumption of Russian military adventurism, and demand for U.S. Army and Marine Corps units across a wider global distribution than any time since the end of the Cold War.

Defense leaders testifying before Congress during this year's budget hearings were unanimous in saying the funding trends of the last few years have forced the services into quixotic choices—none of which bode well for the future of U.S. combat operations.

Vehicles as sensor platforms

On the one hand, technology makes it possible for land vehicles of all sizes to carry an array of sensors and communications equipment. On the other hand, severe funding cuts have left little money for the research and development necessary to upgrade and replace such systems.

"We know that we need a middleweight, mobile, protected firepower platform to allow early entry forces to seize and exploit the initiative," says Gen. Daniel Allyn, Army Vice Chief of Staff. "Our tanks and Bradleys are the finest fighting platforms in the world, but they're heavy. You've got to seize a major airfield to get them in. You'll see, in the future, some equipment that's not quite so heavy, but enables us to have tactical mobility."

A summer 2014 demonstration at Fort Bragg, N.C., saw six defense contractors exhibit their proposals for such a vehicle. Proposals included the General Dynamics Flyer, the Boeing-MSI Defense Phantom Badger, the Polaris Defense deployable

U.S. and allied combat vehicles are receiving secure networking equipment at an accelerated rate for enhanced situational awareness and targeting capability.

advanced ground off-road DAGOR, the Hendrick Dynamics Commando Jeep, the Vyper Adamas Vyper, and the Lockheed Martin High Versatility Tactical Vehicle—a version of the UK Army's HMT-400 Jackal.

The U.S. Special Operations Command already has awarded a contract to General Dynamics Land Systems in Sterling Heights, Mich., for its Ground Mobility Vehicle 1.1 (aka, Flyer) to meet a similar need, but even lighter vehicles may be necessary, says Lt. Col. Kevin Parker, light systems branch chief in the Mounted Requirements Division.

Requirements for an ultralight combat vehicle (ULCV) include a maximum empty weight of 4,500 pounds, the ability to carry a nine-man infantry squad and their equipment (3200 pounds), a range as far as 300 miles on one tank of gas, size to fit inside a CH-47 Chinook heavy-lift helicopter, air-droppable by a C-130 Hercules or C-17 Globemaster cargo aircraft, and by sling load on a UH-60 Black Hawk medium-lift helicopter. It also must have the power and computing capability for advanced sensor and communications suites.

"Nobody had ever asked industry for a 4,500-pound vehicle that can carry nine guys and still be highly mobile and have a long range," Parker notes. "We had requirements that are hard, but that's what we need the vehicle to do."

Meanwhile, development of the ULCV's sensors, situational awareness, and networking equipment also is moving apace, subject to further funding restrictions.

Third-generation FLIR

At a Washington conference in March, Army Acquisition Executive Heidi Shyu said the Army is ready to convert 16 years of research on a third-generation Improved Forward Looking Infrared (IFLIR) electro-optical sensor into a program of record for Abrams tanks and Bradley infantry vehicles. The IFLIR is expected to enable troops to discriminate between shovels and rifles, tanks and commercial trucks.

In April, Raytheon and DRS Technologies announced they have teamed on development of the IFLIR in anticipation of the procurement announcement. An Army request for proposals is expected in this month, leading to an engineering and manufacturing program and production award in the early 2020s.

"The new third-gen technology will dramatically improve the range performance of ground combat vehicle sensors, allowing greater standoff range and identification capability," says Clay Towery, senior manager for business development at Raytheon EO Innovations in Richardson, Texas. "It's very important to the Army and it will provide a significant combat advantage and it's critical that we field this technology to maintain combat overmatch."

The current second-generation FLIR, fielded on more than 20,000

Army, Marine Corps, and Navy platforms in the past decade, uses a linear scanned array that sweeps across its field a view. The third-gen will use staring focal plane arrays that do not sweep but use several detectors on an image plane, thus gathering significantly more information. It also is capable of simultaneous detection in mid- and long-wave bands.

"The Army and our team have a strong track record of delivering state-of-the-art, next-generation FLIR technology on our nation's premiere ground vehicle combat platforms," Sally Wallace, DRS C4ISR group president, said in a statement. "Our experience integrating a common FLIR across the Army's combat vehicle platforms is critical to synchronizing the Army's modernization strategy."

Sensors also are key to improved situational awareness. Blueforce Development Corp. in Salem, Mass., offers this definition of the complexity of field-level situational awareness:

"The asymmetric threat has moved us to a network-centric concept of operations where chaos and non-predictiveness replaces past eras of order; where today's coalition

The Army's WIN-T technology makes use of a sophisticated infrastructure of vehicle antennas and rugged on-board networking routers to keep warfighters abreast of battlefield developments as they unfold.

or interagency workgroup presents a different membership tomorrow. Operational approaches require the complete and total embrace of tactics and technology that address the ultimate in complex adaptive systems where we operate and interoperate in denied, dysfunctional, and disparate last tactical mile environments. These operating environments require complete mobility, but also agility given the non-predictive nature of disasters and manmade incidents."

Vehicle situational awareness

One situational-awareness initiative at the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., is the Ground X-Vehicle Technologies (GXV-T) program to improve the survivability of ground-based armored fighting vehicles through crew augmentation—improved physical and electronically assisted situational awareness for crew and passengers.

GXV-T also involves semi-autonomous driver assistance and automation of key crew functions similar to capabilities found in modern commercial airplane cockpits to reduce onboard crew and training requirements.

According to DARPA's GXV-T program office, potential approaches include:

- a closed cockpit that would use visualization technologies to provide high-definition, wide-angle visibility of external conditions;
- path planning that would display optimal routes;
- sensors that would use a variety of technologies to visualize surroundings and identify and track allies and adversaries;
- terrain classification that would evaluate surroundings for optimal travel surfaces; and
- autopilot capabilities that would automate routine driving tasks to enable drivers to focus on more strategic activities.

The latest increments of the Army WIN-T program make use of lightweight, fast, and maneuverable vehicles to ensure that networking capability keeps up with leading elements on the battlefield.

"Ground-based armored fighting vehicles and their occupants have traditionally relied on armor and maneuverability for protection. The amount of armor needed for today's threat environments, however, is becoming increasingly burdensome and ineffective against ever-improving weaponry," the Agency reports.

"GXV-T seeks to develop revolutionary technologies to enable a layered approach to protection that would use less armor more strategically and improve vehicles' ability to avoid detection, engagement and hits by adversaries. Such capabilities would enable smaller, faster vehicles in the future to more efficiently and cost-effectively tackle varied and unpredictable combat situations."

While some efforts to improve situational awareness are complete system proposals, some defense contractors have developed independent components, such as the BAE Systems CHECK-6 Rear-View System, which uses thermal or color cameras embedded into military-style LED taillights—thus offering commonality across military vehicle types—to provide ground vehicles with a rear vision system.

"This innovative solution provides a streamlined path for vehicle installs that can be accomplished as a field-upgrade kit requiring few tools and minimal vehicle downtime," according to BAE. "Check-6 delivers needed battlefield situational awareness during all weather, day and night operations. (It) is in production and currently supporting 40,000 armored combat and tactical wheeled vehicles across the Joint Armed Forces."

Small, fast movers

Providing each vehicle with independent sensor suites and situational awareness is a major step forward, but new battlefield environments—with fast-moving small vehicles, threats from hidden IEDs and two- or three-man insurgent teams with rocket-propelled grenades (RPGs), sudden attacks from the cover of civilian crowds, hospitals, schools, etc.—make real-time sharing of each vehicle's (and individual warfighter's) information even more critical. But networking on the move involves a number of problems, from jamming and spoofing to encryption and available, reliable bandwidth.

"Bandwidth is probably the biggest problem with all that data. LOS [line-of-sight] is another issue, trying to reach the soldier over the horizon. If you use a satellite, you're going to have a latent connection. Crunching big data numbers strikes me as more a software issue. As far as our wired

network, Gigabit Ethernet is more than sufficient to handle most traffic, with 10 Gigabit Ethernet coming on fast and 100 Gigabit Ethernet also developing rapidly. Wireless is needed to connect everyone on the battlefield," says Ronen Isaac, general manager of military Ethernet specialist MilSource in El Segundo, Calif.

"The requirement is two-fold. One is interoperability and flexibility, where systems need to share information. Flexibility comes in with open architecture; where things are inherently interoperable, everything speaks the same language, so getting them to speak together is a soft-

This British Army Combat Vehicle Reconnaissance (Tracked)) being operated across the harsh desert terrain of Afghanistan by soldiers of the 9th/12th Royal Lancers.

ware issue rather than the much more difficult physical. Which is much easier to do in the software-defined world we're moving to.

"The second is SWaP-C [size, weight, and power-cost]. Because IP is an open platform, the commercial world is able to provide lower cost, high reliability products that are not necessarily specialized. So you can take advantage of COTS with an open standard. And with our current budget situation, cost is a major driving factor. SWaP goes back to leveraging the commercial aspects of IP and having various vendors using IRAD [independent

research and development] to come up with devices that are smaller, lighter, and require less power, but meet the same specs as their larger counterparts."

The next generation of on-board systems also will require multi-task rather than specialized systems, he added, in order to further reduce SWaP and leave more room in the vehicle for crew and passengers.

"So instead of having a mission computer and a router, you would put those together. Same with GPS—all saving space, weight and power. There is a push for that now and we have answered it with some of our technology, but we will see a lot more of that in the future—which, in turn, means a growing demand for more compute power, more capacity," MilSource's Isaac says.

Power over Ethernet allows for the reduction of cables on a mobile platform. A MILTECH 910 POE Ethernet switch can provide connectivity and power to sensors, cameras, and other devices.

"We're starting to see a connected battlefield where you have soldiers and vehicles on the ground, UAVs, and command stations all needing to share video, voice, situational awareness, etc. The only way to connect all those is via IP networking because we can use currently available routers and switches. We're seeing some companies mounting radio hardware, with core-switching and routing hardware, inside autonomous vehicles and essentially using those as giant moving antennas. But a bigger problem, in the short term, is security. If the platform is captured, how do you get its data off, then destroy it, before the enemy can use it?"

Common sensor networks

Since 2009, the Army has been working under a directive to develop "as is" and "end state" network architectures to guide network development, procurement and enhancement. The Army Network Architecture

The shrinking of components and platforms has allowed the consolidation of multiple platforms. The Techaya MILTECH 9012X contains an Ethernet switch, an embedded single-board computer, and a GPS receiver.

Strategy-Tactical version was crafted in response to this directive, with the Common Operating Environment (COE) architecture serving as a key component of that guidance.

"With a COE, the Army can establish a framework similar to industry best practices. One of these Army COEs is the Sensor Compute Environment (CE), which addresses the sensor interoperability questions of: (1) am I using the right sensor standards, (2) am I exchanging data with the correct format, and (3) am I exchanging relevant data. Sensor CE will provide a common sensor interoperability layer, implementing standards and technology for specialized, human-controlled or unattended sensors. This effort is applicable to future UGS [unmanned ground systems]," says Clair Guthrie, sensor computing environment chair at the U.S. Army's program executive office for PEO intelligence, electronic warfare & sensors.

Without the operator having specific knowledge of the available networked sensors, Sensor CE enterprise services include the ability, subject to mission priorities, to:

- identify the existence and determine the capabilities of sensors on a network to support a mission requirement;
- distribute summary event information from sensor observations to the network with a pre-defined distribution and level of priority;
- obtain full motion video streams from sensors;
- request specified sensors on a network to perform operations; and
- request specified sensors for remote management of sensor operations.

In the expanding paradigm of military adaptation of commercial

developments, one of the top requirements is for faster military acquisition and fielding of new sensor, networking, and situational awareness technologies—and doing so before potential adversaries accomplish the same goal using the same openly available technologies.

"Science and Technology Trends 2013-2043: A Review of Leading Forecasts," sponsored by Deputy Assistant Secretary of the Army for Research and Technology Mary Miller, aggregated and analyzed trends from multiple sources and identified, at a macro level, 16 megatrends of significance to the military, including robotics and autonomous systems, human augmentation, big data, 3D printing, the Internet of things and ubiquitous nanotechnology.

Commercially developed technology

"One observation from the report was how sensors—including detection technologies, measuring tools and self-aware feedback mechanisms and their supporting technology development areas, such as data fusion, algorithm development, energy harvesting and networking—were consistently identified as key science and technology (science and technology) enablers across most of these trends. It is imperative to the Army's future effectiveness and efficiency to accept and adapt to the rapid pace of change driven by these global commercial trends," according to Susan Harkrider, deputy director of the Modeling, Simulation & Netted Sensors Division at the Communications-Electronics Research Development and Engineering Center's (CERDEC's) Night Vision and Electronic Sensors Directorate (NVESD).

"Known as the Integrated Sensor Architecture (ISA), this framework identifies the critical capabilities to be adopted for sensor interoperability. This strategic approach enables program management offices to instantly refresh their programs with the latest technology and adapt existing Army portfolio assets to this new environment. Thus the Army could leverage the often very fast development cycle of cheap commercial sensor technologies (like those on cell phones) and integrate them into cross-domain solutions with existing, expensive and unique

military sensors (like those on satellites and military platforms)."

Harkrider views sensors as "the glue that enables the Army to embrace the global trends shaping warfare in 2025 and beyond".

"How the Army chooses to embrace global changes and commercial trends will determine in many ways how successful it is in maintaining technical superiority. Concepts like ISA are but one approach to helping the Army maintain agility in a rapidly changing world. Establishing the adoption of common standards and protocols can be very challenging when working with so many different communities, all of which have different opinions on what 'right' looks like," she says.

Achieving those goals has become an increasingly difficult circle to navigate: Today's warfighters must have vehicles of all types that offer integrated sensor suites and networking to facilitate enhanced situational awareness, for that vehicle and its occupants as well as all other friendly forces in the area. That must be achieved at the lowest SWaP-C possible, which requires funding of new research and development to adapt commercial technologies—and, in some cases, create military-specific elements. All of which need to be accomplished under severe budget restrictions—especially the possible return of sequestration—and a backdrop of fielding urgency to enable the U.S. military to maintain its technological edge over any potential adversaries.

Budget constraints

But as the Army's budget director, Maj. Gen. Thomas Horlander, told reporters in February, funding for research and development is at its lowest point since the turn of the century. At that same briefing, deputy budget director Davis Welch added that while the Army has not terminated any programs, continuing to allocate science and technology funding through 2025, several programs have been delayed—including the future infantry fighting vehicle and full-on-the-move tactical networking.

The latter also is a major blow to Marine Corps modernization plans, which rely heavily on Army research and development. Brig. Gen. Joe Shrader, head of the Marine Corps Systems Command, told a House Armed Services Subcommittee hearing on Army Ground Force Modernization plans that delaying development and fielding of Networking-on-the-Move "leaves two-thirds of our operating forces without the ability to conduct mobile networking in distributed environments." That deficit becomes even more dangerous if they face a future enemy that does have such a capability.

"The Army's modernization budget remains near historic lows. Still, our modernization mission—to develop and procure systems that allow our soldiers to dominate across the full spectrum of operations—remains essential. We must always ensure our soldiers have the right equipment, at the right time and at the right place to accomplish the assigned mission," Lt. Gen. Anthony R. Ierardi, Army Deputy Chief of Staff, and Lt. Gen. Michael E. Williamson, Military Deputy to the Assistant Secretary of the Army for Acquisition, Logistics and Technology, told

the HASC subcommittee.

Among those programs they identified to lawmakers as "critical [to] provide overmatch capabilities at the tactical and operational levels of combat operations" were:

- Joint Battle Command-Platform (JBC-P), the next generation of Force XXI Battle Command Brigade and Below/Blue Force Tracking and "the foundation for achieving affordable information interoperability and superiority on current and future battlefields [as] the principal command and control/situational awareness system for the Army and Marine Corps at the brigade level and below." The Army requested procurement funding for 2988 vehicle platform computer systems, 300 command post systems, satellite receivers, encryption devices, ancillary equipment, program management support, training, fielding, publications, support equipment and post deployment software support.
- Warfighter Information Network-Tactical (WIN-T), which "provides broadband communications for the tactical Army [extending] an IP-based satellite and LOS communications network throughout the tactical force, supporting voice, data, and video." Funds were requested to upgrade 31 WIN-T Increment 1 units to enhance interoperability with units fielded with WIN-T Increment 2, procure 248 communications nodes for WIN-T Increment 2 and continue fielding and support for previously procured WIN-T Increment 2 Low Rate Initial Production (LRIP) equipment.
- Distributed Common Ground System-Army (DCGS-A), which provides integrated ISR processing, exploitation and dissemination of airborne and ground sensor platforms, giving commanders at all levels access to the Defense Intelligence Information Enterprise and leverages the entire national, joint, tactical and coalition ISR community.

The FY16 funding request supports correction of any issues identified during the May 2015 Limited User Test, support for the Increment 2 Request for Proposal and milestone decisions, including plans to begin Increment 2 development, as well as modernize and procure COTS software and hardware components for DCGS-A (fixed, mobile and data centers), integrate hardware and software and equip and train next deployers and high priority units.

Network cyber security

Each new technology incorporated into combat vehicles, especially those involving data exchanges with other vehicles and command centers, also brings an increased need for data security and more research and development funding requirements for the growing field of cyber security—and thus a further drain on available funds.

"Network dominance and defense is an integral part of our national security. The Army is focused on proactively providing increased capabilities to the Joint force. The evolving cyber environment is forcing the Army to adapt to cyber threats by transforming processes, organizations and operating practices to mitigate vulnerabilities," the generals told Congress.

"In terms of new and emerging initiatives, the U.S. Army Cyber Command and the Army acquisition community are pursuing ways to bring 'big data' analytic capabilities to Army operations in order to improve our cyber defense capability. These efforts, as well as cyber science and technology initiatives focused on the enabling technologies for future capabilities, will generate resourcing requirements which will compete against other modernization priorities."

In an increasingly unstable world where demands on ground forces—and threats to them—grow even as the U.S. military and its budget downsize, the technology explosion that has given those forces a decisive edge in recent decades now may be turning against them.

"Army equipment modernization enables the U.S. Army to remain the world's decisive land force. Soldiers and units operate as part of joint, inter-organizational and multi-national teams that are tailorable and scalable to the mission. As we continue to examine how to achieve effective balance among force structure, modernization and readiness, we must have stable, predictable, long-term funding to modernize our force to meet evolving threats and execute our mission," Ierardi and Williamson warned lawmakers.

"The security challenges of tomorrow will be met with the equipment we develop, modernize and procure today. Because adversaries will continue to invest in technology to counter or evade U.S. strengths and exploit vulnerabilities, resource reductions and insufficient force modernization place at risk the Army's ability to overmatch its opponents."

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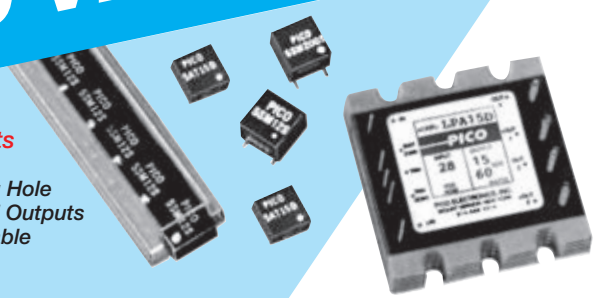

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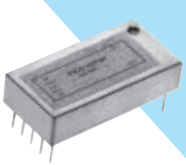

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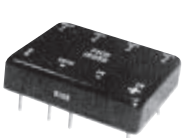

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Averting on-orbit mission failure

Engineers rely on modern radiation-hardened and radiation-tolerant electronics for harsh-environment applications requiring high reliability.

BY **Courtney E. Howard**

"We expect 1,200 new spacecraft of 110 pounds mass or larger to be launched within the next 10 years," says Marco Caceres, senior analyst and director of space studies at the Teal Group market-research firm in Fairfax, Va. "This represents 20 percent growth in the number of spacecraft in this mass category over the preceding 10 years."

Space programs are growing by leaps and bounds, with exponential growth in satellite launches and hosted payloads, manned and unmanned space travel, and similar activities being realized today and forecast into the foreseeable future. The requirements for each aerospace mission are, likewise, growing—a majority of which now specify the use of electronic systems and components capable of withstanding the harsh, radiation-riddled expanse of space.

System failures can be costly in virtually any environment, but perhaps none more so than in space—where even a single computing event upset can bring an untimely end to an entire and very expensive mission. Aerospace engineers and technology providers are increasingly and proactively working together to ensure the reliability and longevity of systems and platforms deployed in the harsh environment of space, through the use of modern radiation-hardened (rad-hard) and radiation-tolerant (rad-tolerant) electronic components.

Lockheed Martin is the prime contractor building the Orion Multi-Purpose Crew Vehicle, NASA's first spacecraft designed for long-duration, human-rated deep space exploration.

"There is a global trend of increasing requirements for both rad-hard and rad-tolerant products for space applications," explains Monty Pyle, vice president of sales and marketing at VPT Inc., a HEICO company, in Bothell, Wash. "Driving this is increased customer awareness of potential detrimental space radiation effects on certain silicon electronic components."

Radiation effects

Space radiation can have serious effects on electronics system and satellite operation. "Some particle radiation is so energetic that it can penetrate to the interior of a satellite and interact with its electronic

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circuitry. This can cause a wide variety of effects that range from unimportant ones to the shutdown of a vital system. For example, if the circuitry controls the way the satellite is pointing its antenna, the satellite can veer out of contact with ground-based receivers and be lost," NASA officials say.

Radiation effects on electronics, including satellite systems, often are grouped into three categories: total ionizing dose, displacement damage, and single-event effects. Total ionizing dose effects in electronics tend to build up over a long period of time and can change the device properties, degrade performance, and eventually cause the device to fail completely.

Displacement damage, a cumulative effect occurring in the electronic device's semiconductor material, can cause the device to deteriorate and possibly fail if exposed to enough radiation. Single-event effects, which can be either non-destructive or destructive to the device, are caused by the passage of a charged particle through a sensitive region in an electronic device, NASA officials say.

The severity of the single-event effects can range from minor and unnoticeable to extreme and causing a system to shut down. A charged particle can cause bit flips in solid-state memory devices, changing ones to zeros or zeros to ones, and corrupt important data.

NASA officials encourage aerospace engineers and program managers to understand the space radiation environment. Underestimating the radiation environment leads to excessive risk, which can result in degraded performance and a shorter mission lifetime, they stress.

Orion Crew Exploration Vehicle and Exploration Flight Test-1 (EFT-1) was the first high orbital test flight for the Orion spacecraft.

Selecting solutions

Customer requests depend on the program requirements and the customers' experience base, Pyle says. Aerospace customers are using VPT radiation-level products—including DC-DC converters and EMI filters—in satellites, space probes, capsules, launch vehicles, and the International Space Station.

"Some experienced customers working on a program may know exactly what is required, right down to the specific internal materials that we may use. That same experienced customer may have another program in its early requirements stages and they are unsure what radiation levels or even what qualification level of product the application will ultimately require," Pyle describes. "In cases such as this, we are able to provide a wide range of product level offerings and as the program requirements become more defined, we work with our customer to pinpoint which products will best meet the specific needs.

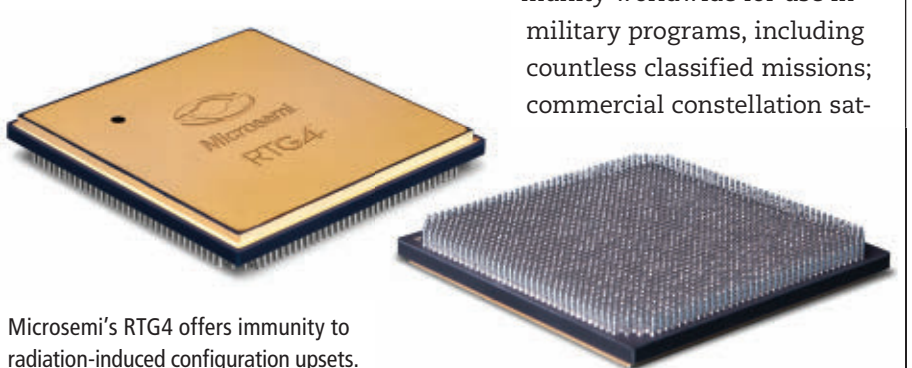
"When other customers are not sure what they need, they typically default to the highest level rad-hard products available and the highest quality level which is MIL-PRF-38534 Class K," Pyle says. "As with all our customers, we work with them to better understand their real needs so they ultimately receive the product that best fits their application without adding unnecessary cost and lead time of the higher-level products."

Time and money

Cost and lead time are two common customer considerations. "As you go from commercial-level material to rad-tolerant material and finally to rad-hard material, cost increases and material lead time increases," Pyle explains. "These increases can have appreciable effects on the program viability. The most frequent bind we see is that the less initiated space customers may use traditional

commercial product lead times in their material scheduling, but that same rad-hard device may have a lead time of 5X. This is why we always encourage customers to place their demand as early in the process as possible.

"We routinely review customer schematics, layouts as well as program requirements, especially for space-level programs," Pyle describes. "This is part of our complimentary services as we know it's critical to catch any potential 'gotchas' or surprises. It's ideal to identify potential snags early on instead of six months in when the customers might learn that they've designed not only the wrong level of product, but the product is already on order."



Microsemi's RTG4 offers immunity to radiation-induced configuration upsets.

"We highly discourage 'sidestepping' the use of rad-hard or rad-tolerant products if radiation performance is required. If you do not need radiation performance, do not use the space-level products and instead select from our broad offering of MIL-PRF-38534 Class H and Class K qualified non-rad products," Pyle advises. "However, if you need rad-tolerant or rad-hard products, the risk of mission failure is very real if you use non-rad material. Space radiation effects are genuine."

Testing technology

"We have seen increased adoption of the established (by-design) radiation-hardened components to mitigate design risks and to minimize time to market," explains Tiva Bussarakons, marketing director for Space Products at International Rectifier, An Infineon Technologies Company, in El Segundo, Calif. International Rectifier has for more than 25 years delivered rad-hard technologies to the space community worldwide for use in military programs, including countless classified missions; commercial constellation satellites; and scientific exploration space programs.

"We have seen increasing needs for expanded test coverage with broader test conditions and increases in sample sizes," Bussarakons says. A product's reliability and performance track records are among the top criteria for any designs, especially those destined for high-radiation environments. "For most instances, these factors would easily outweigh any new technologies and a higher cost of rad-hard technology. Careful trade-offs study and risk assessment/mitigation often are mandatory to build a case for mission success."

Cobham Semiconductor Solutions, a provider of aerospace integrated circuits (ICs), systems, and services in Boston, provides radiation testing

services as well as build-to-specification and build-to-print services, Senior Product Marketing Manager Elaine Gonsalves says.

VPT officials, to better serve the space industry and in response to growing demand for certification and test services, have launched a certified radiation laboratory and testing services facility, VPT Rad. VPT Rad is a 5,000 square-foot radiation laboratory and test services facility in Chelmsford, Mass., designed to serve the radiation and related test needs of aerospace electronics manufacturers. The facility, formerly known as Si-REL, provides specialized environments and equipment for evaluating electronics used in applications where ionizing radiation can degrade device performance, officials say. The VPT Rad facility meets the requirements of MIL-STD-750 and MIL-STD-883, has approved Source Suitability from the Defense Logistics Agency (DLA), and uses European Space Components Coordination (ESCC) 22900 compliant test methods for customers and programs outside the U.S.

"The ever-growing demand of VPT Rad's laboratory and testing services is testament to the growing concerns and considerations of radiation effects of various silicon electronic components in space," Pyle affirms. "The cost of performing a small lot test at VPT Rad is minute compared to a system failure in orbit!"

NASA's Curiosity Mars rover continues making science observations; it has logged 10 kilometers of driving since its 2012 landing.

Deadline demands

Failure is not an option for many missions, so aerospace programs today tend to value systems that are flexible and reprogrammable.

"We are seeing growth, in particular an increased interest in our non-volatile memory solutions as a bulletproof boot solution, not only for processors, but also for field-programmable gate arrays (FPGAs)," Gonsalves says. "There is a lot of interest in supporting re-programmability in space."

Increasingly, engineers designing systems for deployment in harsh environments are adopting field programmable gate arrays (FPGAs). The use of radiation-tolerant (RT) FPGAs has grown dramatically since 1992, when the first FPGA flew in space, says Ken O'Neill, director of space and aviation marketing at Microsemi in Aliso Viejo, Calif.

O'Neill has seen significant growth in the company's global radiation-tolerant FPGA business, especially in North America, Europe, Japan, and India. "It has been linear growth—a straight line going up and to the right—in revenue and numbers shipped. Applications are across the board, commercial satellites, civilian and scientific satellites, navigation satellites, interplanetary orbiters and landers, deep-space probes, military and defense satellites."

Engineers are opting for FPGAs over application-specific integrated circuits (ASICs), which are designed for a specific use. "ASICs, which have long lead times and large non-recurring engineering (NRE) charges, go through long fabrication cycles—and that incurs risk," O'Neill says. "If you're a program manager, you're nervous about finding a late breaking bug or specification change, incurring schedule and cost risks. You don't want to have to pay the tooling charge again. FPGAs protect you from all that. Accomplishing a spec change or fixing a bug is as simple as programming a single part, and is far better than waiting months for ASICs to go through the lab.

"If you're late delivering your system to a satellite integrator, you can be fined for every day that you're late, delaying the launch. In the case of commercial satellite, every day you are late is another day the satellite operator is losing money," O'Neill cautions. "When it comes to a science mission, the repercussions can be even worse. When launching

to Mars, for example, the planets have to be in precise alignment. If you're late with the delivery of your system, you can't launch the satellite to Mars for many more months, until planets come into alignment again. Several Jupiter missions are currently being developed and require optimum planet alignment, which happens only once every few years, to minimize flight time in those long interplanetary missions. FPGAs get around scheduling delays—a risk-mitigation advantage.

FPGA flexibility

FPGAs have become quite sophisticated over time, O'Neill describes. FPGAs, once offering between 1,000 and 2,000 gates of logic, are now measured in millions of gates, he says. In turn, the role of FPGAs has also matured to include more high-performance and demanding responsibilities.

"RT FPGAs have historically been used for command, control, and interfacing applications," O'Neill explains. "Now with the introduction of RTG4, we are seeing the adoption of RT FPGAs for heavy-duty signal processing in payload applications.

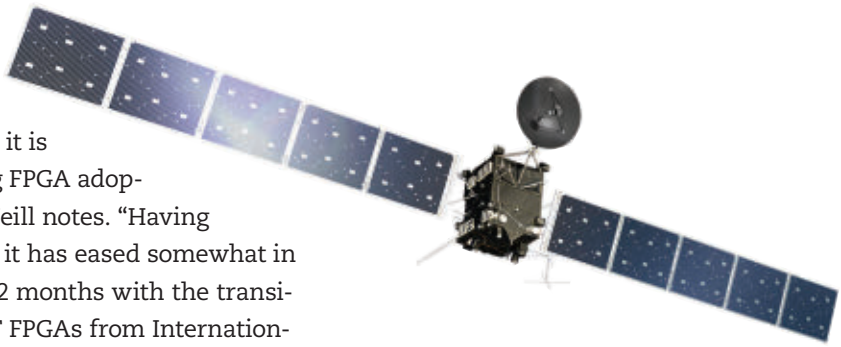
"Science and imaging missions now have sensor data processing taking place onboard satellites, and FPGAs are doing the heavy lifting, the processing, and are used increasingly in the data path," O'Neill adds. "That's the big driver we are seeing for adoption of FPGAs. It's a global trend, with a growing market in North America, Europe, India, and Japan—and a good sales track record in Russia, although sanctions are now in place—for essentially everything: commercial communications and imaging, operations like weather forecasting and meteorology, and civilian and scientific missions. The problems you're solving are the same; the detail of the instruments onboard varies, but the architecture for payload is essentially the same no matter what it is doing. Whether commercial, science, civilian, or military, data is pulled in from a sensor, D/A converters digitize it, and then the heavy-duty digital signal processing (DSP) starts."

Customers are requesting parts that are bigger, faster, and with more features (more memory, multipliers, high-speed transceivers, etc.), O'Neill says. "That's universal for all FPGA consumers, no matter the application area. What RT customers need that other customers don't need are hermetically-sealed ceramic packages, and device manufacturing testing and screening to Mil Std 883 and Mil Prf 38535. Our RT FPGAs are qualified to QML, which is recognized around the world as a gold standard; customers around the world are happy to buy products that are QML qualified."

Flash v. SRAM

O'Neill touts the advantage of Flash-based, rather than Static Random Access Memory (SRAM)-based, FPGAs in space applications. "Next-generation, radiation-tolerant FPGAs eliminate the cost and schedule risks of SRAM," he says.

"SRAM cells are vulnerable to radiation in space," O'Neill says. When



The European Space Agency's Rosetta is the very first mission to rendezvous with a comet.

radiation strikes a part, the SRAM changes state and the device is misconfigured—misbehaving and malfunctioning. A piece of logic in your system not behaving as intended could be catastrophic. For the most part, designers of space hardware are aware of this risk; it is rare for anyone to go into it blindly. They use mitigation techniques, such as requiring triple chip redundancy or continuous monitoring. Then they have to reload the part and that interrupts the mission; you can lose data and opportunities to collect data. Putting it into real terms, the problem is cumbersome design burden. It also increases the size, weight, and power (SWaP) of the solution; you use more parts and they consume more power and board space. It is really a suboptimal way of going about it."

Microsemi RT FPGAs are used in software-defined radios in NASA IRIS and LADEE missions; command and control in the spacecraft and instruments on ESA Rosetta mission; interfacing and control in the telemetry transponder on the European Galileo navigation satellites; and in many systems on the Iridium Next commercial communications satellites. In fact, more than 15,000 of the company's reliable space products—including FPGAs, diodes, transistors, and integrated circuits (ICs)—have been and continue to be used in mission-critical applications over the 10-year, four-billion-mile Rosetta Spacecraft mission by the European Space Agency (ESA), NASA, and technology partners.

Impediments to adoption

"The impediment to adoption of RT electronics around the world is export licensing; it is hindering FPGA adoption," O'Neill notes. "Having said that, it has eased somewhat in the last 12 months with the transition of RT FPGAs from International Traffic in Arms Regulations (ITAR) to Export Administration Regulations (EAR) control; however there are still locations around the world to which exports of RT FPGAs are prohibited. China is biggest potential market that we're currently not able to sell to."

The entire industry is, of course, impacted by the embargo with Russia, but we are seeing good potential both domestically, in Europe, and other International areas, Gonsalves says.

Cost conundrum

Customers are requesting more integrated and innovative solutions while also requiring competitive price points, Gonsalves explains. As a result, Cobham officials "continue to look at appropriate commercial off-the-shelf (COTS) solution identification with optimized flows to meet mission requirements."

Cobham Semiconductor Solutions is expanding its portfolio of off-the-shelf solutions with new bus switches, SSRAMs, and single-board computers. The new boards, Gonsalves says, help to solve "application-specific challenges for command and control applications."

The company is providing its Gen 6 LEON 3FT single board computer for the command and control of weather instruments in both domestic and international missions. "There is also interest in our SBC for some small satellite applications in lower Earth orbit, geostationary orbit (GEO), and also deep-space missions," Gonsalves says. "The density of both volatile and non-volatile memory in a small 3U CompactPCI form factor, while supporting SpaceWire (SpW) interfaces is attractive for many types of missions."

A key market growth area will be in the "Internet in the Sky" missions, which have challenging requirements for cost, schedule, and performance, Gonsalves predicts. "While Cobham understands the cost competitive nature, in particular of high-volume missions, the value of proven technologies to withstand harsh environments for critical applications still needs consideration."

Small satellites

Small satellites, also commonly known as nanosatellites and microsatellites, are big business. Analysts at SpaceWorks Enterprises Inc. (SEI) in Atlanta are currently tracking roughly 1,100 future (2015–2017) nano/microsatellites with masses between 1 kilogram and 50 kilograms in various stages of planning or development.

"The small satellite market continues to flourish, bolstered by increased commercial activity. The commercial sector remains highly interested in using small satellites to provide customers with valuable imagery and data services for a wide

variety of applications," says Elizabeth Buchen, director of SpaceWorks' Engineering Economics Group in Atlanta. Many commercial powerhouses, including Google and SpaceX, are driving to deliver widespread access to the Internet with the help of modern satellite communications technologies and, likely, the launch of myriad small satellites.

The Modular Devices Inc. (MDI) Compact Dual Redundant DC-DC power system with inrush limiting is well suited for scientific payloads.

Space systems engineers at Honeywell are applying their expertise in developing systems for most of the larger satellites orbiting the earth today to improve the performance and reliability of small satellites.

"That means reducing product size, weight, power requirements and manufacturing costs while developing products with the reliability and performance characteristics that enable satellites weighing less than 500 pounds to be cost-effective and achieve their important missions," a representative says. "Smaller satellites are becoming a much larger part of the satellite business, with several major new constellations in various stages of development. In all, these initiatives will place thousands of small satellites in earth orbit."

Honeywell, to meet the needs of this rapidly expanding market, has launched new onboard processing systems that are radiation hardened, offer high throughput, and have modular packaging to support a variety of missions and architectures. As space systems engineers

work on new products to meet the specific needs of small satellites, they're forging partnerships with other Honeywell business units, including those that build aircraft engines, avionics systems, and automotive turbochargers, "to find ways to apply techniques they've perfected to achieving the right balance between affordability and reliability," officials say. They're also actively partnering with other aerospace technology firms.

Orion achievement

NASA's Orion Multi-Purpose Crew Vehicle (MPCV), a deep-space exploration capsule designed to carry as many as four astronauts to or beyond low-Earth orbit via the much-publicized Space Launch System, logged a successful test flight, called Exploration Flight Test 1 (EFT-1), in December 2014.

The Lockheed Martin-built Orion spacecraft launched from Cape Canaveral, Fla., aboard a United Launch Alliance Delta IV heavy rocket and orbited the Earth twice, reaching speeds of 20,000 miles per hour and traveling through belts of intense radiation before enduring a fiery, 4,000 degree Fahrenheit re-entry into Earth's atmosphere. EFT-1 tested technologies that are fundamental to future deep-space missions, says a spokesperson of prime contractor Lockheed Martin, which will use the flight test data to improve Orion's design for future space exploration.

Twice during the test flight, Orion traveled through the Van Allen belt, a layer of intense radiation above Earth's atmosphere, helping to measure the effect of deep-space radiation on the on-board electronics. Honeywell Aerospace designed and developed Orion's command and data handling hardware, navigation systems, and core operating software.

Honeywell Aerospace engineers developed radiation-tolerant Ethernet backbone ASICs as core components of Orion's On-board Data Network (ODN) using TTEthernet switch and end system chip IP cores from TTTech in Vienna, Austria. The ODN multi-hop, redundant backbone network facilitates communication between vehicle management, avionics, power data

units, and other major systems in Orion MPCV. The ODN will also interface to Orion's European Service Module (ESM). These ASICs merge intellectual property (IP) from the core TTEthernet chip with Honeywell IP to create a space radiation-hardened version of TTEthernet, referred to as Time-Triggered Gigabit Ethernet.

Building blocks

Officials at Modular Devices Inc. (MDI), a manufacturer of rad-hard DC-DC converters and rad-hard building blocks for power systems, also are witnessing increased demand for rad-hard components.

"While the DC-DC business is strong, we are seeing more design-ins for the rad-hard building blocks, such as inrush limiters, bus management modules, and active diode ORs," says Steve Summer, president of MDI in Shirley, N.Y. MDI is seeing more activity at the higher level of satellite bus voltages, such as 100 volts DC, 120 volts DC, and even 270 volts DC. "This [trend] is probably due to increased usage of electric propulsion," he says.

Summer cautions aerospace and defense engineers from trying to upscreen commercial parts that are not radiation capable, or relying on radiation shielding in the hope of saving on component cost. "In the end, they will probably be unsuccessful and wind up spending even more money.

"In addition to rad-hard applications for space, we are seeing rad-hard applications in the area of high-energy physics and nuclear power generation," Summer mentions. "These applications demand rad-hard-by-design techniques that are a decade lower in cost than comparable space components."

Much research is happening related to electronics, including robotics, capable of use in harsh nuclear environments, such as in the wake of nuclear explosions. U.S. Navy researchers are working with industry and academia to find new ways to create radiation-hardened COTS electronics able to withstand the effects of radiation from the explosion of nuclear weapons.

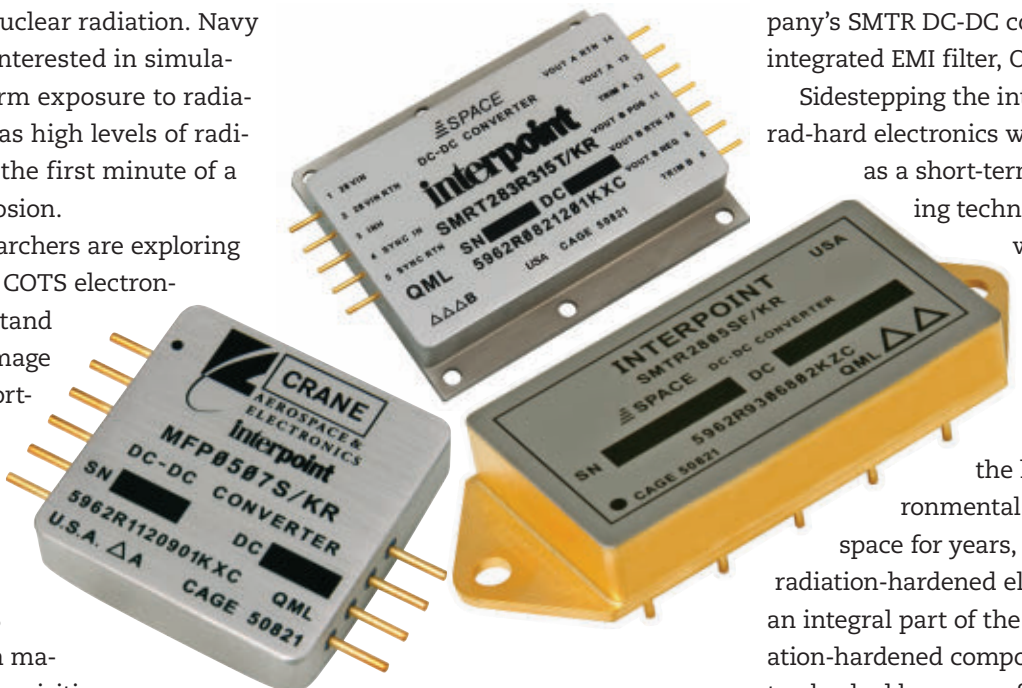
Officials at the Naval Surface Weapons Center in Crane, Ind., have invited organizations to help

evaluate the survivability of COTS electronics that are exposed to the radiation of nuclear explosions. Research will involve evaluating modern electronics when they undergo severe changes in behavior when exposed to nuclear radiation. Navy experts are interested in simulations long-term exposure to radiation, as well as high levels of radiation during the first minute of a nuclear explosion.

Navy researchers are exploring how modern COTS electronics can withstand radiation damage long- and short-term radiation exposure, with an eye to using survivable COTS electronics in major defense acquisition programs. Research also will involve radiation-hardened microelectronic devices such as integrated circuits, ASICs, magnetoresistive random-access memory chips (MRAMs), micro-electro-mechanical systems (MEMs), and FPGAs.

Commercial space

"Commercial satellites, most notably for communication, are driving the demand for radiation hardened electronics," affirms Peter Odell, electrical engineer and lead RHA coordinator at Crane Aerospace & Electronics in Redmond, Wash. Odell is seeing global adoption of rad-hard electronics from China, India, Russia, and European countries as well as the growing U.S. market. "Communication satellites use powerful sensors and processors to capture and process data for telecommunication companies based all around the world. The long life expectancy and orbital location of these satellites require them to have radiation immunity at a minimum of 50 krad(Si) total ionizing dose (TID), and often up to 100 krad(Si). Electronics systems comprising sensors, transponders, and stabilization subsystems all require reliable and stable power to last the entirety of the mission—and rad-hard power modules like Crane Aerospace & Electronics DC-DC converters play pivotal roles in the satellites."



Engineers are adopting Interpoint rad-hard electronics from Crane Aerospace & Electronics for myriad space projects.

Crane's Interpoint brand converters are used in a wide variety of space applications from launch vehicles, space exploration, and commercial and scientific satellites, Odell describes. "The converters are used in critical electrical systems because of their robust design."

The Orion Spacecraft uses Interpoint rad-hard Point-of-Load MFP converters, whereas the Curiosity Mars Science Laboratory uses a variety of Interpoint DC-DC converters and electromechanical interference (EMI) filters, including the company's SMTR DC-DC converter with integrated EMI filter, Odell says.

Sidestepping the integration of rad-hard electronics will only serve as a short-term, money-saving technique, Odell warns. "When an entire mission relies on a robust system that can withstand the harsh environmental conditions of space for years, time-tested radiation-hardened electronics play an integral part of the mission. Radiation-hardened components are often backed by years of research and testing conducted to comprehend the myriad effects introduced in the space environment.

"Our understanding of the space environments is always evolving as new standards and testing are introduced to accommodate the advancement of technologies," Odell continues. "For example, the trend in electronics systems is to implement smaller and faster processors, resulting in lower supply voltage. This leads to higher susceptibility to noise and transients, which are introduced by charged ions prevalent in space called Single Event Effects (SEE). In order to protect these systems, the SEE rating of components is now more important than ever to ensure proper protection from a larger range of ions and energies encountered in space."

New photonics sensor masts to improve submarine stealth and survivability

BY **John Keller**

WASHINGTON—U.S. Navy submarine experts needed improved sensor photonics masts for Virginia-class fast attack submarines to improve stealthiness and survivability. They found their solution at L-3 KEO (formerly Kollmorgen Electro-Optical) in Northampton, Mass. Officials of the Naval Sea Systems Command announced an $111.8 million contract to L-3 KEO to develop deployable prototypes of the Low Profile Photonics Mast (LPPM). With options, the contract could be worth $157 million.

Photonics masts operate in place of the traditional submarine periscope aboard Virginia-class attack submarines. The photonics mast uses various electro-optical sensors, and does not penetrate the submarine hull like a traditional periscope does. Photonics mast sensors connect to the submarine by optical fiber.

The LPPM is a modular non-hull-penetrating imaging sensor in a telescoping universal modular mast bay that provides submarines with improvements in stealth and survivability. Imagery from the LPPM is displayed on high-definition screens aboard the submarine. Features include short-wave infrared (SWIR) and high-definition imaging, laser range-finding, special stealth features, and an antenna suite with broad spectral coverage and direction finding.

The LPPM is a low-observable optical mast that reduces the submarine's risk of detection by enemy submarines and surface warships while the system is in use, while improving the submarine's sensor capability.

Virginia-class attack submarines like the one shown above are receiving new photonics masts to enhance situational awareness and targeting capability.

Navy Chief of Naval Operations Adm. Jonathan Greenert has asked for all Pacific Fleet Virginia-class submarines to be equipped with the LPPM and spare parts for the system to be made available beginning this year to support sensitive missions vital to national security. LPPM prototypes initially were developed without the installation and spares necessary to support deployments and intended only for integration and testing as part of local operations.

Production masts will not be available as fleet deployable assets until 2018. The only way to provide the LPPM capability this year is to employ the LPPM prototypes on all deploying Virginia-class submarines.

L-3 will do the work in Northampton, Mass., and Newington, Va., and should finish by December 2018. ←

FOR MORE INFORMATION contact **L-3 KEO** online at *www.l-3com.com/keo.*

Army scientists seek electro-optical camouflage fabrics

U.S. Army electro-optics experts are reaching out to industry for ideas on how to develop electro-optical camouflaged fabric to help warfighters hide from enemy short-wave infrared (SWIR) sensors. Officials of the U.S. Army Natick Soldier, Research, Development, and Engineering Center (NSRDEC) in Natick, Mass., released a request for technical papers for the Short Wave Infrared Signature Reducing Technology project. Researchers are searching for ways to help warfighters on the ground avoid potentially hostile surveillance using electro-optical sensors.

Night Optics to provide military night-vision devices

U.S. Army night-vision experts needed low-light vision equipment for the Jordanian armed forces. They found their solution at Night Optics Inc. in Huntington Beach, Calif. Officials of the Army Contracting Command at Aberdeen Proving Ground, Md., awarded an $8.8 million contract for 2,000 PVS-14 night-vision monoculars for the Jordanian military under foreign military sales. Internally, Night Optics refers to the PVS-14 military night-vision device as the Sentry 14 night-vision monocular, which is designed to help infantry warfighters navigate in difficult terrain in extremely low-light conditions. Infantry warfighters can use the Sentry 14 electro-optical device as a handheld or hands-free single eye goggle, or as a night-vision weapon system when coupled to a daytime close-quarters battle sight. ←

General Dynamics network encryptor certified top-secret

The U.S National Security Agency (NSA) at Fort Meade, Md., certified the KG-175X TACLANE-10G in-line network encryptor from the General Dynamics Mission Systems segment in Fairfax, Va., for government cyber security use at the Top Secret level and below. NSA certification authorizes U.S. government organizations to order the 10G data encryption device. This newest member of the General Dynamics cyber defense product family, can encrypt the equivalent of a high-definition feature film in moments.

BAE Systems to provide Navy shipboard IFF interrogators

U.S. Navy aviation experts are asking BAE Systems to build identification-friend-or-foe (IFF) interrogators for surface ships and land installations to help identify friendly and potentially hostile aircraft. Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced an $8.5 million contract modification to the BAE Systems Electronic Systems segment in Greenlawn, N.Y., to provide 22 AN/UPX-41 digital interrogators for ships and land sites. For this order, 14 are for the Navy and eight are for the government of Japan.

Four companies to develop affordable sub-reflector-based imaging radar

BY **John Keller**

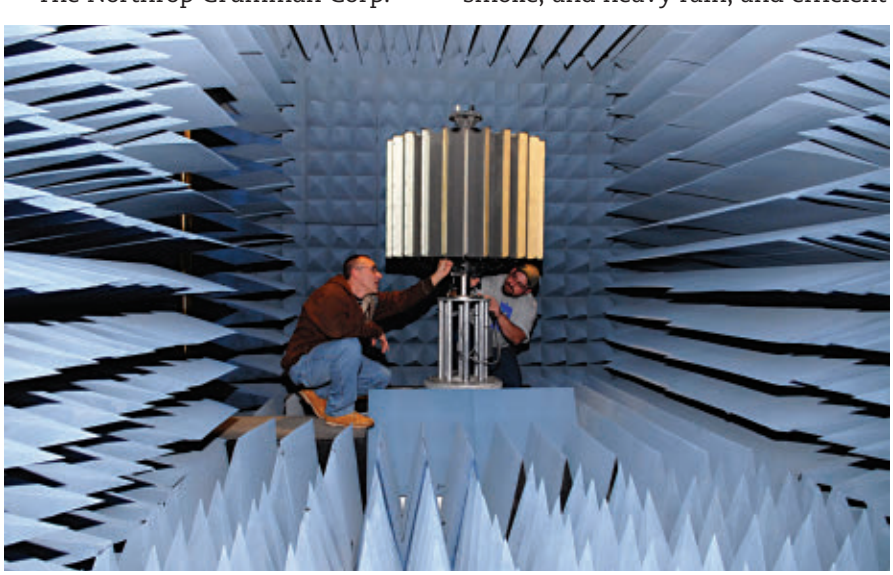
ARLINGTON, Va.—U.S. military researchers have chosen four companies for contracts worth a potential $11.3 million to carry out a project to design new kinds of imaging radar that rely on electronic sub-reflector designs, rather than on a moving platform or target, to perform scanning.

Officials of the Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., are choosing the companies for the Advanced Scanning Technology for Imaging Radars (ASTIR) program that seeks to design a cost-effective imaging radar system with similar performance to synthetic aperture radar (SAR).

The companies are:

- The Northrop Grumman Corp. Electronic Systems sector in Linthicum, Md., which won a $713,256 contract;
- HRL Laboratories LLC in Malibu, Calif., which won a base contract of $881,786, with potential options for $5.9 million;
- First RF Corp. in Boulder, Colo., which won a $499,237 base contract with potential options for $2 million; and
- Vadum Inc. in Raleigh, N.C., which won a $364,141 base contract with potential options for $962,523.

These companies are developing technologies for advanced radar that provides high-frame-rate, three-dimensional (3D) imaging of objects through adverse obscurants like fog, smoke, and heavy rain, and efficient



DARPA is working with four companies to develop new kinds of affordable imaging radar that rely on electronic sub-reflector designs.

beam steering and radar imaging.

ASTIR technology will use one transmit and receive chain and electronic sub-reflector designs that produce a readily available, cost-effective sensor that does not require platform or target motion as in SAR or ISAR, DARPA officials say. The ASTIR concept will minimize system complexity by using a compound antenna with an electronic sub-reflector that works together with a large primary aperture that would define the angular resolution of the radar.

Ways to do this could include replacing an electro mechanically displaced mirror, as currently used in some imaging radars, with a planar electronically reflecting surface for beam steering; using phase-shifters on the sub-reflector to steer a small spot across the main reflector; or digitally modulating each element on the sub-reflector with an orthogonal phase code.

The ASTIR program's goal is to provide high-resolution 3D imaging for enhanced identification and targeting, independent of platform or target motion; well-focused images at speeds faster than 10 frames per second, even when there is no platform or target motion; and beam steering with one transmit and receive chain to reduce system complexity.

The four ASTIR contractors will focus on an electronic sub-reflector for use with a larger aperture to generate 3D images of stationary and moving objects. A government team, meanwhile, will identify potential military applications of this technology.

In 2016 DARPA officials plan to issue another industry solicitation to build prototype imaging radar systems that use the electronic sub-reflector for a specific military application.

This effort to develop a new kind of imaging radar electronic sub-reflector has two technical areas: electronic sub-reflector approaches, which will last for six months; and electronic sub-reflector prototype demonstration, which will last for 18 months.

FOR MORE INFORMATION visit the **DARPA Strategic Technology Office** at *www.darpa.mil/Our_Work/STO*.

Raytheon to build 250 EW drones to defeat enemy missile defenses

U.S. Air Force airborne weapons experts are asking Raytheon to build 250 electronic warfare (EW) jamming drones under terms of a $91.6 million contract. Officials of the Air Force Life Cycle Management Center at Eglin Air Force Base, Fla., are asking the Raytheon Missile Systems segment in Tucson, Ariz., to provide 250 Miniature Air Launched Decoy Jammers (MALD-J), which are relatively simple air-launched unmanned aerial vehicles (UAVs) designed to jam enemy radar. The contract involves lot 8 of the MALD-J missile program. MALD-J is an electronic jamming version of the Raytheon Miniature Air Launched Decoy drone that navigates and operates much closer than conventional EW to the victim radar, Raytheon officials say. The MALD-J EW drone can loiter in the target area for an extended time to help keep manned aircraft out of harm's way. The MALD-J low-cost, air-launched programmable unmanned aircraft that duplicates the combat flight profiles and signatures of U.S. and allied aircraft.

DARPA eyes unmanned sensors to detect and classify surface vessels

U.S. military researchers are surveying industry to find mature electro-optic sensor payload and

Air Force to convert 25 F-16 jet fighters to target drones

BY **John Keller**

EGLIN AIR FORCE BASE, Fla.—Military avionics experts at the Boeing Co. will convert 25 retired U.S. Air Force Lockheed Martin F-16 jet fighters into sophisticated manned and unmanned target drones under terms of a $28.5 million contract.

Officials of the Air Force Life Cycle Management Center at Eglin Air Force Base, Fla., are asking experts at the Boeing Defense, Space & Security segment in St. Louis to handle the conversion of 25 F-16 fighters into QF-16 Full-Scale Aerial Targets (FSATs).

The Air Force has used converted jet fighters as target drones for decades, beginning in the 1960s when the Air Force converted 24 Lockheed F-104 Starfighter jets into target drones. Other U.S. jet fighters, including the F-100, F-102, F-106, and F-4, have become target drones. Air Force experts use converted jet fighters as target drones to test sophisticated missiles and electronic warfare systems. Although some of these retired jet fighter target drones are destroyed during weapons tests, often the drones rely on onboard sensors to calculate the point of missile detonations to record "kills" without destroying the target aircraft.

The order represents lot 3 of the Air Force's planned QF-16 target drone buy. These aircraft are replacing the Air Force's fleet of QF-4 target drones, which are converted McDonnell Douglas F-4 Phantom jet fighters, which were phased

Retired Air Force F-16 jet fighters are getting a second life as sophisticated target drones to help fighter pilots hone their air-to-air combat skills.

out of active service in the 1980s. The newer QF-16s bring a new level of sophistication to U.S. supersonic target drone capability. The F-16 is a fourth-generation fighter, and brings new challenges for weapons testing over the third-generation F-4.

Boeing started converting the first F-16s into QF-16 drones in 2010. Company experts strip down retired F-16 fighters to remove unnecessary parts like the jet's 20-millimeter cannon and APG-66/68 radar. Boeing alters the aircraft to fly unmanned or with human pilots. Boeing also installs a flight termination system that can destroy the drone if it goes out of control, command telemetry systems so the drone can be controlled from the ground, a scoring system to gauge the accuracy of air-to-air missiles fired at the drone, as well as avionics packages to enable these plans to fly unmanned.

This lot-3 F-16 conversion will bring the QF-16 fleet to 76. Air Force leaders are expected to buy a total of 120 QF-16 target drones through 2019. Optionally Air Force leaders are considering buying a total of 2010 QF-16 through 2022. The fleet should last until 2025.

Navy developing swarming drones for overwhelming land and sea attacks

BY **John Keller**

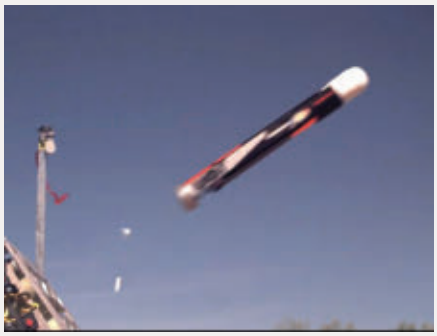
ARLINGTON, Va.—U.S. Navy researchers have demonstrated swarming unmanned aerial vehicles (UAVs) designed to overwhelm an adversary autonomously as the UAVs fly together like flocks of birds.

UAV experts at the U.S. Office of Naval Research (ONR) in Arlington, Va., announced they have conducted recent technology demonstrations of swarming drones as part of the Low-Cost UAV Swarming Technology (LOCUST) program.

The LOCUST program is developing enabling technologies to help sailors and Marines launch overwhelming swarms of reconnaissance and armed UAVs from launchers on land or at sea. The LOCUST program includes a tube-based launcher that can send UAVs into the air in rapid succession. The drones then share information among themselves on a wireless network to coordinate their behavior in defensive or offensive missions, Navy officials say.

Navy researchers are designing UAVs and launchers small enough to operate from surface ships, land vehicles, manned aircraft, other UAVs, or unmanned marine vehicles. Navy researchers also are working on small reconnaissance UAVs that can be launched covertly from submarine missile tubes.

ONR LOCUST demonstrations, held last month in several locations, included Coyote UAVs able to carry varying payloads for different missions. A separate nine-UAV demonstration showed autonomous UAV synchronization and formation flight. Even hundreds of small autonomous UAVs cost less than one manned tactical aircraft; this capability will force adversaries to focus on UAV swarm response.



Navy researchers are demonstrating the ability to launch many small, inexpensive air drones from canisters to create swarms of unmanned aircraft that fly together like flocks of birds.

"This level of autonomous swarming flight has never been done before," says Lee Mastroianni, the LOCUST program manager at ONR. "UAVs that are expendable and reconfigurable will free manned aircraft and traditional weapon systems to do more, and essentially multiply combat power at decreased risk to the warfighter."

ONR officials note that while the LOCUST autonomy is cutting edge compared to remote-controlled UAVs, there will always be a human monitoring the mission, able to step in and take control as necessary.

ONR announced the LOCUST demonstrations last month at the Navy League Sea-Air-Space conference and trade show in National Harbor, Md. ←

FOR MORE INFORMATION visit the **Office of Naval Research** online at *www.onr.navy.mil*.

signal-processing technologies that can help unmanned surface vessels (USVs) detect and classify other surface ships in the area. Officials of the Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a request for information (DARPA-SN-15-27) for the Hardware and Software for Unmanned Vessel Perception project. Unmanned vehicle payload experts in the DARPA Tactical Technology Office are trying to identify sensor systems and image-processing technologies to support automatic real-time surface vessel detection and classification from electro-optical and infrared (EO/IR) and light detection and ranging (LIDAR) sensors.

Boeing Insitu boosts sensor and image processing 2d3 acquisition

Executives of unmanned aerial vehicle (UAV) specialist Insitu Inc. in Bingen, Wash., are boosting their company's expertise in digital signal processing for unmanned sensor payloads with the acquisition of 2d3 Sensing in Irvine, Calif. 2d3 Sensing's software and services are used by the U.S. Air Force and other government and commercial customers. Their products can be found on the Insitu ScanEagle and Integrator UAVs. The acquisition will enable further integration of 2d3 Sensing's video analysis and other capabilities, into Insitu UAVs. Insitu is a subsidiary of the Unmanned Airborne Systems branch of the Boeing Co. Defense, Space & Security segment in St. Louis. ←

PRODUCT applications

ELECTRONIC WARFARE

Transmitters from Cobham chosen for radar jammers aboard Navy EA-18G jets

U.S. Navy electronic warfare (EW) experts are looking to Cobham plc to provide RF transmitters for electronic jammers aboard the Navy EA-18G jet aircraft that are designed to spoof and blind enemy low-frequency radar systems.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced their intention to award a contract to the Cobham plc Advanced Electronic Solutions segment in Lansdale, Pa., to provide low-band transmitters (LBT) for the AN/ALQ-99 jammers on EA-18G aircraft.

The upcoming contract involves the AN/ALQ-99 Low-Band Consolidation (LBC) system now in production. The value of the contract has yet to be determined.

As part of the EA-18G Growler jet's electronic warfare suite, the LBT will provide the capability to jam hostile, low-frequency radar and communications signals in a tactical environment, Navy officials say.

The proposed low-band transmitter contract will call for Cobham engineers to carry out an engineering change to modify the existing LBT system and will include the design, manufacture, integration, and test of the LBC kit.

The effort also will ask Cobham to deliver two test articles to support future qualification and testing of the modified transmitter, as well as applicable technical data.

FOR ADDITIONAL INFORMATION visit **Cobham Advanced Electronic Solutions** online at *www.cobham.com*, and **Naval Air Systems Command** at *www.navair.navy.mil*.

SPACE COMPUTERS

European designers choose Curtiss-Wright data handling for Space Station

European space experts needed data handling equipment for use on the International Space Station. They found their solution from the Curtiss-Wright Defense Solutions division in Ashburn, Va.

Curtiss-Wright won a contract from Kayser Italia S.r.l. in Levorno, Italy, to supply the Curtiss-Wright

Acra KAM-500 data acquisition units for use on the International Space Station's Advanced Closed Loop System (ACLS).

The space electronics contract came from Kayser Italia through Astrium GmbH in Paris and the European Space Agency (ESA) headquarters in Paris. The contract, worth more than $1 million, started in 2012 and Curtiss-Wright should be finished after in 2015 after shipping flight model units.

The Space Station's ACLS will demonstrate European technologies, and eventually will become part of the station's life support system. The ACLS converts carbon dioxide into breathable oxygen.

Two networked Acra KAM-500 units will monitor sensors aboard the Space Station and will interface to the ACLS's onboard avionics supplied by Kayser Italia S.r.l. The prime contractor for the ACLS

is Airbus Defense & Space in Toulouse, France.

The Curtiss-Wright Acra KAM-500 is a compact, low-power data acquisition unit (DAU). It is driven by hardware finite state machines that provide data acquisition for low Earth orbit applications.

FOR MORE INFORMATION visit **Curtiss-Wright Defense Solutions** online at *www.cwcdefense.com*, or **Kayser Italia** at *www.kayser.it*.

VETRONICS

GE to provide rugged computing systems for British Army Scout

Vetronics designers at General Dynamics UK in Bryn Brithdir, Wales, needed embedded computing subsystems for the British Army Scout specialist vehicle (Scout SV). They found their solution from GE Intelligent Platforms in Towcester, England.

General Dynamics UK has made about $100 million worth of orders to GE for scalable, open-architecture subsystems, which include Ethernet switches, gateway processors, data servers, and video servers.

GE's embedded systems will enable low Scout SV platforms to be easily upgraded during their lifetime as new requirements and technologies emerge, GE officials say.

These subsystems provide the backbone of the Scout SV's vehicle electronics (vetronics) architecture. The Ethernet switch connects the networked elements of the vehicle together; the gateway processor provides processing for the General Dynamics UK software to run the platform; and the data and video servers enable the vehicle to store and distribute data and video around the platform and on into the wider connected battlefield.

The GE offering took advantage of two GE capabilities. GE's close working relationship with NVIDIA and its expertise in developing and deploying rugged graphics processing unit (GPU) technology that helped GE meet the Scout SV's size, weight, and power (SWaP) constraints.

GE designers also were able to use their company's OpenWare switch software to help optimize the vehicle's network to Scout SV requirements.

FOR MORE INFORMATION visit **GE Intelligent Platforms** at *www.geautomation.com*, or **General Dynamics UK** at *www.generaldynamics.uk.com*.

DISPLAYS

Argon flat-panel sonar displays to replace CRTs aboard submarines

U.S. Navy submarine sonar experts needed flat-panel color displays to replace old-model cathode ray tube (CRT) displays for sonar technicians aboard U.S. submarines. They found their solution from Argon Corp. in Great Neck, N.Y.

Officials of the Naval Undersea Warfare Center Division in Newport, R.I., announced their intention to purchase Argon 17-inch ruggedized display units in support of the Submarine Fleet Maintenance Activities and NAVSUP.

These displays are to upgrade

all legacy CRT sonar displays in the fleet, Navy officials say. The displays will be upgraded with new flat panel technology, increased display size within the same physical footprint, lower power consumption, and air-cooling instead of water-cooling.

For this order, Navy officials expect to order 10 displays with an option for five more. The order will sole-source because Argon makes the only displays that are 100 percent form-, fit-, and function-compatible with the CRT sonar displays they will replace in the Navy's submarine fleet.

Argon displays also are shock tested to comply with Navy submarine requirements for shock, vibration, and other harsh operating conditions found aboard Navy fast-attack and ballistic-missile submarines.

Argon produces the ARD17 rugged 17-inch display that is suitable not only for submarine sonar displays, but also for command and control console applications where space is at a premium, such as in military tactical vehicles, mobile shelters, and other close-in naval spaces.

The ARD17's small bezel size, flexible mounting configurations, configurable I/O, and universal AC/DC power supply make it a solution for many mission-critical applications, Argon officials say.

FOR MORE INFORMATION visit **Argon Corp**. online at *www.argoncorp.com*.

new PRODUCTS

To submit new products for consideration, contact John Keller at jkeller@pennwell.com.

DATA STORAGE

Secure solid-state drives with encryption and self-destruct introduced by Microsemi

Microsemi Corp. in Phoenix is introducing a secure 64-gigabyte solid-state drive (SSD) for embedded computing in harsh environments where data protection is of the utmost importance. The secure data storage device can overcome malicious attack concerns with Microsemi's factory firmware lockdown technology to prevent covert firmware repurposing. Offered in a 32-by-28-millimeter ball grid array (BGA) package, the SSD is a self-encrypting drive. For sensitive applications, the encryption key can be erased in less than 30 milliseconds and a second security layer can be activated to erase the entire storage media in less than 10 seconds, virtually rendering data forensically unrecoverable.

FOR MORE INFORMATION visit **Microsemi** online at *www.microsemi.com*.

RF AND MICROWAVE

Ku-band iso-divider RF and microwave unit for space applications introduced by Crane

The Crane Aerospace & Electronics Microwave Solutions segment in Chandler, Ariz., is introducing the

8-way Ku-band iso-divider RF and microwave unit for space applications. The unit combines the functions of high-performance power dividers with ferrite isolators to provide a high-isolation power divider solution, making the external isolators redundant, for satellite receiver applications. Integrating the two functions into one package enhances product reliability due to fewer external components, interconnects, and switches, Crane officials say.

FOR MORE INFORMATION visit **Crane Aerospace & Electronics Microwave Solutions** online at *www.craneae.com/Products/Microwave*.

BOARD PRODUCTS

3U and 6U VPX embedded computing boards with server-class processors introduced by X-ES

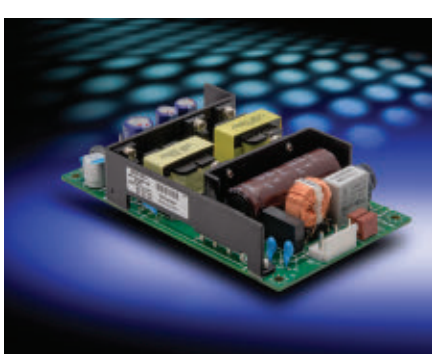
Extreme Engineering Solutions Inc. (X-ES) in Middleton, Wis., is introducing the XPedite7670 3U OpenVPX REDI single-board computer and the XCalibur4640 6U VPX single-board computer for military and aerospace embedded computing applications. The embedded computing boards are based on the Intel Xeon D server-class processor with support for as many as eight Xeon cores and two channels of ECC memory. Dual integrated 10 Gigabit Ethernet ports natively support XAUI/KX4/KR to further enhance I/O capabilities, while reducing concerns for size, weight, power consumption, and cost.

FOR MORE INFORMATION visit **X-ES** online at *www.xes-inc.com*.

POWER ELECTRONICS

Low-profile power supplies for industrial applications introduced by TDK Lambda

TDK-Lambda Americas Inc. in San Diego is introducing CUT75 low-profile, triple output power supplies for test and measurement, industrial, and broadcast applications. The power suppliers come in the industry-standard, 3-by-5-inch footprint, and measure 1.06 inches high. Operating from a universal input voltage of 85 to 265 volts AC, the CUT75 is available in two standard models. The units can be configured as dual-output power supplies (5-to-24-volt or 5-to-30-volt) by connecting outputs 2 and 3 in series. Options



for the product include a cover, baseplate, or screw terminal blocks replacing plug-in type connectors.

FOR MORE INFORMATION visit **TDK Lambda** t *www.us.tdk-lambda.com*.

RUGGED COMPUTERS

Rugged mission computer for image and signal processing introduced by Curtiss-Wright

Curtiss-Wright Defense Solutions in Ashburn, Va., is introducing the MPMC-9355-0002 multiplatform mission computer for image, signal, and radar processing aboard military and commercial aircraft and ground vehicles. Users can configure the five-slot 3U OpenVPX rugged mission computer with as many as four 2.1 GHz VPX3-1257 3U OpenVPX single-board computers, each with a quad-core 3rd Generation Intel Core i7 processor. Connecting the MPMC's computer boards is a managed Layer 2 Ethernet switch and a PCI Express backplane infrastructure. The VPX3-652 Ethernet switch supports as many as eight external Gigabit Ethernet connections for inter-system communication.

FOR MORE INFORMATION visit **Curtiss-Wright Defense Solutions** online at *www.cwcdefense.com*.

TEST AND MEASUREMENT

Oscilloscopes to help circuit designers introduced by Keysight

Keysight Technologies Inc. in Santa Rosa, Calif., is introducing the Infiniium V-series oscilloscopes for circuit designers and engineers to make rapid progress from first silicon to eventual product release. The oscilloscopes range from 8 to 33 GHz. When engineers are designing high-speed digital products or components, they need a test and measurement oscilloscope to help them debug, validate and optimize their designs, perform precompliance tests, discover the root cause of failures, and make the most of design margins. The Infiniium V-series offers engineers the capability to perform these tests faster and more accurately, allowing them to get their products to market faster and with more confidence in design quality.

FOR MORE INFORMATION visit **Keysight Technologies** online at *www.keysight.com/find/Vseries*.

AVIONICS DATABUSES

Interface computer introduced by DDC to develop MIL-STD-1553 and ARINC 429 system applications

Data Device Corp. (DDC) in Bohemia, N.Y., is introducing the Avionics Interface Computer (AIC), a scalable, programmable, and portable platform to develop and test MIL-STD-1553 and ARINC 429 system applications via an Ethernet network. The AIC has two PMC and two Mini-PCI Express expansion sites that enable users to select interface boards optimized for their applications and connectivity needs. An onboard Intel Atom E3845 Quad Core 1.91 GHz processor provides programming flexibility and simplifies connectivity by automatically bridging messages in real-time between Ethernet, ARINC 429, and MIL-STD-1553.

FOR MORE INFORMATION visit **DDC** online at *www.ddc-web.com*.

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Unlocking The Insights That Inspire Your Next "Eureka!" Moment—Sooner

Mark Wallace
Vice President and General Manager
Keysight Technologies, Inc.

For more than 75 years we have been helping you unlock measurement insights, first as the electronic-measurement businesses of Hewlett-Packard and Agilent Technologies, and now, as Keysight Technologies.

From Day 1, there have been two sides to the story. One is the work we do, creating leading-edge instrumentation and software. The other is the work you do: designing, developing, debugging, troubleshooting, manufacturing, testing, installing and maintaining components, devices and systems.

Those seemingly unrelated activities are actually connected by something profound: the "A-ha!" that comes with a moment of insight. When those happen for us, the results are innovations that help you reach new breakthroughs.

Enabling the right idea at the right time

This is our legacy. Keysight is a company built on a history of firsts, dating back to the days when Bill Hewlett and Dave Packard worked in the garage at 367 Addison Avenue in Palo Alto, California. Our firsts began with U.S. patent number 2,268,872 for a "variable-frequency oscillation generator." Appropriately, the heart of Bill's design was a light bulb, which is often used to symbolize a new idea.

Our future depends on your success, and our vision is simple: by helping engineers find the right idea at the right time, we enable them to bring next-generation technologies to their customers—faster.

Keysight's leading-edge measurement tools and sophisticated, future-friendly software cover all phases of the 5G development cycle.

Offering expertise you can leverage

This is happening in aerospace and defense applications where increasingly realistic signal simulations are accelerating the development of advanced systems that protect those who go in harm's way. It's happening in research labs where our tools help turn scientific discovery into the discovery of new sciences.

It's taking place with 400G Ethernet and the enabling PAM-4 technology, where our end-to-end solution ranges from simulation of new designs to characterization of hardware inputs, outputs and connectors. And in wireless communications we're providing leading-edge measurement tools and sophisticated, future-friendly software that cover all phases of the 5G development cycle.

Within these application areas, there are often more standards than a single engineer can keep up with. That's why so many of our people are involved in standards bodies around the world. We're helping shape those standards while creating the tools needed to meet the toughest performance goals.

Through our global presence, we also have measurement experts near you: our application engineers have the skills and experience to help you unite the hardware and software solutions that meet your unique requirements.

Helping inspire your next breakthrough

To help Keysight customers continue to open new doors, we're concentrating our effort and experience on what comes next in test and measurement. Our unique combination of hardware, software and people will help enable your next "A-ha!" moment, whether you're working on mobile devices, cloud computing, semiconductors, renewable energy, or the latest glimmer in your imagination. Keysight is here to help you see what others can't, and then make it reality—sooner.

KEYSIGHT TECHNOLOGIES