JUNE 2016

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Nuclear disarmament

Would ridding ourselves of nuclear weapons really lead to a safer world? PAGE 2

Rad-hard space electronics

Cost and time-to-market pressures lead to new options in shielding, upscreening, and system redundancy. PAGE 16

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Robots hit the ground running

Machine autonomy yielding optionally driven vehicles and military trucks that operate on their own. PAGE 8

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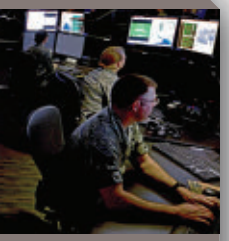

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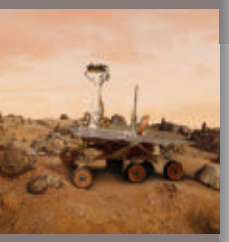

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BY **JOHN KELLER**, EDITOR IN CHIEF

Nuclear disarmament and the likelihood of global military conflict

Nuclear events on the world stage give me an unsettling feeling of dread. It's not so much signs of approaching conflict (although there's that, too) but what worries me are indications that potential adversaries are operating in separate realities.

U.S. President Barack Obama is making plans to visit the Japanese city of Hiroshima, site of the world's first nuclear attack, and one of two atomic bombing missions that ended World War II. The trip itself is the kind of thing a president in his last year in office ought to do; yet it's the visit's role in Obama's stated goal of global nuclear disarmament that's keeping me up at night.

Is the notion of global nuclear disarmament a worthy goal? Maybe, and maybe not. Moreover, one country on its own can't pursue nuclear disarmament when plenty of other nations that have the Bomb. There's too much at stake in the global nuclear chess game, and one power that walks away from the table could encourage others into nuclear mischief, or worse.

Obama authored a column in *The Washington Post* headlined "How we can make our vision of a world without nuclear weapons a reality." It outlines the president's plan "to strive for our vision of the world as it ought to be," without nuclear weapons.

Maybe that's not such a bad idea; yet, at the same time, I have seen other recent headlines that read, "Russia to test unstoppable 'Satan 2' stealth nuke capable of wiping out an entire nation," "China scrambles fighters as U.S. sails warship near Chinese-claimed reef," and "Russian army to start taking deliveries of next-generation battle tank that outguns M1 Abrams."

Here's the point: The world's a dangerous place, powerful U.S. adversaries are arming with the latest nuclear and conventional weapons, Iran is close to developing a nuclear bomb (if it doesn't have one already), and North Korea is moving forward to develop submarine-launched ballistic missiles capable of delivering nuclear warheads virtually anywhere.

The world is less stable than it's been since the Cuban Missile Crisis of 1962, and our president is talking about nuclear disarmament. If Obama thinks the U.S. can disarm unilaterally and the rest of the world will fall into line, he's sadly mistaken. On the face of it, I shouldn't criticize Obama for his desire to rid the world of nuclear weapons. He begins his *Washington Post* column with the words, "Of all the threats to global security and peace, the most dangerous is the proliferation and potential use of nuclear weapons."

Who would disagree? At the same time, one could argue that the very existence of nuclear weapons over the past 70 years has prevented the kinds of global conflagrations we saw in World War I and World War II. Have the nuclear weapons we so fear kept the world in check for more than half a century? What happens if we get rid of all nuclear weapons? Would the world truly be a better place? On the contrary, I believe a world without nuclear weapons would make global warfare far more likely.

The U.S. dropped nuclear bombs on two Japanese cities in August 1945. While these acts ended WWII and compelled the Empire of Japan to surrender, they did more than that. The first half of the 20th Century saw two of the world's largest and bloodiest wars precisely for the reason that starting a world war was conceivable. After those atomic bombs fell, that notion flipped; it became inconceivable for a country to start a world war because it would mean national suicide. With the nuclear attacks on Hiroshima and Nagasaki, the U.S announced to the world that war on a global scale was finished. No more.

With the president's upcoming trip to Hiroshima in mind, I'd hate to see him apologize for that. Maybe ridding the world of nuclear weapons isn't such a simple thing after all.

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DARPA RSGS program eyes space robot to maintain geosynchronous satellites

BY JOHN KELLER

ARLINGTON, Va. — U.S. military researchers are asking industry to develop a space robot to be based in geosynchronous Earth orbit (GEO) to repair, maintain, and upgrade satellites operating in this high-altitude and difficult-to-reach orbit.

This artist's rendering depicts a future space robot for basing in geosynchronous orbit to repair, maintain, and upgrade satellites.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a solicitation (DARPA-PS-16-01) for the Robotic Servicing of Geosynchronous Satellites (RSGS) program. The RSGS seeks to create a dexterous robotic capability able to provide persistent robotic servicing capabilities in GEO — the orbit 22,000 miles above the Earth's surface in which geostationary satellites operate.

The program will begin by creating a robotic servicer operated by a commercial company, and ultimately will establish an enduring, reliable, cost-effective GEO satellite servicing presence, DARPA officials say. DARPA experts want a U.S. space industry team to build, own, and operate a robotic servicing vehicle in or near GEO. This space vehicle will integrate a government-provided payload, provide communications with the ground, and operate the vehicle commercially for many years.

The idea is for the servicing robot owner to make money by servicing commercial and government GEO satellites. Most damaged or disabled spacecraft operating in GEO are not recoverable or fixable, and often are left to drift uselessly in space.

Robotic servicing capabilities should include inspecting functional spacecraft with anomalies; correcting mechanical problems like solar array and antenna malfunctions; moving satellites to different orbits; fixing malfunctioning propulsion systems; and upgrading satellites with new capabilities. The target date to launch the robotic servicer on a government-furnished rocket to or near GEO for demonstration is spring 2021. This demo is to validate the robotic servicer's readiness for commercial use.

DARPA experts aim to choose the RSGS team by the end of January 2017. Companies interested should submit summaries to DARPA online at https://baa.darpa.mil no later than 5 June 2016. Full proposals will be due at a later time. E-mail questions to DARPA-PS-16-01@darpa.mil.

MORE INFORMATION IS online at http://1.usa.gov/1TIohJs.

IN BRIEF

DARPA taps companies for Gremlins swarming drones program

Dynetics Inc. in Huntsville, Ala.; General Atomics Aeronautical Systems Inc. in San Diego; and Lockheed Martin Aeronautics in Fort Worth, Texas, have joined the Composite Engineering Unmanned Systems Division in Sacramento, Calif., in a U.S. military research program that seeks to build swarms of drone aircraft. U.S. Defense Advanced Research Projects Agency (DARPA) officials in Arlington, Va., hired the companies for the first phase of the Gremlins program, which will rely on relatively inexpensive unmanned aerial vehicles in volley quantities to saturate enemy defenses. DARPA Gremlins will use military C-130 aircraft to launch drone swarms of networked and cooperating unmanned aircraft for electronic attack and reconnaissance missions from standoff ranges, and recover surviving drones when their missions are completed.

Navistar to repair and upgrade as many as 450 MRAP military vehicles

Armored combat vehicle experts at Navistar Defense LLC in Lisle, Ill., will rebuild and upgrade 250 mine-resistant ambush protected (MRAP) military vehicles and vetronics systems under a $29.8

million contract modification. Officials of the Army Contracting Command in Warren, Mich., are asking Navistar to reset and upgrade 250 MRAPs, with an option for an additional 200 vehicles. MRAP is a wheeled armored personnel carrier with a V-shaped hull designed to deflect the energy from improvised explosive devices (IEDs) detonated from beneath the vehicle. MRAP vehicles use such electronic subsystems as rugged Gigabit Ethernet switches from Aeronix in Melbourne, Fla. and from Sixnet in Ballston Lake, N.Y.; Falcon II AN/VRC-104 HF military radio from Harris RF Communications in Rochester, N.Y.; smart display units from General Dynamics Canada; and infrared night-vision driver's vision enhancers from DRS Technologies and BAE Systems.

Iron Bow to replace old networking equipment with IP-based upgrade

Officials of the Army Contracting Command in Alexandria, Va., announced a $10.4 million contract to Iron Bow in Chantilly, Va., to replace the Army's Asynchronous Transfer Mode (ATM) and Synchronous Optical Network (SONET) infrastructure at the Army's Camp Humphreys near Anjeong-ri and Pyeongtaek, South Korea with Internet Protocol (IP)/Multiprotocol Label Switching (MPLS) equipment.

Exelis turbo-charges intelligence signal-processing with supercomputer power

BY JOHN KELLER

HANSCOM AIR FORCE BASE, Mass. — Military surveillance experts at Exelis Inc. in Herndon, Va., will add high-speed InfiniBand networking capability to a U.S. Air Force intelligence imagery-distribution and signal-processing system under terms of a $10.4 million contract modification.

Officials of the Air Force Life Cycle Management Center at Hanscom Air Force Base, Mass., are asking Exelis, a wholly-owned subsidiary of Harris Corp., to provide an InfiniBand wide-area network high-speed transport layer and data usage and dissemination capabilities to the Air Force Distributed Common Ground System (AF DCGS). The AF DCGS, also called the AN/GSQ-272 Sentinel weapon system, is the Air Force's primary system for intelligence, surveillance, and reconnaissance (ISR) planning and direction, collection, processing, exploitation, analysis, and dissemination.

The AF DCGS produces intelligence from information taken from the U-2 manned high-altitude reconnaissance aircraft, as well as from the RQ-4 Global Hawk, MQ-9 Reaper, and MQ-1 Predator unmanned aerial vehicles (UAVs), and other intelligence platforms. With computers and software connected on a network, it processes and disseminates images and other information from the manned and unmanned reconnaissance aircraft.

The system uses a global communications architecture that connects several intelligence platforms and sensors. Airmen assigned to AF DCGS produce actionable intelligence from data collected by a variety of sensors on the U-2, RQ-4 Global Hawk, MQ-1 Predator, MQ-9 Reaper, and other ISR platforms. The AF DCGS has 27 different globally networked sites, and is capable of sensor tasking and control. It can support several ISR platforms in several theaters of operation simultaneously.

Exelis tactical networking experts will provide the AF DCGS with a direct feed of information without going through a third party; increased speed for data collection and processing; and a cloud computing architecture, while supporting growing technologies, Air Force officials say.

This deal is a modification of a $13.2 million contract the Air Force awarded to Exelis last December for the Air Force Distributed Common Ground System Distributed Mission Site Reference Imagery Transition program. December's contract asked Exelis to use the InfiniBandC wide-area-network, high-speed transport layer and data storage and dissemination capabilities of the Peregrine high-performance computer (HPC) at the National Renewable Energy Laboratory (NREL) in Golden, Colo., for the AF DCGS.

The NREL's Peregrine high-performance computer architecture has 6,912 Intel Xeon E5-2670 SandyBridge processor cores; 24,192 Intel Xeon E5-2695v2 IvyBridge processor cores; and 27,648 Intel Xeon E5-2670v3 Haswell cores. This total of 58,752 Intel Xeon processor cores provide about 1.68 quadrillion floating point operations per second (PetaFLOPS) of processing power.

The Air Force Distributed Common Ground System (AF DCGS) will receive supercomputer upgrades to speed intelligence imagery distribution and signal processing.

Peregrine also has 576 Intel Phi many-core co-processors with an aggregate performance of about 582 trillion floating point operations per second (TeraFLOPS). In total Peregrine is capable of 2.26 PetaFLOPS.

Peregrine nodes are connected on a 56-gigabit-per-second InfiniBand network. The supercomputer runs the Linux operating system and has a dedicated Lustre file system with about 2.25 petabytes of online storage and an initial capacity of 3 petabytes of mass storage.

In addition to Exelis, AF DCGS contractors include Raytheon, Lockheed-Martin, L-3 Communications, Northrop Grumman, Leidos, UTAS, Houston-Fearless, Booz Allen Hamilton, TASC, MITRE, General Dynamics, and CSRA Inc. (formerly SRA International).

On this contract modification, Exelis will do the work at separate DCGS locations and should be finished by July 2017. ←

FOR MORE INFORMATION visit **Exelis** online at *www.exelisinc.com*, or the **Air Force Life Cycle Management Center** at *www.wpafb.af.mil/aflcmc*.

Anti-tamper program to protect weapons from theft and reverse engineering

BY JOHN KELLER

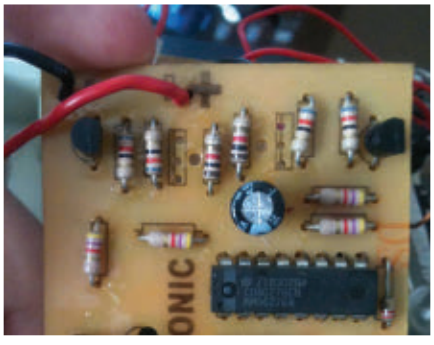
WRIGHT-PATTERSON AFB, Ohio — U.S. Air Force researchers are asking industry for new anti-tamper technologies to help safeguard U.S. military weapon systems from exploitation, reverse engineering, technology theft, and countermeasures. Officials of the Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, have issued a broad agency announcement (BAA-AFLCMCX-ZZ-2016-0001) for the AFLCMC/XZZ Anti-Tamper program.

Military leaders need anti-tamper technology to prevent U.S. military secrets from falling into enemy hands from the capture or loss of sensitive military electronics that contain sensitive information or advanced component technologies. The 5-year program seeks to mature anti-tamper technologies in: secure commercial-off-the-shelf (COTS) architectures; secure COTS processor solutions; anti-tamper sensor technology; and anti-tamper enabling technology.

Secure COTS computing architectures involves the exploitation of critical program information from systems assembled from COTS parts. This kind of technology will be compatible with defense industry open-architecture designs to enable upgrades of unsecure systems to more secure versions. Secure COTS processor solutions involves technologies to enable secure field-programmable gate array (FPGA) software that resides on programmable hardware to protect critical program information at rest and during runtime from known exploitation techniques.

Anti-tamper sensor technology would offer anti-tamper protections to new or legacy military systems, including enclosures, packaging, and sensors that can protect critical program information at the system, board, or component level.

Anti-tamper enabling technology, meanwhile, will support development of secure COTS architecture processors when integrated into new or existing components that can support a secure system.



Air Force researchers are searching for new ways of securing COTS electronic technologies from tampering, theft, and reverse engineering.

Air Force experts want to award several contracts, each worth between $500,000 and $2 million, in the AFLCMC/XZZ Anti-Tamper program. The entire program should spend about $49 million. Contractors chosen must have valid security clearances. Companies interested should e-mail questions or submit white papers no later than 30 June 2016 to the Air Force's Timothy Gicale at timothy.gicale@us.af.mil. The Air Force will invite formal proposals for the most promising ideas.

MORE INFORMATION IS online at *https://www.fbo.gov/notices/c3167f99821779e274542e6550d7efcc.*

Robotic technologies for the future land warrior

The latest enabling technologies for machine autonomy are yielding applications ranging from optionally driven land vehicles and military trucks that follow on their own, to robotic exoskeletons that give warfighters super powers.

BY **J.R. Wilson**

Predictions during the past century had it that aviation would dominate future combat, that tank warfare has become obsolete, and that "boots on the ground" are only necessary for post-combat mop-up operations. So far, those predictions have proven less than accurate, despite the importance of air dominance and asymmetric insurgent warfare in which tanks have very limited roles.

Electronic warfare (EW) and cyber warfare also are growing in importance, offensively and defensively.

At the same time, however, infantry remains the backbone of U.S. military power once an enemy has been engaged, no matter the size, shape, location, or environment of the battlespace. Even so, U.S. Army and Marine Corps warfighters in 2016 bear little resemblance to their predecessors of even 20 years ago.

It is an evolution — if not a revolution — that will continue into the foreseeable future, with greater reliance on robotic systems to help the human warrior accomplish his mission more quickly, efficiently, and successfully with reduced personal endangerment or collateral damage.

Ground robotics are older than most people realize. Nazi Germany and the Soviet Union deployed rudimentary, tele-operated robots during World War II; Germany had the wire-controlled Little Goliath, while the Red Army fielded two battalions of radio-controlled "teletanks."

Soviet forces used the teletanks against Finland in the "Winter War" of 1940, but retired them after the two nations signed a treaty. Turns

An unmanned ground vehicle is put through its paces at a testing facility in West Palm Beach, Fla.

out the teletanks lacked protective armor or adequate armament to go against German tanks.

Nazi armed forces used the Goliath more widely throughout the war to destroy Allied tanks, disrupt infantry formations, and blow up bridges and buildings with the 220-pound high explosives it carried. Designed to self-destruct during its mission, the 5-foot-long, 3-foot-wide "beetle tank" (as it was called by the Allies) had a range of only 2,130 feet, the length of its longest control wire. That combined with its high cost, slow speed, poor ground clearance, vulnerable control cables, and thin armor to limit the robot's success, leading to its ultimate demise with the defeat of Nazi Germany.

The U.S. Army military line-haul tractor with the Autonomous Mobility Appliqué System offers driver-assist or autonomous features like leader-follower.

History's lessons

Having observed the German and Soviet efforts, experts at the U.S. Army Tank Automotive Research, Development, and Engineering Center (TARDEC) in Warren, Mich., began researching ground robotics in the 1950s, starting with Little David. The purpose-built, tele-operated 4-wheel drive platform about 6 feet long, 2 feet wide, and 2 feet high, was demonstrated with a weapons system, a camera for situational awareness, and casualty evacuation capability.

To many, combining "military" and "robotics" conjures visions of Hollywood's *The Terminator* — and for some other nations, especially Russia, that is truer than it is for the U.S. and most of its allies. While the Russians have made no secret of their desire to field an army of lethal autonomous robots, the U.S. continues to move forward on semi-autonomous, man-in-the-loop systems that significantly improve the range, firepower, situational awareness, and overall capabilities of soldiers and Marines.

One of the key elements is manned and unmanned teaming, with humans and robots working seamlessly as partners, assisted by unmanned air and ground platforms working together, just as manned air and ground systems do today.

"During the past 15 years of war in Southwest Asia, you saw commercial robots being brought in, mostly fixed on explosive ordnance disposal," says Robert Sadowski, Army Chief Roboticist at TARDEC. "But we've come a long way since then. In response to the IED [improvised explosive device] challenge, we started looking at how to automate logistics. So the technologies we've been working on are how to take an old analog Army truck and turn it into not only a digital vehicle with all the modern safety features (auto braking, object detection, etc.) but put an autonomy kit on top of that — AMAS [Autonomous Mobility Applique System].

"If I have a convoy, I can remove the human drivers from trucks carrying ammo and other explosives," Sadowski continues. "That's fairly well along, with spinout 1.2 going to Army demonstration this fall. There will still be a driver in the lead, but using leader-follower technology, we can remove drivers from the others. Those vehicles run about 50 to 100 meters apart, so if one truck is hit, it doesn't take out the whole convoy. You also have to 'sensor' the vehicle in front of you to keep the proper pace and spacing. And if you need fewer soldiers to do that job, you can increase their presence elsewhere."

Finding explosives

The first major 21st Century U.S. efforts in ground robotics centered on the need to inspect vehicles for explosives at security checkpoints in Iraq and Afghanistan; locate — and later deal with — improvised explosive devices (IEDs); and inspect abandoned buildings, caves, and the other side of obstacles without endangering human warfighters.

Those were all small robots, some tethered, capable of carrying only minimal sensor payloads or manipulator arms, yet their value soon made them integral parts of small combat units. Throughout the wars in Southwest Asia, however, military, academic, and industry researchers worked on a wide range of robotic concepts, including:

- small "dogs" or "mules" to follow humans on patrol or in combat, carrying extra supplies as well as reducing the load carried by the warfighters themselves;
- mid-size vehicles (in the same general size as a Humvee) to support larger unit logistics and provide medevac capability, improved communications, and sensor technologies — and possibly to serve as weapons platforms;

- unmanned tanks and other armored vehicles for first engagements with the enemy; and
- unmanned logistics trucks to remove human convoy drivers (and their guards) from harm's way.

Infantry warfighters today must carry much heavy equipment onto the battlefield, so TARDEC researchers have worked on projects like the Squad Mission Support System (SMSS), Ground Unmanned Support Surrogate (GUSS), Multipurpose Unmanned Tactical Transport (MUTT), and a squad multipurpose equipment transport called Protector to help them out, says TARDEC's Sadowski.

The SMET enables infantrymen to take a lot off his back, for example, which reduces fatigue and increases the amount of equipment he can carry. Experts have field tested the SMET in the Arctic and the jungle, which revealed that some things work better than others in different places.

Helping warfighters

"We also have a platform that can carry more than just the soldier's load, such as weapons, giving a small unit greater fire power than they've ever had," Sadowski says. We've been doing testing with that, all man-in-the-loop, that allows the robot to go around the corner and lay down fire rather than risking a human warfighter. But they need to be easy to operate, so the soldier can view the robot as a teammate."

Autonomy is a controversial element in the future of combat robotics, from technological and operational perspectives. While other nations are pursuing fully or semi-autonomous weapons systems, the U.S., so far, has elected to maintain a man-in-the-loop requirement for "pulling the trigger," focusing its autonomous developments in the areas of guidance and navigation.

"Autonomous systems are not functionally reliable in terms of performing basic tactical tasks in relevant environments," warns Dan Rogers, autonomous program manager at General Dynamics Land Systems in Sterling Heights, Mich. "Even if the tasks are simple, they must be performed to standard in relevant

conditions. The problem with autonomous systems in a tactical setting is, if the utility ends up being less than advertised, the burden of owning, operating, and maintaining the autonomous system overwhelms the benefits of the added utility. The primary challenges associated with tactical mobile ground robotics are perception and communications; perception is the weakest link in the technology, [but] communications is a close second.

"The key to effective decision-making is intelligence — and machine learning is the proper perception to feed those automated thinking machines," Rogers continues. "Without perception, the system won't perform in its intended environment. The sensor technology investment seems to be a big technology oversight; the commercial world is using inexpensive camera technology and doing wonders with that modality along with some radar technology. However, development of proper environment sensing in nighttime operations in all-weather in unstructured environments is not keeping pace. They are necessary for successful operations in a tactical environment."

Open-systems architectures

The Lockheed Martin Mission Systems & Training segment has a long history with unmanned ground vehicles (UGVs), unmanned underwater vehicles (UUVs), and unmanned aerial vehicles (UAVs), including unmanned helicopters as well as hand, bungee, and pneumatic-launched unmanned aircraft — all oriented toward tactical use. Lockheed Martin also has been a proponent of open-systems architectures, from software to components to control stations.

"Research and development has been driven by open-system architecture, modular so we can maintain the newest and greatest payload capabilities, in the air and on the ground, so the user eventually will be able to use a variety of different platforms for different missions with a common control system," says Jay McConville, business development director for unmanned integrated systems at Lockheed Martin.

A lineup of military vehicles all equipped with Lockheed Martin's Autonomous Mobility Applique System (AMAS) technology awaits the start of highway testing.

"We want to have a common architecture and software we can apply to a number of different hardware applications, which we categorize under a robotic common software control architecture that runs on a number of different platforms, from handheld to larger," McConville says. "That also reduces training requirements for the user. And when you have that architecture, you can add tools to it, sort of like apps on a cell phone."

Lockheed Martin Robotics & Intelligent Systems Advanced Technology Laboratories (ATL) was one of the companies involved with the robotic land challenge of the U.S. Defense Advanced Research Projects Agency (DARPA), developing technologies that went into a small car and showed it could be driven, obey traffic rules, avoid pedestrians, etc.

"We then developed the Squad Mission Support System using the same set of technologies, enabling it to follow soldiers around the battlefield and carry supplies," notes Kingsley Fregene, ATL's robotics group leader. "We're also part of DARPA's Warrior Web program to assist soldiers who start having muscular-skeletal injuries from carrying heavy loads. So we developed a soft exo-suit, almost like a vest, that can be worn under the uniform to provide additional support to reduce those types of injuries. It covers the torso and down to the knee joints, using different attachments."

Aids to navigation

"Another issue ground soldiers encounter is fratricide, so we developed a UAV-based technology that provides navigation aiding to help ground soldiers determine their

This vehicle is a demonstrator for the Light Combat Tactical Vehicle (LCTV), which will have optionally driven capabilities.

location within an operational space and helps the squad leader know where all friendly soldiers are in that immediate area," Fregene continues. "That operates from small, organic squad micro-UAVs that also can carry a camera, allowing the operator to see across a wide area. These rotate at 10 times or more per second, enabling 360-degree imagery of any area without any complex systems. That provides good situational awareness."

Lockheed Martin Missiles & Fire Control in Orlando, Fla., has been involved with robotic programs for at least the past 15 years, including the Consolidated Automated Support System (CASS) and its recent successor, eCASS, and capability-advanced demonstrators. The

Several demonstrator vehicles, like the Oshkosh MRAP All-Terrain Vehicle (M-ATV) shown above, are used to demonstrate robotic vehicle technologies.

company's current robotic focus is on next-generation systems like Autonomous Mobility Applique System and Squad Mission Support System — basically, putting autonomous and semi-autonomous capability on Army vehicles to increase the safety of the vehicle and the soldiers in it by reducing accidents, along with more advanced features, such waypoint-following and leader-follower.

"Within the military, AMAS is to feed transitions to other systems, not go into production itself," says Joe Zinecker, Lockheed Martin's director of combat maneuver systems. "The Army is developing several programs of record into which AMAS will fit, such as route clearance and interrogation systems, beginning with tele-operated, but eventually fully autonomous vehicles to do counter-IED ops without having a solder sitting in the vehicle.

"The Army also is implementing AMAS in various stages onto

a number of logistics vehicles," Zinecker continues. "So far, we have integrated AMAS into eight different vehicle types. The next step is for the Army to select one of those and retrofit it onto those vehicles. The Army is still deciding what level of AMAS to put on those heavy vehicles, from simple driver warning systems to driver-assist systems to leader-follower to fully autonomous capabilities."

Soldiers with an unmanned "follower" vehicle conduct training missions to test the utility of the new vehicle.

It is unlikely U.S. unmanned systems will operate with full independence in the foreseeable future. Instead, the military services are working to make robots and humans seamlessly integrated teammates.

"The Army has started to work on manned and unmanned teaming with UAVs and we expect them to do the same with UGVs," says Brad Curran, defense analyst with market researcher Frost & Sullivan. "Increased situational awareness and ISR for manned ground vehicles is definitely a trend for the future, such as updating Stryker, Bradley, etc."

More computing power

"They need more computing power, more raw power, and the ability to distribute it, because all these platforms will have better electro-optical sensors, active protection measures, counter rocket and mortar systems, improved situational awareness, and communications ability," Curran continues. "So VICTORY-based standardization of connector and power assets will enable them to easily integrate advanced sensors as they come online, including things we haven't even thought about yet but will be available for upgrades in the 2020s."

Another area of military robotization involves enhancing the capabilities of the individual warfighter through mechanical augmentation, such as exo-skeletons. Already in use by industry and some military logistics facilities, these are the real-world version of the huge robotic skeleton the lead character used to battle a giant adversary in the movie *Aliens*.

Lockheed Martin Corp. developed the Human Universal Load Carrier (HULC) for the Army's Natick Soldier Research Development and Engineering Center. In a series of tests, Natick experts evaluated the potential for exoskeleton technology to alleviate strain and fatigue for soldiers who carry heavy loads over long distances. Further innovations are building on HULC and related efforts to produce lighter and more user-friendly exoskeleton technology.

The enabling technologies that have turned combat robotics from science fiction to military integration in the past two decades largely have come from the commercial world, especially automotive and communications. Those, in turn, have been based on improvements in computing speed, power, and miniaturization.

Those also will be the keys to future advances, along with stronger, lighter materials, better use of broadband, greater data compression, sensor fusion at the source, secure and fully integrated networking, better and more intuitive man/machine interfaces, comprehensive training — from platoon-level users to senior commanders — and faster acquisition protocols.

Areas for improvement

Industry officials generally agree most needed advancements in technology fall into three main categories:

1. Developing efficient electronics that can be packed into a small form factor for improved SWAP. While it is now possible to put together processing power that only a few years ago would have been far heavier and larger, further advances are needed for even smaller, manpackable robotics.

The Lockheed Martin Squad Mission Support System (SMSS) is an autonomous vehicle designed to carry the equipment and supplies for infantry warfighters. Equipped with a satellite communications package, the Lockheed Martin SMSS can serve as a reconnaissance vehicle controlled via satellite from more than 200 miles away.

2. Building on the remarkable progress already being deployed in autonomy algorithms, which previously saw limited infantry use due to a lack of processor capability; those have improved dramatically in recent years, a trend that is expected to continue, enabling better algorithms to provide advanced robotic capabilities ground warfighters.
3. Critical improvements in sensors. Ten years ago, DARPA's Open Challenge saw vehicles using large LIDAR systems to measure distance and speed. Today, that same capability or more is available in a cell phone. With smaller, faster, more powerful processors, not only are individual sensors improving, so is the ability to place multiple sensors on the same platform, along with the computing power to convert raw data into useful information before transmitting it on the network, thus putting far more capability into the hands of the warfighter.

While commercial developments will remain the leading source of such advances, there are many areas where civilian and military requirements differ substantially.

"Most of the requirements we've been getting are in the operational realm, such as being able to contend with severe terrain and austere conditions, requirements far different from those leading to self-driving cars on public highways, where you have a known infrastructure and good communications," says John Beck, chief principal engineer for unmanned systems at military vehicle designer Oshkosh Defense.

"So intelligent control and interpretation of the environment, requiring a lot of improved processing, are needed," Beck continues. "Our detection can filter out environmental clutter, such as vegetation, so the vehicle's motion planner can decide how to negotiate the terrain and environmental hazards. On top of that, using machine-learning techniques, it can determine between airborne obscurance, vegetation, etc. — you can drive over some vegetation, but avoid trees. That has been a big focus for our approach to autonomy."

Future ground warfare — as with air and naval combat — will be nearly unrecognizable even for recent veterans. At the same time, military leaders should not try to oversell the technology or ignore lessons from past conflicts. "Maybe every squad doesn't get a big robot, but has a lot of smaller robots or specialized robotic units or heavy robotic units to absorb initial combat power," says TARDEC's Sadowski. "The nature of combat may be changed by having more attritable assets, but you still need people to seize and hold territory."

One way to see into the future is to start with building enough unmanned platforms for a platoon and learn what can or can't be done, Sadowski says. How, and how quickly, that can and will be done also will determine how the U.S. advances its robotic capabilities, in concert with allies and in conflict with adversaries.

Space: the next frontier of rad-hard

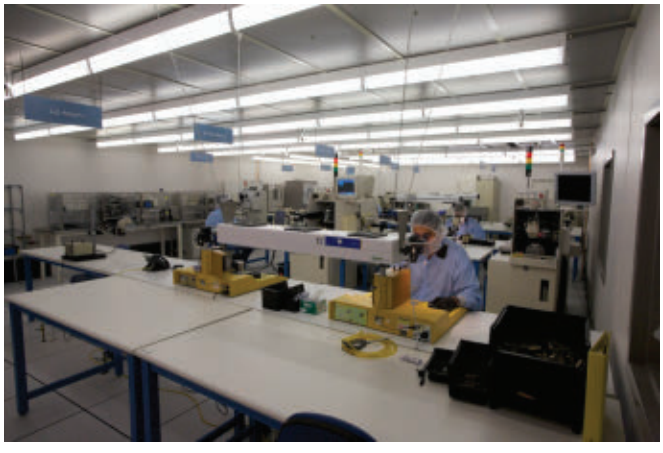
Burgeoning commercial satellite market confronts designers with cost and time-to-market pressures and opens new options in shielding, upscreening, and system redundancy.

BY **John Keller**

The past few decades have seen vast changes in the market for radiation-hardened electronic components. Since the 1990s, the rad-hard industry has evolved from Cold War-driven demand to enable military electronics to survive and even operate through nuclear weapons explosions, to today's needs for radiation-hardened parts that can operate for lengthy periods in space.

The market's transition to space applications is not the end of this market evolution — far from it, in fact. Today's vibrant space market involves a transition from monolithic satellites the sizes of school buses to so-called "disaggregated" satellites that involve orbiting clusters of spacecraft tied together by wireless data links.

This emerging market transformation to spacecraft disaggregation is giving rise to electronics design trends more akin to the commercial market than to what we've become accustomed to in space. Satellite systems designers today are under more cost and time-to-market pressures than ever before, which is forcing designers to sharpen their pencils and come up with new ways of delivering space products quickly, at reasonable costs, and that can survive the harsh radiation operating environment of space.



Rad-hard specialists like Cobham Microelectronics have the design expertise to help choose space parts and shielding for a variety of space operating conditions.

The nuclear threat

Before the Berlin Wall came down in 1989, the rad-hard market was in place primarily to design and manufacture electronic components that could operate through the intense radiation of a nuclear weapon explosion. Cost was no object in America's global struggle with its adversary the Soviet Union.

An established rad-hard supplier base that included companies like IBM, TRW, and Honeywell took great pains and incurred great expense to craft microelectronics design methodologies to yield analog and digital parts that either could operate through a nuclear event, or had the circuitry onboard to detect a surge in radiation and shut down vulnerable parts before damage occurred.

Space applications still were an important part of the rad-hard market back then, but did not wield nearly the influence that they do today. Military communications and reconnaissance satellites like MILSTAR and the KH-11 "Keyhole" satellites were important drivers of rad-hard designs, but these spacecraft were designed to survive a nuclear blast in space.

Military rad-hard parts during the Cold War were not restricted to space applications; there were plenty of ground-based systems like strategic communications and combat vehicles that benefitted from the rad-hard electronics supplier base.

Yet the end of the Cold War slackened demand for rad-hard parts, and today what then was the traditional rad-hard supplier base has dwindled to a handful of suppliers. This is not to say that nuclear weapons applications have no influence on the rad-hard market. U.S. land- and sea-based ballistic missiles, for example, still have stringent radiation-hardening requirements.

Still, technological needs today revolve around the burgeoning commercial satellite market, rather than the need to survive nuclear explosions. This market shift has imposed a fundamental transformation on the rad-hard electronics market.

The challenges of space

Substantial amounts of radiation in the form of charged particles occur naturally in space. Much of this naturally occurring space radiation comes from the Sun. Much of this space radiation is much less intense than the radiation produced by nuclear explosions, yet still is a primary factor when it comes to operating in space.

Earth's orbits moving out from the planet's surface typically have different levels of radiation. There are two primary belts of radiation formed as layers of energetic charged particles that the Earth's magnetic fields hold in place. These two radiation belts, one inner belt and another outer belt, are called the Van Allen belts.

The so-called South Atlantic Anomaly is part of the inner Van Allen Belt, where the radiation field is closest to the Earth's surface dipping down to about 124 miles in altitude. Between the inner and outer Van Allen Belts is a relatively benign area typically called the safe zone,

Specialist companies are providing chips and single-board computers that are able to withstand the effects of radiation in space.

where radiation is not as intense as it is within the Van Allen Belts.

The upper reaches of Low-Earth Orbit are within the lower Van Allen Belt, and can pose significant radiation risks to the electronics of orbiting satellites. Spacecraft orbiting in the higher-altitude geosynchronous orbit can be exposed to the outer Van Allen Belt.

The point is that different orbits have different levels of radiation. Spacecraft designers must account for the radiation found in their intended orbits.

Charged particles in radiation environments can cause malfunctions, damage, or even destruction of electronic devices, depending on the intensity of the radiation and duration of radiation exposure. Space electronics subject to radiation over time, moreover, can experience degradation in performance, shortened life cycles, or even major failures.

Solid-state memory chips, for example, can experience bit flips when hit with charged particles, which can corrupt stored data. Another kind of single-event upset is called a single-event latchup, which disrupts how the part functions. Curing the problem usually requires shutting down and powering up the affected part. Without this kind of correction the part can go into overcurrent, which can cause damage or destruction.

Evolving space applications

There was a time years ago when virtually all satellites required use of electronic components that were designed from the ground-up to be rad-hard. A widening variety of satellites and spacecraft applications, however, has broadened design options.

Radiation-hardening levels represent calculations of expected intensity of radiation, and duration of the satellite's lifetime.

"Space has been a relatively boring industry for a while, but over the past two or three years things have gotten very exciting," says Joshua Broline, product marketing manager for military products at rad-hard specialist Intersil in Palm Bay, Fla. Growing interest in small satellites, CubeSats, and disaggregated satellites is opening a variety of radiation-hardening options, he says.

Depending on mission orbit and duration, designers can choose from options that range from rad-hard by design, commercial off-the-shelf electronic components that have been upscreened for reliability, to various rad-hard approaches that use a combination of radiation shielding and error correction.

Companies that specialize in radiation-hardened components typically have the design expertise to blend a variety of techniques, recommend parts appropriate for the job, and provide shielding, redundancy, and error correction where necessary.

"The trick is to pick the right technology and ask if it meets your needs and will be sufficient for the project," says Intersil's Broline. "There are a lot more choices today in rad-hard than there were 20-plus years ago."

Some satellite applications don't require any radiation-hardened electronics at all. Those typically include experimental satellites of extremely short lifetimes of a few months to just a couple of weeks.

"For those putting up satellites for missions of three to six months sometimes there are no requirements," says Anton Quiroz, business area director for systems and development at Cobham Semiconductor Solutions (formerly Aeroflex) in Colorado Springs, Colo.

"They just put it out there and hope it functions," Quiroz says. These can include university research projects, short-term Earth-observation satellites, or temporary

military communications satellites designed to provide short-term connectivity to battle theaters.

Other short-term satellite applications can require only light levels of radiation hardening, which can help operators avoid high costs. These include the so-called SmallSats and CubeSats, which are being designed to operate in low Earth orbit (LEO) for about one to five years. These applications require a minimal level of radiation hardening, Quiroz says.

New Space

Some call these applications New Space, or Low-Cost Space, says Larry Longden, vice president and general manager of the Data Device Corp. (DDC) Microelectronics Group in San Diego (formerly the Maxwell Technologies Microelectronics Group). Among these are the proposed OneWeb and SpaceX small satellite constellations to blanket the globe with Internet access.

OneWeb seeks to launch more than 600 tiny satellites orbiting at 750-mile altitudes to beam high-speed Internet down to Earth.

SpaceX, meanwhile, seeks to launch 4,000 SmallSats in 750-mile-high altitudes for the same purpose. Internet search giant Google reportedly has provided $1 billion to help fund the SpaceX project.

These kinds of satellites would have short life cycles presumably because they could be replaced quickly and inexpensively. Their required levels of radiation hardness is open to debate.

There have been some hard lessons learned in recent years when it comes to on-orbit failures, which could make designers think twice about cutting corners with radiation hardness — even with short-duration satellites.

"A company trying to make money out of what the payload is doing might want to make it more reliable," warns Cobham's Quiroz. For these applications radiation levels of about 25 kilorads might be sufficient, he says.

Intersil is a longtime space electronics provider of analog, digital, and power electronics that are radiation-hardened for satellite applications.

Satellite designers for New Space applications often will try to avoid radiation-hardening components throughout the spacecraft, but concentrate hardening efforts only on those components performing mission-critical functions, like attitude and telemetry, data handling, and databus functions, Quiroz says.

Low-Earth Orbit

Satellites designed to operate in low Earth orbit for durations longer than five years might need more stringently radiation-hardened components — especially since these spacecraft will be exposed to the inner Van Allen belt.

"If you're operating in LEO for five to seven years, then you need significant radiation hardening above commercial level, and you need to move above commercial plastic-packaged components to something more robust, like ceramic," says DDC's Longden. "You're typically talking about 20 to 50 kilorads total-dose, and a high-flux environment."

The Mars Rover operating on Mars has a variety of radiation-hardened electronic components to help systems stand up to the harsh Martian landscape.

For these kinds of environments satellite designers typically call out well-known rad-hard standards like MIL-PRF-38535 and MIL-PRF-38534, when these kinds of parts are available. These are the gold standards when it comes to radiation hardening, and designers choose these parts over upscreening and shielding wherever they can.

"The costs can be the same of a rad-hard-designed part or a COTS [commercial off-the-shelf] part that needs to be upscreened," says Intersil's Broline. "Assuming that the costs are similar, you don't have to convince a designer to use the rad-hard part. It represents a standard flow, is well recognized, and is a lot easier to get passed."

Sometimes components are unavailable that meet these kinds of standards, however, which poses a bigger challenge for space systems designers.

"If there is no other path, the upscreening takes more time, effort, and money to convince the end customer that it is flyable, and that the parts supplier has done his due diligence," Broline says.

Higher orbits

Moving to higher orbits from LEO can present different challenges for satellite designers. Although there may be less radiation at higher orbits, the charged particles higher up can affect electronics differently. "Protons and electronics hit the satellites harder" in higher orbits such as geosynchronous orbit, says Cobham's Quiroz.

"Through GEO is where we see the 100-kilorad total-dose requirements," Quiroz says. Satellites operating in GEO typically also have longer life cycles (as long as 15 years), so hefty rad-hard requirements are the rule for these designs. Roughly the same requirements are necessary for polar-orbiting satellites.

For more stringent requirements, designers often look for electronic component technologies that are inherently rad-hard, such as those fabricated on silicon-on-insulator (SOI) processes. "Those processes are very difficult to upset," Quiroz says.

Beyond GEO venture the deep-

space probes that must be able to withstand high radiation levels of open space. Some of these deep-space applications, depending on the anticipated duration, required total-dose radiation hardness of 300 kilorads to 1 megarad. These kinds of parts are difficult to find, and are expensive when they're available.

"Requirements for 300 kilorads total-dose would include the deep-space probes, which must take a lot more radiation, and must look at some shielding on top of that," says Cobham's Quiroz. "We look at the process to ensure that the part will be suitable and make sure what you are working with," he says. "We have a design team that knows its components really well."

The future NASA Orion multipurpose crew vehicle will be able to carry a crew of four astronauts to destinations at or beyond low Earth orbit.

For these kinds of applications Cobham offers quantified COTS parts, which "is a commercial product that has been quantified so you know exactly what you're getting," Quiroz says. "We can screen and test parts, and take care of a lot of the up-front headache for the customer rather than have them do the up-screening themselves. We test a lot of off-the-shelf products, and a lot of rad-hard product, as well."

DDC Microelectronics experts, meanwhile, put their expertise to work in the company's RAD-PAK technology, which involves carefully selected parts and shielding. "Think about going to the beach and getting a sunburn," says DDC's Longden. "The longer you spend at the beach the deeper your sunburn. Our RAD-PAK technology is like putting on sunscreen. We take a commercial semiconductor and put it inside of our shielded package to reduce the radiation environment."

Boeing to upgrade RF and microwave avionics on Navy combat aircraft

BY **John Keller**

PATUXENT RIVER NAS, Md. — Boeing military avionics experts will design and build an advanced electronic device that enables two or more radio-frequency (RF) and microwave systems to operate together aboard U.S. Navy F/A-18E/F and EA-18G combat aircraft without interfering with each other.

Boeing to tackle RF co-site interference aboard U.S. Navy F/A-18E/F Super Hornet jet fighter-bombers.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $13.5 million order to the Boeing Defense, Space & Security segment in St. Louis to build and test the Radio Frequency Blanking Unit (RFBU). An RF interference blanker permits simultaneous operation of two or more pieces of radio or radar equipment without confusion of intelligence, or that suppresses undesired signals when used with one receiver.

The RFBU is to be a form, fit, and function replacement for the Enhanced Interference Blanking Unit (EIBU) aboard the Navy's carrier-based F/A-18 E/F Super Hornet jet fighter bomber and EA-18G Growler electronic warfare aircraft. The RFBU will help mitigate the effects of co-site interference aboard the Super Hornet and Growler. Both aircraft have many sophisticated RF and microwave systems on board, which can pose the risk of interfering with one another, especially given that aircraft use closely spaced antennas.

The RFBU will be a same-size upgrade and replacement of the EIBU that switches out obsolete electronic parts, or those difficult-to-find parts with diminishing manufacturing sources. Boeing also will design the new RFBU to accommodate future upgrades and growth in capabilities.

The new RFBU will enhance input/output signal capacity of the AN/USQ-140 Multifunctional Informational Distribution System (MIDS) Low Volume Terminal (LVT) aboard the F/A-18E/F and EA-18G aircraft. MIDS LVT is a secure data and voice communication network using the Link-16 tactical wireless networking architecture. MIDS LVT provides enhanced situational awareness, positive identification of participants within the network, secure fighter-to-fighter voice and data networking, secure voice communications, and tactical air navigation.

Boeing will do the work in St. Louis and Melbourne, Fla., and should be finished by February 2018. ←

FOR MORE INFORMATION visit **Boeing Defense, Space & Security** online at *www.boeing.com/defense*.

Exelis to provide COTS radar for military airfields

U.S. military air traffic control experts needed a commercial off-the-shelf (COTS) precision-approach radar to replace the AN-FPN-63(V) radar. They found their solution from Exelis, a subsidiary of Harris Corp. in Van Nuys, Calif. Officials of the Naval Air Warfare Center Aircraft Division in Lakehurst, N.J., announced a $70.3 million contract to Exelis to provide 42 COTS precision-approach radar systems; 21 are for the U.S. Army, 16 are for the Navy, and five are for the U.S. Air Force.

BAE Systems to maintain long-range missile-defense radar system

Officials of the U.S. Air Force 21st Contracting Squadron at Peterson Air Force Base, Colo., announced a $49.6 million contract to BAE Systems Technology Solutions & Services in Rockville, Md., to manage, operate, maintain and logistically support the Solid State Phased Array Radar Systems (SSPARS). SSPARS — once referred to as the Phased Array Warning System (PAVE PAWS) and the Ballistic Missile Early Warning System (BMEWS) — is a radar, computer, and communications system for missile warning and space surveillance with sites at Air Force locations in Calif., Mass., Alaska, England, and Greenland. ←

Navy orders UUVs able to mimic quiet enemy submarines

U.S. Navy anti-submarine warfare (ASW) experts needed target underwater drones that mimic the acoustic and non-acoustic signatures of advanced nuclear- and diesel-powered submarines. They found their solution at Lockheed Martin Sippican in Marion, Mass. Officials of the Naval Undersea Warfare Center (NUWC) in Newport, R.I., announced a $49.5 million contract to Lockheed Martin Sippican to build 39 unmanned underwater vehicles (UUVs) able to emulate the behavior and sensor signatures of enemy submarines to help Navy ASW experts practice their skills from surface warships, submarines, helicopters, and fixed-wing aircraft. Sippican UUVs that can disguise themselves as potentially hostile submarines, called MK 39 Mod 2 expendable mobile antisubmarine warfare (ASW) training targets (EMATT), are designed to help Navy submarine-, surface ship-, and aircraft-based ASW forces train to detect, hunt, and destroy quiet enemy submarines. Navy aircraft and surface warship crews will use the second-generation EMATT to train in open-ocean, unrestricted, and on-range ASW training missions. ←

FOR MORE INFORMATION visit **Lockheed Martin Sippican** online at *www.sippican.com*.

Aurora Flight Sciences to develop high-speed DARPA VTOL X-Plane

BY **John Keller**

ARLINGTON, Va. — Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced an $89.4 million downselect contract to Aurora Flight Sciences in Manassas, Va., for the second and third phases of the Vertical Take-Off and Landing Experimental Plane (VTOL X-Plane) project.

Aurora Flight Sciences was selected to develop and flight-test the DARPA VTOL X-Plane high-speed VTOL aircraft with the hover capability of a helicopter that can fly nearly 50 percent faster than the Boeing V-22 Osprey tiltrotor aircraft.

The second phase of the DARPA VTOL X-Plane program will involve design, development, and integration; the third phase will involve flight-test demonstrations. Aurora is working with team members Rolls-Royce PLC in Manchester, England, and Honeywell International Inc. in Morris Plains, N.J., on the VTOL X-Plane project. The Aurora team will build a prototype VTOL X-Plane with a distributed hybrid-electric propulsion system based on the Aurora LightningStrike unmanned aircraft.

Aurora's LightningStrike design includes distributed hybrid-electric propulsion ducted fans; a synchronous electric-drive system; tilt-wing- and tilt-canard-based propulsion for vertical takeoff and landing; and high-efficiency hover and fast forward flight. The aircraft design features a Rolls-Royce AE 1107C turboshaft engine powering three Honeywell generators, and 24 ducted fans distributed on the wings and canards.

This artist's rendering depicts the future Vertical Take-Off and Landing Experimental Plane (VTOL X-Plane) design of Aurora Flight Sciences.

The VTOL X-Plane effort is a four-year, $130 million effort to fly an experimental aircraft with a top sustained flight speed of 300 to 400 knots; hover efficiency of at least 75 percent; cruise efficiency lift-to-drag ratio of at least 10; and useful load capacity of at least 40 percent of the vehicle's projected gross weight of 10,000 to 12,000 pounds.

Aurora Flight Sciences engineers will design a hybrid aircraft that will push VTOL limits in speed, hover efficiency, cruise efficiency, and useful load. Flight tests are scheduled for 2018.

On this contract the Aurora Flight Sciences team will do the work in Manassas, Va.; Indianapolis; Tucson, Ariz.; and Ventura, Calif., and should be finished by September 2018. ←

FOR MORE INFORMATION contact **Aurora Flight Sciences** online at *www.aurora.aero*.

Navy asks Kent Optronics to develop wide-field-of-view binocular night-vision goggles

CRANE, Ind. — U.S. Navy electro-optics experts needed wide-field-of-view, night-vision goggles to enable sailors, Seabees, Special Forces, Coast Guard, and Air Force personnel to see more clearly at night. They found their optimal solution at electro-optical technology company Kent Optronics Inc. in Hopewell Junction, N.Y.

Night-vision devices the military uses today could be upgraded with wide-field-of-view capabilities from Kent Optronics.

Officials of the Naval Surface Warfare Center in Crane, Ind., announced a $47.6 million research contract to Kent Optronics for wide-field-of-view, night-vision systems, retrofits, and data as part of the electro-optics project.

Kent Optronics experts will provide new wide-field-of-view, night-vision devices, as well as upgrade kits for existing night-vision systems. The contract is a 5-year, phase-three small business innovation research (SBIR) agreement.

These night-vision systems will involve an optical foveal design with 80-degree field of view that does not compromise optical resolution or size, weight, and power consumption, Navy officials say.

Kent Optronics engineers will provide new wide-field-of-view, night-vision binocular goggles, as well as kits to upgrade existing AN/PVS-15 night-vision binocular goggle systems for airborne, sea, undersea, and land-based military applications.

The company will build binocular night-vision systems that weigh no more than less than 24 ounces, offer less than 4 percent distortion, and provide eyepiece output in the green light spectrum around 543 nanometers.

Kent Optronics specializes in liquid crystal devices and electro-optical components and subsystems for infrared displays, special-purpose displays, infrared imaging and sensing, lasers, and optical communications. ←

FOR MORE INFORMATION visit **Kent Optronics Inc.** online at *www.kentoptronics.com*, and the **Naval Surface Warfare Center – Crane** at *www.navsea.navy.mil/Home/WarfareCenters/NSWCCrane*.

Lockheed Martin and Raytheon lock-up contracts for Paveway and AMRAAM

Officials of the Air Force Life Cycle Management Center at Hill Air Force Base, Utah, announced a combined $649.7 million order to Lockheed Martin Missiles and Fire Control in Archibald, Pa., and Raytheon Missile Systems in Tucson, Ariz., for Paveway II guided bomb production. Officials of the Air Force Life Cycle Management Center at Eglin Air Force Base, Fla., meanwhile, announced a $104.6 million contract to Raytheon Missile Systems in Tucson, Ariz., to upgrade guidance on the Advanced Medium-Range Air-to-Air Missile (AMRAAM). Raytheon's AMRAAM contract involves foreign military sales to Korea, Saudi Arabia, Australia, and Romania.

Rugged laser module for targeting introduced by Laser Components

Laser Components USA Inc. in Bedford, N.H., is introducing the rugged Flexpoint heavy-duty HD laser module for targeting, marking, or positioning in harsh operating conditions. The lasers meet IP67, can withstand the effects of sandstorms, and can go into one-meter-deep water for as long as 30 minutes. Flexpoint HD modules are available as dot lasers, line lasers with fan angles from 10 to 100 degrees, or cross-hair lasers with fan angles from 2 to 60 degrees. They emit at 520 or 635 nanometers. The 520-nanometer light spectrum is visible in daylight. ←

Pentagon asks industry for new sensors to detect nuclear weapons

BY **John Keller**

FORT BELVOIR, Va.—U.S. military researchers are asking industry for new sensors and sensor-processing technologies to identify, locate, and characterize nuclear weapons and nuclear weapons materials.

Officials of the Defense Threat Reduction Agency (DTRA) at Fort Belvoir, Va., have issued a broad agency announcement (HDTRA1-17-NTD-BAA) for the New Initiatives for Nuclear Detection and Monitoring and Verification Technologies program.

DTRA researchers particularly are interested in enabling technologies for radiation imaging; search and localization; upstream detection; non-permissive environments; computer vision; vehicle and material tracking; and explosive depth in mountainous topology.

Military authorities are trying to exploit the full range of electro-optical sensing to detect the presence of nuclear weapons.

Radiation imaging involves solutions for fast and thermal gamma-ray and neutron radiation imaging, as well as radiation imager data exploitation.

Search and localization involves solutions to enable rapid detection, localization, and preliminary identification of special nuclear material in vehicles, on people, underwater, and in shipping containers.

Upstream detection involves ways to detect and characterize trace amounts of weaponized portable and ruggedized nuclear materials.

Non-permissive environments involves solutions for remotely detecting, locating, and characterizing nuclear materials with tagging and tracking sensors, remote leave-behind sensors, and sensor payloads for unmanned vehicles.

Computer vision involves using computer vision to detect, identify, and track authorized and unauthorized nuclear materials in transit.

Vehicle and material tracking involves non-computer-vision-based solutions for the detection, identification, and tracking of authorized and unauthorized transportation of weapons and materials.

Explosion depth in mountainous topology involves technical methods for remote determination of the depth of explosions in mountainous topology.

Companies interested should submit quad charts and white papers no later than 14 July 2016 to the DTRA submission Website at www.dtrasubmission.net. Companies with promising white papers will be invited to submit formal proposals, which are due no later than 3 Oct. 2016.

Email questions or concerns to DTRA at dtra.belvoir.J9.mbx.ntd-baa-inbox@mail.mil.

MORE INFORMATION IS online at *https://www.fbo.gov/spg/ODA/DTRA/DTRA01/HDTRA1-17-NTD-BAA/listing.html*.

PRODUCT applications

RUGGED NETWORKING

Navy chooses 1553-to-Ethernet converter from Alta Data for landing craft upgrades

U.S. Navy shipboard electronics experts needed Ethernet appliances to remote MIL-STD-1553 databus operations onto 10/100/1000 Ethernet IP/UDP local area networks (LAN) aboard the Navy's Landing Craft Air Cushion (LCAC). They found their solution at Alta Data Technologies LLC in Rio Rancho, N.M.

Officials of the Naval Surface Warfare Center in Panama City, Fla., announced a sole-source contract to Alta Data for 85 of the company's eNet2-1553-1D-E data-remoting devices for the LCAC Command, Control, Communications, Computers, and Navigation (C4N) project. LCAC is a fast air-cushioned hovercraft designed to transport Marines, soldiers, combat vehicles, and other equipment ashore from Navy surface ships during land invasions. The specialized landing craft skims across the surface of the ocean on a cushion of air, and can move at speeds faster than 40 knots. The entire hull rides about four feet above the ocean's surface, as well as above the sand on landing beaches.

Navy experts will use the Alta Data eNet2-1553 units for the LCAC C4N system baseline configuration 4 (SBC4) Ethernet 1553 assembly. The contract will have options for an additional 20 Ethernet appliances.

The LCAC C4N project seeks to upgrade the LCAC's electronics and other equipment to replace obsolete equipment, focusing on replacing the vessel's LN-66 radars with modern, high-power P-80 radar systems. LCAC C4N focuses on open-architecture systems with modern commercial-off-the-shelf (COTS) equipment.

In addition to Alta Data, LCAC C4N contractors include Aitech Defense Systems Inc. in Chatsworth, Calif., for single-board computers; Concurrent Technologies in Woburn, Mass., for single-board computers; and Tracewell Systems in Westerville, Ohio, for rackmount chassis.

FOR MORE INFORMATION visit **Alta Data Technologies** at *www.altadt.com*.

SHIPBOARD DISPLAYS

Lockheed Martin builds new displays for surface warships

U.S. Navy shipboard electronics experts needed enterprise displays for Navy surface warships. They found their solution at the Lockheed Martin Corp. Mission Systems and Training segment in Manassas, Va.

Officials of the Naval Sea Systems Command in Washington announced an $8.1 million contract to Lockheed Martin for the Technology Insertion 16 production portion of the Common Display System (CDS) program. The CDS is a family of enterprise display systems for Navy surface warships, and has the potential for use with the U.S. Marine Corps, as well as with allied navies.

With this contract, Lockheed Martin effectively takes over from DRS Technologies Inc., a wholly owned subsidiary of Finmeccanica S.p.A., as the lead systems integrator for the latest versions of the Navy Common Display System.

A $15.5 million contract for the Technology Insertion 12 portion of the CDS program went to the DRS Laurel Technologies segment of DRS Technologies in Johnstown, Pa., one year ago. Lockheed Martin was a key partner to DRS on that and on previous CDS technology

insertion contracts.

Other companies that historically have taken part in the Navy CDS program include General Dynamics Mission Systems in Fairfax, Va.; Barco in Duluth, Ga.; and Aydin Displays Inc., a Sparton company in Birdsboro, Pa.

Successive technology insertions represent a procurement approach designed to equip Navy vessels, aircraft, and shore installations with the latest technologies at the most reasonable costs. Technology insertions normally involve mature technologies available largely as commercial off-the-shelf (COTS) items.

Navy experts initially developed the CDS for the DDG 1000 Zumwalt-class, surface-attack destroyer, as well as for Aegis modernization efforts aboard the Navy's Ticonderoga-class cruisers and Arleigh Burke-class destroyers.

Navy electronics experts have expanded the requirement for CDS to Navy aircraft carriers, amphibious assault ships, and dock landing ships. Navy leaders also are considering the CDS for Navy aircraft and submarines.

Navy leaders scrapped plans to build 32 Zumwalt-class destroyers, and are likely to build only two of the large vessels, which are built around the Advanced Gun System (AGS), a 155-millimeter cannon designed to hurl special shells as far as 83 nautical miles at a rate of 10 rounds per minute, and are designed primarily for shore bombardment.

FOR MORE INFORMATION visit **Lockheed Martin Mission Systems and Training** online at *www.lockheedmartin.com/us/mst, and* **Naval Sea Systems Command** at *www.navsea.navy.mil*.

AIRBORNE SENSORS

Raytheon continues building terrain-following radar to infiltrate enemy territory

U.S. Special Operations experts needed special terrain-following radar to enable military aircraft to infiltrate enemy territory by hiding in mountain passes, valleys, and in bad weather. They found their solution at Raytheon Co.

Officials of U.S. Special Operations Command at MacDill Air Force Base, Fla., announced a potential $49.5 million contract to the Raytheon Space and Airborne Systems segment in McKinney, Texas, for continued low-rate initial production of the Silent Knight radar system.

The Silent Knight radar is an above-K-band, multi-aircraft, terrain-following and terrain-avoidance radar designed to enable Special Forces aircraft to infiltrate dangerous areas undetected and at night with reduced risks of crashing while flying at low altitudes.

The system is designed for the Lockheed Martin MC-130J four-engine turboprop; Boeing MH-47G heavy-lift helicopter; Sikorsky MH-60M medium-lift helicopter; and CV-22 block 30 tiltrotor aircraft.

Special Operations commanders need aircraft capable of flying at low altitudes covertly at night to insert and remove commando forces for operations behind enemy lines.

The system also provides navigation support, ground mapping, and weather information to air crews. The radar has advanced terrain-following and terrain-avoidance capabilities and will be lighter and require less power than its predecessors.

Raytheon's principal partners on the Silent Knight radar include DRS Technologies in St. Louis, and Rockwell Collins in Cedar Rapids, Iowa.

The Silent Knight radar operates at low power levels to reduce its chances of being detected by enemy passive RF receivers. The system also has color weather tactical data displays to enhance pilot situational awareness.

Essentially the Silent Knight radar system enables MC-130J and other Special Forces aircraft to fly close to the ground — hugging low spots in mountain passes, valleys, and other terrain features — even when darkness and bad weather cause zero-visibility.

The system's sophisticated weather radar also enables the aircraft to hide in clouds, fog, dust, rain storms, and total darkness at very low altitudes. Its radar can pick out key details like electrical towers and high-tension power lines while providing pilots with enough warning to avoid them.

On this contract Raytheon will do the work in McKinney, Texas, and Forest, Miss., and should be finished by October 2018.

FOR MORE INFORMATION visit **Raytheon Space and Airborne Systems** online at *www.raytheon.com*, and **U.S. Special Operations Command** at *www.socom.mil*.

new PRODUCTS

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

CHIP PACKAGING

Ceramic packaging for hermetic sealing introduced by Coining

Coining Inc. in Montvale, N.J., is introducing ceramic packaging called the Coining Ceramic Cover Assemblies (CCCAs) for hermetic sealing electronics applications. Ceramic and metal cover assemblies offer many adhesives and encapsulants advantages for the hermetic sealing of electronic packages. The one-piece, cover-frame construction simplifies assembly and eliminates seal failures caused by misalignment of lid and frame. Coining's automated cover assembly manufacturing process supports low- and high-volume

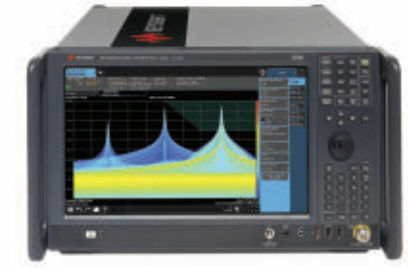
production, and ensures consistent, high-quality cover assemblies. Along with the ceramic cover assemblies, Coining has improved the quality of and enhanced production capabilities for its metal cover assemblies.

FOR MORE INFORMATION visit **Coining** at *www.ametek-ecp.com/brands/coining*.

TEST AND MEASUREMENT

Signal analyzer for military radar introduced by Keysight

Keysight Technologies Inc. in Santa Rosa, Calif., is introducing the X-Series signal analyzer systems for test and measurement applications to help military radar systems developers create next-generation devices. Most notable is a multi-touch user interface (UI) that streamlines measurement setup and creates a solid foundation for new solutions. Performance improvements and feature enhance-



ments address emerging needs in aerospace, defense, and wireless communications.

The UI enables optimization of measurement parameters in no more than two touches. Support for gesture-driven controls, such as pinching, dragging, and swiping makes analysis more immediate and intuitive. With consistent operation across the UXA, PXA, MXA, EXA, and CXA, learning one means knowing them all.

FOR MORE INFORMATION visit **Keysight** online at *www.keysight.com*.

MOBILE COMPUTING

Rugged tablet computer that meets MIL-STD-810G introduced by Handheld

Handheld Group AB in Lidköping, Sweden, is introducing the Windows 10-based Algiz 10X ultra-rugged tablet computer that meets MIL-STD-810G military standards for protection against dust, water, vibrations, drops, and extreme temperatures. The Algiz 10X features a quad-core

Intel N2930 1.83-gigahertz processor and an expandable 128-gigabyte, solid-state drive. It has four gigabytes of DDR3 RAM and offers several connectivity options, including WLAN and BT, USB 2.0 and USB 3.0, VGA, and RS232 ports. It has a 10.1-inch touchscreen with high-brightness MaxView screen technology. This compact tablet weighs 1.3 kilograms (2.9 pounds) and measures 32 millimeters (1.2 inches) thick.

FOR MORE INFORMATION visit **Handheld Group** online at *www.handheldgroup.com*.

RAD-HARD MEMORY

MRAM-based, rad-hard, non-volatile memory for space introduced by Cobham

Cobham Semiconductor Solutions in Colorado Springs, Colo., is announcing QML V radiation-hardened certification of its non-volatile semiconductor memory products. QML V involves especially rugged microelectronics devices that are qualified for space applications. Cobham Semiconductor Solutions (formerly Aeroflex) uses Magnetoresistive Random-Access Memory (MRAM) intellectual property from Everspin Technologies Inc. in Chandler, Ariz., to help achieve QML V for these non-volatile products. The MRAM-based product offering includes a 64-megabit device, UT8MR8M8,

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offered in a 40-lead quad flatpack, and a 16-megabit device, UT8M-R2M8, available in a 40-lead flatpack. Both are in production and have been designed into various future satellites, company officials say.

FOR MORE INFORMATION visit **Cobham Semiconductor Solutions** online at *www.cobham.com/HiRel*.

EMBEDDED COMPUTING

6U OpenVPX multiprocessor for radar and sonar introduced by Abaco

Abaco Systems in Huntsville, Ala., is introducing the DSP282 6U OpenVPX rugged embedded computing multiprocessor for processor-intensive systems deployed in harsh environments such as radar, sonar, image-, and sensor processing. The board delivers as much as 665.6 GigaFLOPS of throughput per card slot, as well as support for advanced 3D graphics. It is suited for manned and unmanned airborne, ground, and

naval applications that need maximum performance and constrained size, weight, and power consumption (SWaP). The DSP282, which featuresdual 5th generation Intel Core i7 2.4 GHz quad core processors for high-performance embedded computing (HPEC). It uses RDMA-enabled InfiniBand and Ethernet dual network interface cards for scalability as well as for high inter-processor bandwidth at low memory-to-memory latencies.

FOR MORE INFORMATION visit **Abaco Systems** online at *www.abaco.com*.

EMBEDDED NETWORKING

Rugged Ethernet switch with fast power-on introduced by Abaco

Abaco Systems in Huntsville, Ala., is introducing a managed Ethernet switch for networked embedded computing applications with a 'power on to fully functional' elapsed time comparable to that of an unmanaged switch. The new Ethernet switch is based on the Abaco GBX411 3U OpenVPX Layer 2/3

rugged Ethernet switch, and is for mission-critical environments that demand superior quality of service, high reliability, and improved uptime through the ability to recover from partial network failure via redundancy and fail-over. Military and aerospace applications with the need to conserve power and minimize heat dissipation in delivering sensor-derived data, such as from IP cameras, cannot tolerate a delay of even a few seconds, Abaco officials say. Abaco engineers adapted the company's GBX411 3U OpenVPX Layer 2/3 rugged Ethernet switch to reduce the device's 'power on to fully functional' time from about 30 seconds to 15 seconds.

FOR MORE INFORMATION visit **Abaco Systems** online at *www.abaco.com*.

TEST AND MEASUREMENT

Radio test set for military applications introduced by Astronics

Astronics Test Systems in Irvine, Calif., is introducing the CTS 6000 series radio test and measurement device for commercial aerospace,

military, and civil security applications. The test and measurement unit incorporates nine test capabilities into one tester with a touchscreen interface for testing radio communications systems at the factory, at the depot, or in the field. The CTS 6000 is for use by all branches of the military, TSA, police, fire, private security, airline personnel, and other industries requiring secure, reliable radio communications. It helps reduce testing time and cost, maintenance and calibration costs, life cycle ownership costs, and the number of "no fault found" results. Users can test tactical handsets, amplifiers, antennae, and any other component of a radio system.

FOR MORE INFORMATION visit **Astronics Test Systems** online at *www.astronicstestsystems.com*.

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