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Military electronics budgets

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Efficient power electronics

New designs and open-systems architectures enable manufacturers to provide small, lightweight, and power-efficient devices. **PAGE 22**

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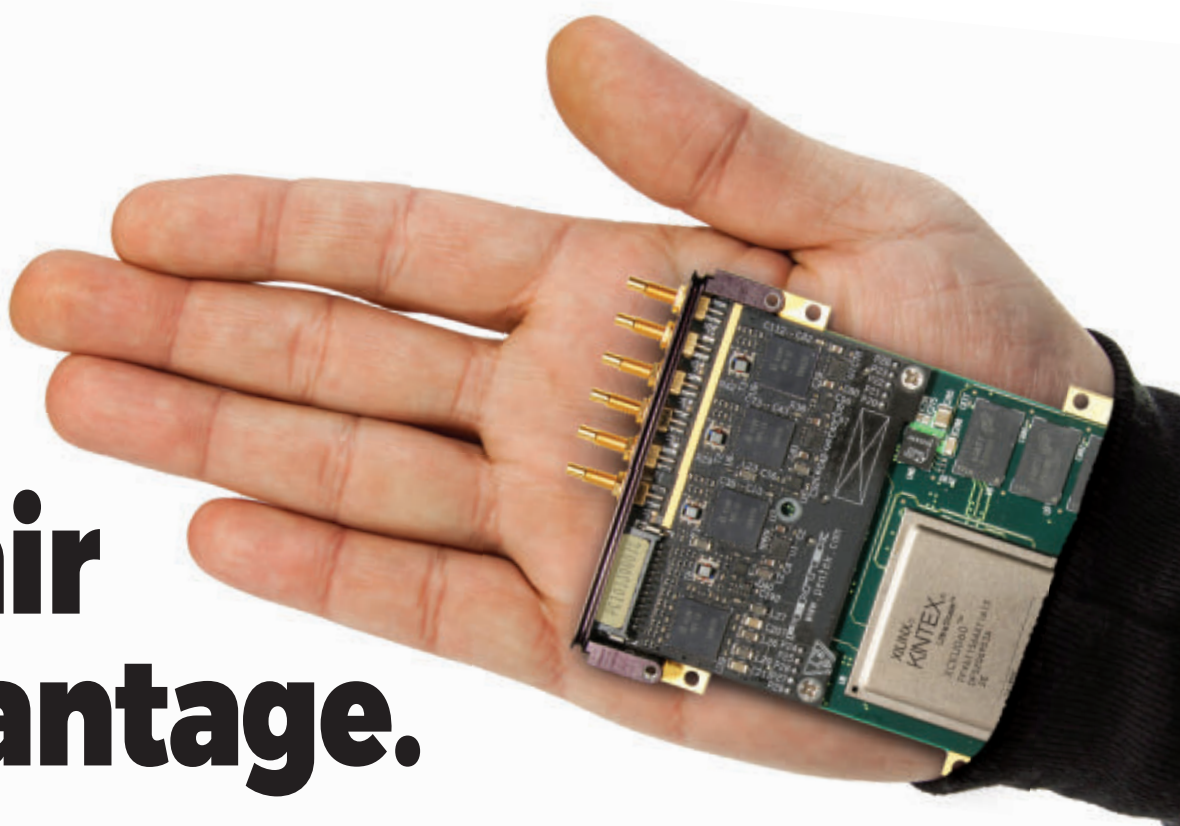
Technologies for combat robots

Artificial intelligence, machine automation, and collaborative algorithms to make tomorrow's drones smarter and more lethal than ever. **PAGE 12**



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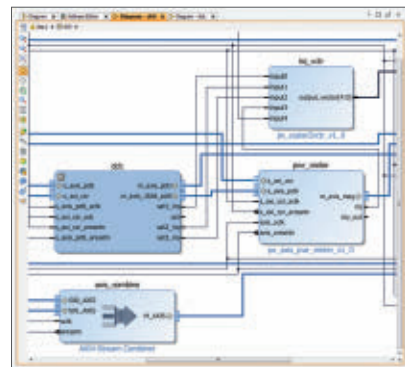
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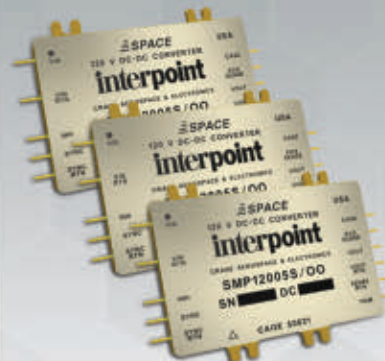
36 NEW PRODUCTS

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Newfound Pentagon wealth should focus on enabling technologies for tomorrow's conflicts

By now, pretty much everyone has heard that the U.S. Department of Defense (DOD) is flush with cash. It's probably more money than the military has had in decades. Yet, once we get beyond the initial euphoria, several questions come up:

- How is the Pentagon going to spend all that money?
- How can military leaders transform money into meaningful readiness?
- What might be the disruptive new technologies that the DOD's sudden new wealth should help promote most aggressively?
- Can we trust the U.S. military industrial complex, which already is notorious for wasting vast amount of money, to husband this newfound wealth wisely?

There are big risks with sudden wealth; we've all seen the stories of professional athletes and multimillion-dollar lottery winners who, overtaken by excitement, waste their money on flashy cars, big houses, yachts, and jewelry. In a few years, they end up right back in poverty where they started.

The DOD isn't immune to this phenomenon. It has been a long time since I've seen this kind of excitement in government and in the defense industry. Folks think we're back to the Reagan military build-up of the early 1980s, or to the money-is-no-object days of post-9/11. That kind of attitude could lead us in the wrong direction.

Experience shows us that the Pentagon's money spigot won't flow full-blast forever. It might not even last longer than a few years, so today's military leaders must plan now for the long term. Defense spending is a huge chunk of money, and remains a favorite target of political factions that would like to see the money spent elsewhere. So, what can we do now to make the most of this windfall?

Some of the most important agenda items already are in progress. Take laser weapons, for example, which will be crucial for deterrence and national security enforcement as we move further into the 21st century. Laser weapons don't run out of bullets, will be difficult to overwhelm with numbers, and should be reasonably effective against advanced enemy munitions like mortars, rockets, and perhaps even hypersonic missiles.

Still, there are plenty of challenges to laser weapons that must be overcome, and this is where all this extra money in the defense budget could be put to best use. Laser power must be increased to avoid the necessity of keeping the laser beam on target for more than a few seconds. Lasers must be powerful enough to destroy targets in a second or less, and then move quickly on to the next target.

Although laser weapons don't run out of bullets, they will have voracious appetites for electrical power. That's why some of the Pentagon's newfound

wealth should go for advanced energy-generation and energy-storage technologies to fuel future generations of laser weapons. There are other enabling technologies, as well.

People talk about the importance of stealth aircraft technology for tomorrow's military, yet just as important is advanced and secure tactical networking that will enable stealthy aircraft to find targets quickly, and then fire weapons from remote platforms. Think of the F-35 fighter-bomber firing weapons remotely from a stand-off B-52 bomber.

New kinds of electronic warfare will be necessary in the future not just to jam enemy sensors and communications, but also to spoof them into detecting targets that aren't there, and encourage them to eavesdrop on communications with false and misleading information. Fast optical processing likely will be a key enabling technology, among many others.

New surveillance and reconnaissance technologies will be necessary, and a new breed of swarming unmanned aerial vehicles will be key to tomorrow's surveillance and reconnaissance capabilities. The list goes on.

Military leaders need to think now about long-term investments in enabling technologies before the money stream dries up, as it inevitably will. We shouldn't squander this golden opportunity to align our military forces for tomorrow's conflicts. ◀

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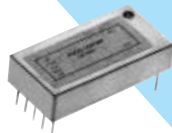
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New planes for Joint-STARS radar surveillance killed in DOD budget

The proposed national defense budget would kill plans to buy new planes for Joint Surveillance Target Attack Radar System, or J-STARS. The Joint-STARS recapitalization program had called for buying 17 new planes at an estimated cost of \$7 billion. The Air Force has already spent \$265 million on the program, with another \$400 million planned for this year. The move to cut the J-STARS recap is not a surprise. Word leaked out last year that Air Force leaders were reconsidering. Air Force Secretary Heather Wilson has publicly questioned whether J-STARS is the best way to fulfill the mission of battlefield surveillance, particularly in a future conflict against a foe that can shoot down aircraft. Joint-STARS, in an early prototype version, gained international fame in 1991 during the Persian Gulf War when its wide-area surveillance radar detected retreating Iraqi columns, which enabled widespread U.S. air strikes on the retreating forces.

Harris to provide sophisticated EW jamming systems for combat aircraft

Electronic warfare (EW) experts at Harris Corp. will provide the U.S. Navy and Australian air force with 86 sophisticated EW jamming systems designed to protect combat aircraft from incoming radar-guided missiles. Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., have announced a \$161 million order to the Harris Corp. Electronic Systems segment (formerly Exelis Inc.) in Clifton, N.J., to build 86 full-rate production lot 15 AN/ALQ-214A(V)4/5 integrated

Army asks industry for exoskeletons to help warfighters lift heavy loads

BY John Keller

NATICK, Mass. — U.S. Army scientists are reaching out to industry for new ways to relieve infantry warfighters of heavy loads with load-bearing robotic suits called exoskeletons.

Army Contracting Command officials at Aberdeen Proving Ground, Md., have issued a sources-sought notice (01760-5011) called Request For Concept Papers On Exoskeleton Technologies For The Warfighter. The Army Contracting Command is issuing this industry call for papers on behalf of the Army Research, Development, and Engineering Command (RDECOM) Natick Soldier Research, Development, and Engineering Center (NSRDEC) in Natick, Mass.

The U.S. warfighter, whether on foot or in a vehicle, typically is physically overburdened, researchers point out. This increases fatigue, reduces movement and maneuver, and increases the likelihood of acute and chronic musculoskeletal injuries.

Exoskeletons are considered a promising approach to enable warfighters to maintain peak performance for longer than they can today. These exoskeletons are designed to improve strength, endurance, and ergonomics while maintaining

user safety and reducing physical injury risk during various load tasks.

The Army is asking for industry white papers that outline innova-

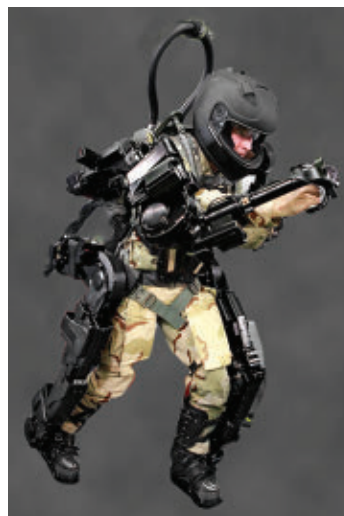
tive exoskeleton approaches to improve warfighter performance while they are moving over uneven terrain, performing ergonomically challenging load tasks for long periods in awkward postures, doing heavy lifting, or other repetitive lifting.

Effective exoskeleton systems demonstrate the principles of user safety, comfort, ease of use, integration with user clothing and individual mission equipment,

energy efficiency to enable long operating durations, and low system costs.

Army experts expect they will need a variety of exoskeleton systems for infantry warfighters and logistics and mission support, for ergonomically challenging tasks, medium and heavy lift and carry, and specialized tasks like explosive ordnance disposal and chemical and biological protection.

Exoskeletons for infantry warfighters would facilitate running and walking for long periods, and help warfighters shoot, move, communicate, protect, and sustain. Logistics and mission support exoskeletons would focus on



The U.S. Army is interested in a new generation of wearable robotics called exoskeletons to help warfighters lift heavy loads and fight at close quarters.

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strength-enhancing or injury-reducing, low- or medium-mobility capabilities during lifting, loading, unloading, and transporting tasks. Light-task and medium-lift-and-carry exoskeletons would help warfighters with ergonomically challenging tasks, and make lifting tasks safer and more effective. Heavy-lift-and-carry exoskeletons would enable one person to perform load-handling tasks that one or more people normally handle. This could serve as a force multiplier, creating a smaller force with greater capabilities.

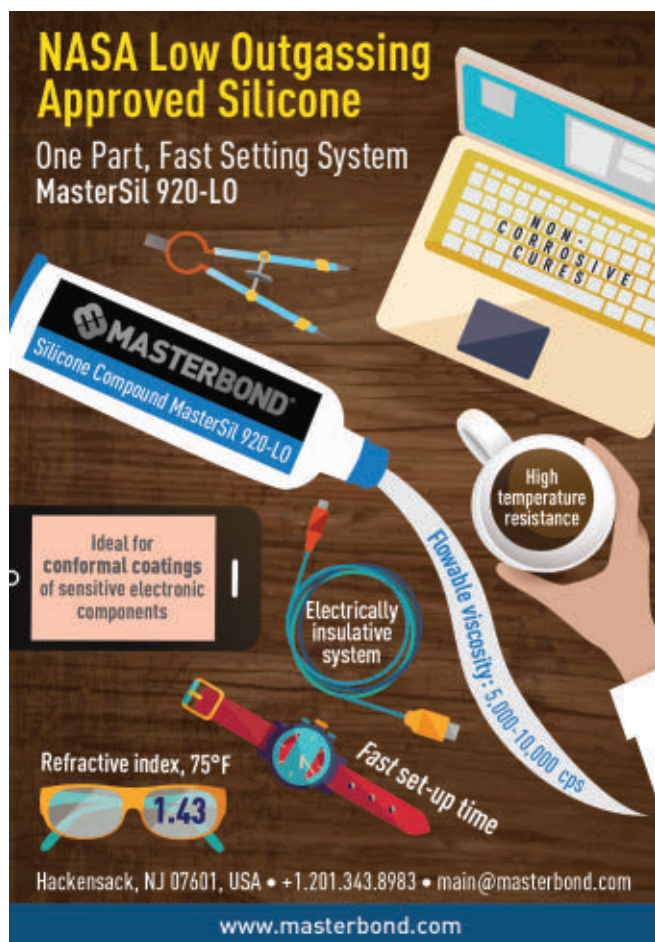
Specifically, Army researchers are looking for exoskeletons that could enable an infantry warfighter to march with loads of 99 to 136 pounds safely and without excessive exhaustion, and walk in a crouch, crawl, or jump obstacles while carrying loads of 75 to 90 pounds.

Exoskeletons should enable infantry warfighters to break down doors and fight at close quarters, load and unload cargo from vehicles, maintain land vehicles and aircraft, dig trenches, carry wounded comrades, and move hundred-pound obstructions to rescue others.

The Army would like to demonstrate some of these exoskeleton concepts as early as this summer. Companies interested should e-mail white papers to the Army's Greg Kanagaki at gregory.b.kanagaki.civ@mail.mil. For technical questions or concerns, contact the Army's Kimberly Pumyea at kimberly.b.pumyea.civ@mail.mil or 508-233-5167. ◀

More information is online at <https://www.fbo.gov/notices/9ba5618073c7bfa2d4abd42e1f5c4ee4>.

defensive electronic countermeasures jammer systems for the F/A-18C/D and F/A-18E/F Hornet and Super Hornet jet fighter-bombers. The AN/ALQ-214A(V)4/5 is an electronic jammer component of the integrated defensive electronic countermeasures system (IDECM) from a joint venture of Harris and BAE Systems. It protects F/A-18 fighter-bombers from radar-guided surface-to-air and air-to-air missiles by jamming the enemy missile guidance systems. The ALQ-214 component of the IDECM EW system has been delivered to the U.S. Navy, as well as to the Royal Australian Air Force for contemporary versions of the Boeing F/A-18 fighter-bomber. The system blends sensitive receivers and active countermeasures to form an electronic shield around the aircraft, Harris officials say. ◀



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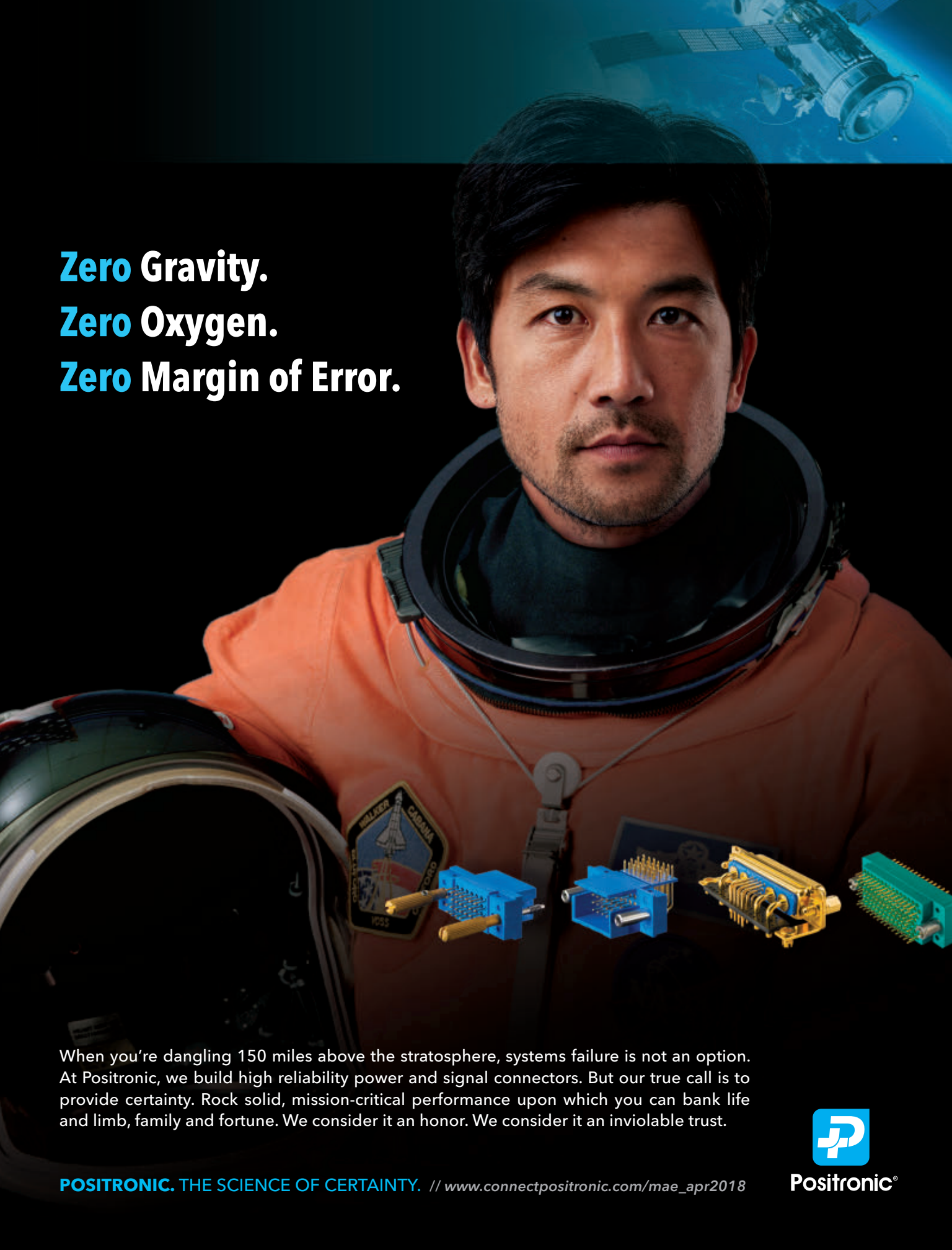
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DARPA asks for cooperating sensors technologies for data-rich urban monitoring

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are approaching industry for new kinds of cooperating sensors to improve urban sensing capabilities for monitoring city traffic flow, crowd management, public safety monitoring, resource use, and environmental protection.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a request for information (DARPA-SN-18-44) on new urban sensing technologies. Responses could support future DARPA programs to improve urban sensing capabilities.

From industry, DARPA researchers are interested in sensor capabilities, sensor packaging, unique and enabling sensor technologies, sensor technology maturity levels, concepts of operations, and system affordability for supporting urban sensing.

Of interest are low-cost, miniaturized sensors and sensor-packaging

designs, with technology maturity levels that could support fielded experimentations within the next one to two years.

Sensor technologies should have extended operation durations, and involve visual, acoustic, optical, radio-frequency, pressure, spectrum, and polarization sensors to capture previously untapped properties and characteristics of urban elements, including crowd, pedestrians, objects, and activities.

The advancement of embedded technologies is driving rapid growth of sensing technologies that can yield data from citywide deployments for monitoring, modeling, and understanding urban activities, researchers explain.

DARPA would like responses from companies, universities, non-profit research centers, U.S. government laboratories, foreign entities, and individuals. Responses should involve technologies at least as mature as component and breadboard validation in the laboratory.



Cooperating and networked sensors could help researchers learn more about city traffic flow, crowd management, public safety monitoring, resource use, and environmental protection.

DARPA's interests include:

- integrated multi-sensor suite technologies;
- composition of sensing elements and specifications;
- sensing operation specifications;
- system-level performance capabilities;
- capability to support cross-sensor elements data integration;
- data communication and networking capabilities;
- processor and storage capabilities;
- ways to reduce power consumption and enhance power harvesting;
- estimated size, weight, and power (SWaP) requirements;
- system affordability (cost) assessment;
- ability to integrate third-party sensing elements;
- technology maturity assessment;
- program outline for maturing the system for demonstration;
- sensing technologies;
- sensor specifications;
- sensing operation specifications;
- special or unique capabilities;
- ways to support cross-sensor, cross-location data integration;
- data communication and networking capabilities;
- processor and storage capabilities;
- affordability assessment;
- technology maturity assessment;
- maturing subsystem technology for integration; and
- maturing the system for demonstration.

Companies interested should e-mail five-page responses to DARPA-SN-18-44@darpa.mil. Email questions or concerns to the same address. ←

More information is online at <https://www.fbo.gov/spg/ODA/DARPA/CMO/DARPA-SN-18-44/listing.html>.

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Raytheon to begin production of upgraded AMRAAM missile with new guidance section

BY John Keller

EGLIN AIR FORCE BASE, Fla. — Aircraft missile experts at the Raytheon Co. are gearing-up to produce an upgraded version of the U.S. Air Force and Navy AIM-120 Advanced Medium Range Air to Air Missile (AMRAAM) to extend the missile's lifetime well into the 2020s.

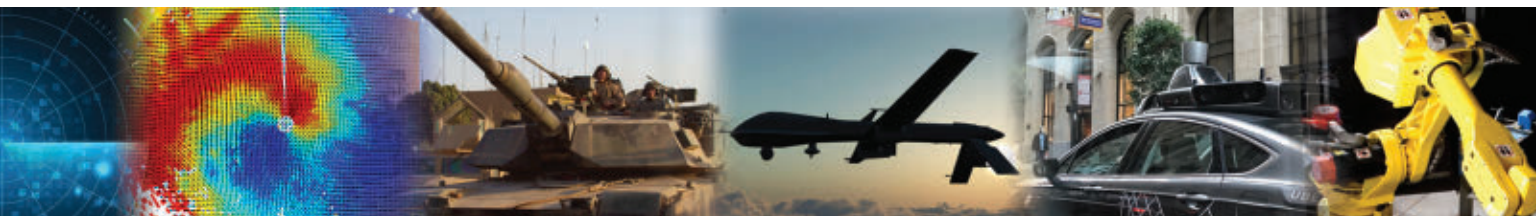
Officials of the U.S. Air Force Life Cycle Management Center at Eglin Air Force Base, Fla., announced nearly a half-billion-dollar order for a redesigned AMRAAM missile with a new guidance section.



The latest version of the Raytheon AIM-120 Advanced Medium Range Air to Air Missile (AMRAAM) will have an upgraded guidance section.

The Air Force is awarding Raytheon Missile Systems in Tucson, Ariz., a \$523.1 million order for AMRAAM production lot 31, as well as for AMRAAM

production lot 32 missiles and other AMRAAM system items. The contract involves foreign military sales to Japan, Kuwait, Poland, Indonesia, Qatar,



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Germany, Australia, and the United Kingdom.

AMRAAM lot 32 is expected to be the first batch of production missiles that integrate the Form, Fit, Function Refresh (F3R) of the AMRAAM guidance section.

The Air Force's AMRAAM F3R project is a comprehensive effort to mitigate the effects of parts obsolescence and diminishing manufacturing sources in the missile's guidance section to enable AMRAAM production beyond lot 31.

The Air Force and Navy AMRAAM is one of the nation's most sophisticated radar-guided, air-to-air missiles, and one of the world's most advanced all-weather, all-environment, medium-range, air-to-air missiles for engaging enemy aircraft and missiles from beyond visual ranges.

AMRAAM is an active radar-guided intercept missile with inherent electronic protection capabilities for air-to-air applications against massed penetration aircraft. AMRAAM has been in service since 1991, and was designed to replace the AIM-7 Sparrow air-to-air missile.

Raytheon won a \$573 million order in March 2016 for AMRAAM lot 30 production. Each AMRAAM lot roughly consists of 400 to 500 missiles.

Mitigating the effects of obsolescence and diminishing manufacturing sources can involve the substantial redesign of subsystems by replacing electronic chips and other components that the original manufacturers no longer can produce.

In 2015, Raytheon experienced technical difficulties with the AMRAAM F3R application-specific integrated circuit (ASIC) design, hardware integration, and guidance section performance demonstration, which delayed the program's critical design review (CDR) for a year.

www.militaryaerospace.com

In January 2017, Raytheon officials announced a project to develop a new signal processor for the AMRAAM under the F3R project to help ensure AMRAAM production well into the 2020s. Air Force officials say they plan to cut F3R technology into the latter part of AMRAAM lot 31 production in 2019 or 2020.

On this order, Raytheon will do the work in Tucson, Ariz., and should be finished this month. ◀

For more information contact **Raytheon Missile Systems** online at www.raytheon.com, or the **Air Force Life Cycle Management Center** at www.wpafb.af.mil/aflcmc.



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COMBAT ROBOTS

As recently as 30 years ago, the only combat robots were in science fiction movies and TV shows. That began to change in 1991 with the introduction of the U.S. military's first — and, by today's standards, primitive — unmanned aerial vehicle (UAV).

The RQ-2A Pioneer's success as an unarmed reconnaissance UAV marked the beginning of a new era in warfare that would make unmanned aircraft of all sizes and mission capabilities ubiquitous and essential in the second Gulf War a decade later. Operation Iraqi Freedom and Operation Enduring Freedom-Afghanistan also saw the introduction of the first ground robots, which U.S. warfighters used to scout caves and check under vehicles for explosives.

Virtually every nation on Earth now operates some form of UAV for military or law enforcement — with many also seeking to develop an indigenous production capability.

Gill Pratt, CEO and executive technical advisor for the Toyota Research Institute Inc. in Los Altos, Calif., and a former program manager at the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., headed that agency's 2015 Robotics Challenge. He compares the current state of robotic development — including unmanned vehicles (UVs) — to the

Unmanned vehicle technology developers focus on artificial intelligence, machine automation, and collaborative algorithms to make tomorrow's robots smarter and more lethal than ever.

BY **J.R. Wilson**



“Cambrian Explosion,” a period roughly 500 million years ago when the diversity and complexity of life on Earth increased at the most intense pace in the planet's history.

Since the Pioneer UAV, the U.S. has progressed to fielding a wide range of unmanned aircraft, from small hand-launched, over-the-hill reconnaissance platforms to the massive U.S. Air Force RQ-4 Global Hawk and U.S. Navy MQ-4C Triton.

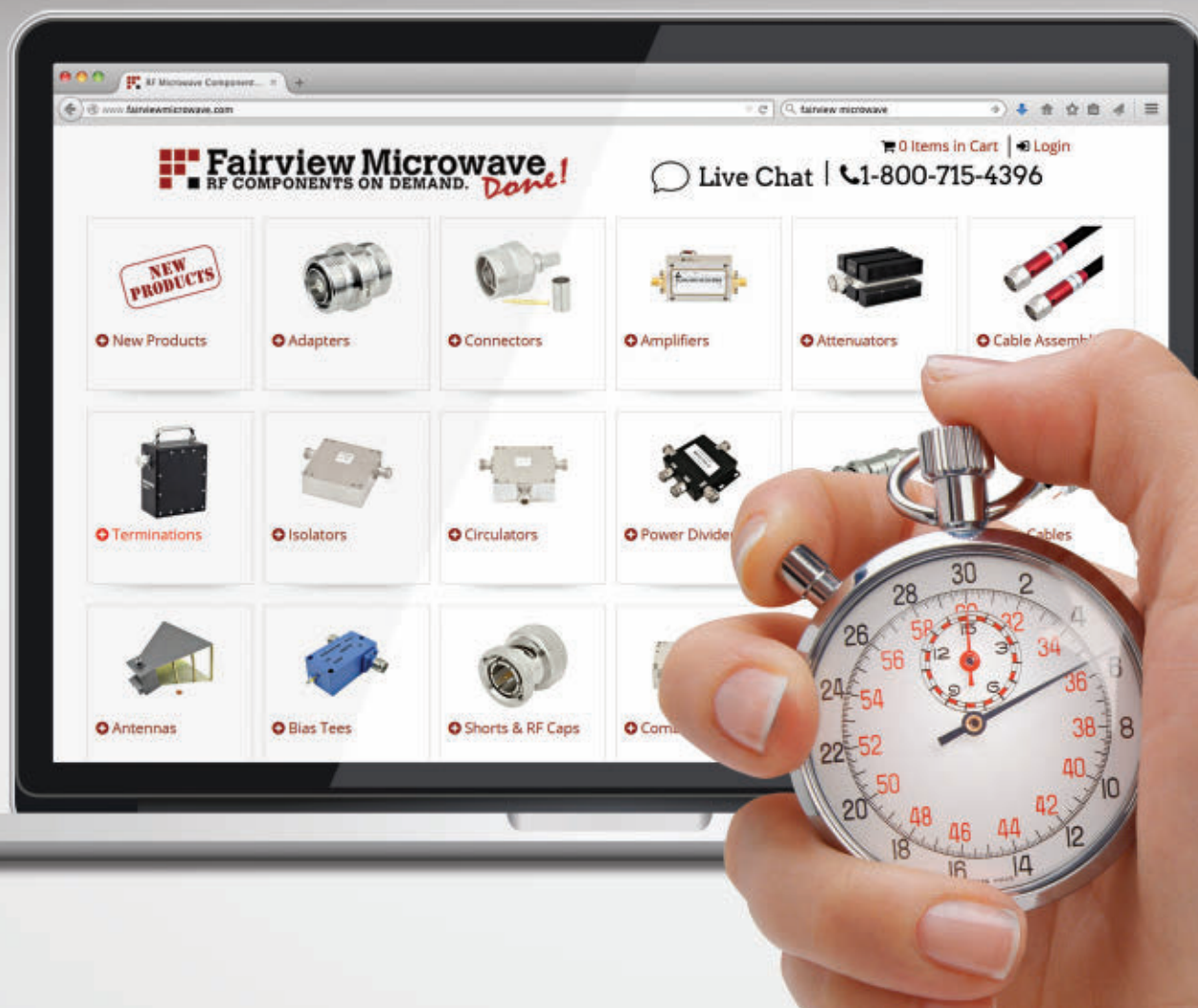
Unmanned aircraft deployment

The U.S. Army, with input from the Marine Corps, is working with DARPA and other U.S. Department of Defense (DOD), academic, and industrial labs to create viable unmanned ground vehicles (UGVs) — wheeled, tracked, and legged. The U.S. Navy, in addition to its unmanned combat air vehicle (UCAV) programs, is seeking to develop unmanned underwater (UUV) and unmanned surface vehicles (USVs) to increase the defensive shield around aircraft carriers, amphibious assault ships, submarines, and other combat vessels.

Other nations, especially Russia and China, also are devoting more

◀ The DARPA Fast Lightweight Autonomy (FLA) competition seeks to provide increased safety and situational awareness to battlefield airmen.

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money and research to future generations of advanced unmanned vehicles and the enabling technologies expected to provide a battlespace edge in an area the U.S. has dominated since 1991.

UVs also have begun to make their mark in civilian applications. UAVs have been proposed deliver pizzas. UGVs are proposed for driverless cars. Unmanned rotorcraft are flown by news organizations, law enforcement agencies, and farmers and ranchers, while public utilities agencies use them to survey power lines, oil and gas pipelines, wildlife populations, forest fires, and highway traffic. Terrorists and criminal organizations also are using UAVs.

“We need unmanned systems that are much more survivable than existing platforms,” says Phil Finnigan, a UAV analyst for The Teal Group market analyst firm in Fairfax, Va. “The next generation needs to be stealthy and much more autonomous, so in the event communications are jammed, it can continue to carry out its mission and return. It needs to have more power, be faster, and be able evade enemy air defenses. Those are all key technologies that will be needed for the next generation.”

Other enabling technologies and capabilities required for those advanced UVs, Finnigan adds, are:

- unmanned logistics for delivering food, water, ammunition, and batteries to forward-deployed troops without risking lives in a traditional convoy;
- refueling, primarily aerial, such as the Navy’s airborne tanker program, but also for ground troops;
- swarming, distributing capabilities among several small, less expensive UAVs; and
- low-cost, disposable platforms for swarms.



As part of its initiative to certify a remotely piloted aircraft to fly in national airspace, General Atomics is creating a certifiable ground control station for MQ-9B pilots.

Enabling technologies

“I think we will see more and more of that due to AI [artificial intelligence] advances on the commercial and civil side,” Finnigan says. “AI is a really key area. China is making a strong push in there, which is a serious concern. The U.S. is still in the lead, but China has made this a national priority, with large investments and a huge focus.”

“Another revolutionary technology is low-cost HALE [high altitude, long endurance]. Some of the systems being developed for the civil and commercial world, primarily by Airbus and AeroVironment, for example, offer tremendous potential for long-term surveillance or communications at low cost,” Finnigan says. “That is being driving by commercial programs, but will have a lot of defense and homeland-security applications.”

A key enabler in the rapid evolution in UV numbers and capabilities to date has been the satellite-based global positioning system (GPS). Providing UAVs and precision-guided munitions with

precise positioning, navigation, and timing (PNT) — against which enemy forces were helpless — has given the U.S. battlespace dominance since Operation Desert Storm. Ironically, as the likelihood of facing peer or near-peer forces in any future conflict grows, a key enabling technology for advanced future UVs will allow the same or better PNT in GPS-denied environments.

“GPS made a big difference and bootstrapped a lot of things, although we want to move beyond being reliant on it to other navigation and time systems that are less vulnerable,” notes Matt Whalley, focus area lead for autonomous and unmanned systems at the U.S. Army Aviation & Missile Research, Development & Engineering Center (AMRDEC) at Redstone Arsenal, Ala. “There is a lot of development in LIDAR [light detection and ranging] for terrain and environment sensing that started out as surveying equipment, but has been repackaged and miniaturized for terrain perception. Computational systems have gotten a lot smaller and higher power.

"We're trying to move beyond the simple interoperability levels we have now, controlling the location of the UAV, to give it the ability to behave in a more intelligent way, which can be very simple or complicated, moving beyond two people controlling one aircraft," Whalley continues. "In certain situations, UAVs have much longer endurance than manned aircraft. The promise is there, if and when we make them more intelligent, to give them teaming behaviors that are more flexible or adaptable than what human pilots can perform."

Sensors, networking, and secure communications will be key to accomplishing that, along with understanding the certification and qualification processes required for those platforms, Whalley adds, noting that today "different pieces are at different levels, so we're working toward trying to pull those together." The ability to sense and act will be key.

"It all breaks down into perception and execution," Whalley says. "I wouldn't say more recent developments in AI have found their way onto these systems quite yet, but that is the desire and is being considered. We're still working on how to integrate those kinds of things."

Adding an advanced man/machine interface is imperative, regardless of the level of AI future systems may incorporate. "There is a whole line of research on how an operator can manage multiple UAVs, which rapidly convey situational awareness to the operator through proper displays of information, all part of developing trust in the system," Whalley explains.

Revolutionary technology

Today's state of the art (SOTA) comprises many technologies — evolutionary and revolutionary — that make the

rapid rise of UAVs to date merely prologue to what is coming, in the commercial and military arenas.

"We are leveraging a lot of advancement in lightweight computing, MEMS [micro electro mechanical systems], high-resolution cameras, then developing a new class of lightweight

algorithms that can run on computers not too different from what's in a smartphone," says Jean-Charles Ledé, program manager for two major DARPA UV programs. "We can do this at high speed, flying through the environment and looking at the video stream in real time. A lot of the systems we use were



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developed for the cell phone industry, then we add advanced algorithms in computer vision, mission planning, advanced flight controls.”

Ledé’s two programs are Fast Lightweight Autonomy (FLA) and Collaborative Operations in Denied Environment (CODE), each of which has potential applications for military and civilian UAVs operating in all domains.

“FLA is about developing autonomous elements in complete RF blackout, no GPS and very little imagery, with all computation and sensing done onboard the platform. The aircraft is loaded with a mission plan, takes off by itself, and flies its mission. If it runs into a dead end, it will back out and find another way through the maze,” Ledé explains. “We mostly use a combination of inertial measurements and video cameras to maintain an understanding of its position and attitude, velocities, etc., integrating that over time to know where it is in the world. We use some laser range finder and sometimes LIDAR to look at the world to avoid obstacles.”

While FLA also can be used for civilian or military ground vehicles or even worn by an individual soldier to determine position and navigate even more precisely than GPS, CODE is more specifically military. Its objective is to develop algorithms to enable teams of unmanned platforms to work together. DARPA’s focus is on UAVs, but the fundamental concept is capable of doing multi-domain, with collaboration among seaborne, airborne, and ground UVs.

Algorithms for autonomy

“We’re really focusing on the algorithms for autonomy, not the platform. Small-footprint computers, embedded computers, and radios are critical parts.

If you have that, I can put in the CODE software and make it a collaborative aircraft, enabling future behaviors, such as the ability to distribute tasks among UAVs, coordinate the task, and reorganize the team based on the mission. And do it in a denied environment, no longer having access to GPS and potentially RF challenged, if not denied,” Ledé continues.

“It also has to work in a target-rich environment, doing all that coordination at a very low bandwidth — no more than 50 kilobits per second. That is a key enabling technology — to look

“Autonomy is not independence; you have to take orders as to the purpose of the mission, and the preference of the user. All that can be expressed in a mission plan. Once the UAV understands those mission objectives, it communicates its execution plan. So autonomy is the ability to choose a course of action that achieves the commander’s intent, not choose the mission. Once a course of action is chosen, it must be communicated back to the commander for validation,” Ledé says.

“CODE just recently entered phase three, where all the advanced algo-



Pictured is an artist’s concept of the CODE program’s focus on improving collaborative autonomy, or the capability of groups of unmanned aircraft systems (UAS) to work together under one person’s supervisory control.

at the value of the information and only communicate what is important. Today’s UAVs will tell you their fuel levels every second, whether you need it or not, which you probably don’t. With CODE, the aircraft will only send information that is impactful and important to the rest of the team,” Ledé describes.

Also critical to the success of CODE is developing the interface to enable man/machine communication.

rithms selected during the first two phases are being implemented into the software and demonstrated in flight. The software can be hosted on any number of computers and operating systems, so platforms can talk to each other. In phase two, we also demonstrated the ability to use live aircraft and virtual aircraft, so multiple countries, manufacturers, domains — all are possible with modified algorithms. And finally, the ability to expand capabilities

beyond what we can do today, enabling future engineers to use the open architecture to upgrade systems.”

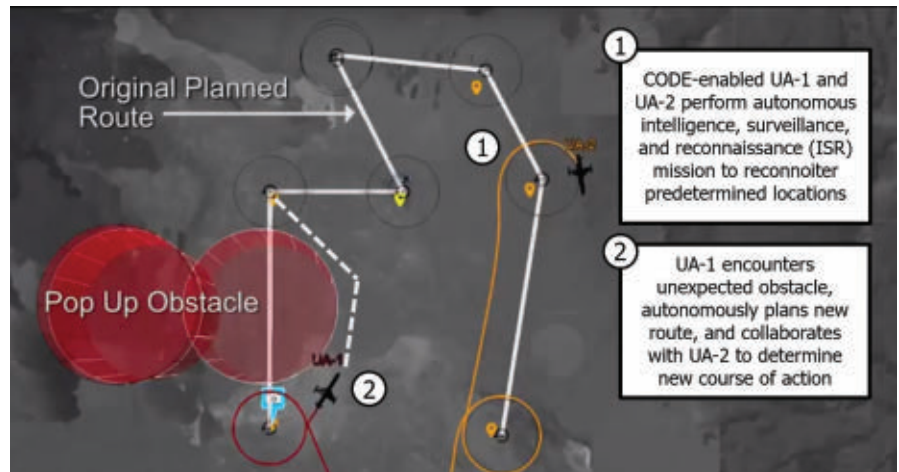
New technologies for future UV operations are not limited to the platform, notes Chris Dusseault, senior director of international programs at UAV designer General Atomics Aeronautical Systems Inc. (GA-ASI) in Poway, Calif.

Centralized ground control

“When UAVs were first deployed, you put the GCS [ground control station] right next to the aircraft, which would take off, go out a couple hundred miles, then return and land at that airfield. Then they decided to put all the pilots in one location — Nellis Air Force Base in Las Vegas — but you still need a local operator to deal with take-off and landing,” Dusseault says.

“The SATCOM Launch & Recovery (Automatic Takeoff and Landing) system is trying to remove the need for the forward location and pilots, which would be a significant cost saving. You

still need a forward maintainer to refuel and turn on the sat system as part of a preflight check. Then the system contacts the pilots in Vegas or elsewhere, who handle the takeoff, mission, and



The DARPA Collaborative Operations in Denied Environment (CODE) program conducted successful Phase 2 flight tests with teams led by Lockheed Martin Corp. in Orlando, Fla., and the Raytheon Co. in Tucson, Ariz.

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landing, then the forward maintainer takes care of the aircraft.”

Another major effort at General Atomics is certifiability to remotely piloted aircraft (RPA), introducing new capabilities, such as detect and avoid avionics, that will qualify future UAVs to be cleared by the FAA (and other global authorities) to fly in the national airspace (NAS), currently the domain of manned aviation. The company’s platform for this effort is the MQ-9B Protector, being built for the United Kingdom’s Royal Air Force. Although a military platform, the United Kingdom (U.K.) does not have the large military air zones the U.S. has for training flights and so must fly through civilian airspace.

“If you want to fly over a populated area, the FAA or CAA [the U.K.’s Civil Aviation Authority] will say it has to be designed to their standards, which requires significant redesign and improvements to the aircraft to give it the same airworthiness as manned aircraft. It has to be able to handle direct lightning strikes, harsh weather, and have all the design margins of FAA standards,” says General Atomics’s Dusseault.

“Once certified, the MQ-9B Protector will break the mold on what it takes to get an aircraft certified for NAS operations, which will have a significant impact on all future UAVs, including those for commercial applications. A large part of what we’re doing is applying known manned aviation standards to UAVs, but the development side is really the Due Regard Radar (DRR), which GA is building as a project that can go on any aircraft large enough to accommodate it,” Dusseault says.

The DRR comprises a two-panel active electronically scanned array (AESA) antenna and a radar electronics



Last summer, the General Atomics MQ-9B remotely piloted aircraft received FAA approval to fly in non-segregated airspace, representing another step toward eventual certification of an RPA to fly in national airspace.

assembly to enable a UAV pilot to detect and track aircraft across the same field-of-view as a manned aircraft. AESA technology allows DRR to track several targets while simultaneously continuing to scan for new aircraft.

Deconflicting unmanned traffic

“We’re focused on deconflicting the low-altitude airspace and safe airspace integration, enabling beyond visual line-of-sight flying, using sensors that create an accurate 3D image of what’s out there. You also can use that data for security applications around critical infrastructure,” says Craig Marcinkowski, vice president of strategy and business development at Gryphon Sensors.

“Everything we do right now is basically ground sensors — radars, EO/IR cameras, and weather sensors — to get an airspace picture. That can be used in multiple models, using a common infrastructure. In an unmanned traffic management [UTM] system, we can

interact with other sensors. We’re doing fixed infrastructure around test sites, for example, but we also have our Mobile Skylight System on a 35-foot telescoping mast, with multiple masts and different sensors in use at the same time,” Marcinkowski says.

Gryphon’s approach seeks to fill the gap from ground to “below the radar” levels — basically, 500 feet and below.

“In radars, we design sensors from the ground up for UAV traffic management — the low altitude, low-slow-small mission is a very difficult target for radar, which is designed to see larger craft at high altitudes. These are full 3D AESA systems, leveraging next-generation chip technology, including some of our own ASIC chips,” Marcinkowski explains.

“The FAA’s see-and-avoid requirement for pilots created a new problem for unmanned aircraft. We began using ground radar to detect non-cooperating items and show the FAA we can reliably

detect those for unmanned aircraft. That low-altitude aircraft picture didn't really exist until recently, but now that is an emerging and growing market. We're focused on making the system smarter, with more automation."

Ground robots

At the Army Tank Automotive Research, Development and Engineering Center (TARDEC) in Warren, Mich., Dr. Robert W. Sadowski, the Army's chief roboticist, is focusing on Army-specific requirements and future UGVs designed to integrate smoothly into ground force operations and combat environments. That includes the Army's watercraft mission autonomy and some work with transformable systems for riverine, but TARDEC's predominant focus is on UGVs and small UAVs. That includes looking at landing small UAVs on moving ground platforms, a difficult task, but essential to the future use of short-range micro-UAVs.

UGV development has lagged behind UAVs, but the push is now on, especially in light of aggressive Russian and Chinese programs in the land domain.

"Good displays and information technology; a secure wireless network that can handle the EW [electronic warfare] and spectrum challenges of the future; reasonable SWaP [size, weight and power], high-performance sensors that are small, ruggedized, and don't cost a lot; targeting systems; good (and cheap) IR — if you're going to fight robots in the future, all those are going to be needed," Sadowski says.

It is and will remain essential to have UV operators in the same battlespace as the platforms to decrease signal latency, which is an issue when trying to drive a platform on the ground at suitable speeds, Sadowski says.

"In some ways, it's a tougher problem on the battlefield than NASA faces with its robots on Mars. The ground domain is really hard because it is so cluttered compared to the air and sea domains. We're trying to get latencies under 100 milliseconds — closer to 50 — especially for high-speed, better-than-human

speeds. We've done some long-distance testing over satellite, but it is a challenge," Sadowski explains.

Gryphon Sensors in Syracuse, N.Y., also is working to enable UAV operations in the NAS, using off-platform technology to satisfy the FAA's strict sense-and-avoid requirements.

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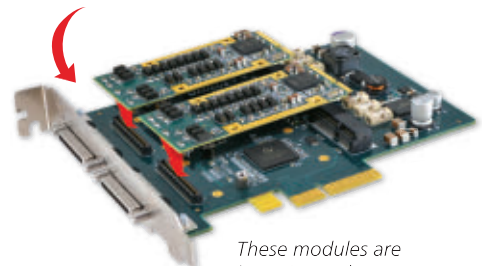
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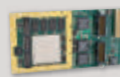
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Autonomy: How much is too much?

Any unmanned vehicle, to be fully operational in a complex and confusing battlefield environment, must have some degree of autonomy. One of the major debates among the military, commercial users, politicians, and technologists themselves is what level of artificial intelligence (AI) is required and acceptable in next- and future-generation UVs and other robotics. That is further complicated by the lack of a universally accepted definition of AI.

The development of “smart” systems — from military walking robots able to navigate rough terrain without human guidance to smartphone digital assistants — is on a continuum of machine learning, starting with adaptive (the ability to adapt to a new situation or information in real time) to cognitive (self-learning systems that use data mining, pattern recognition, and natural language processing to mimic

the way the human brain works) to true AI (self-awareness and the desire and ability for self-improvement).

Although the U.S. has the lead in research and deployment of UVs in all domains, the realization that other nations are closing the gap rapidly has led to increased funding, new strategy documents, and the stand-up of new organizations. One of those is a TRADOC program office on Maneuver Robotics and Autonomous Systems (MRAS) under the Army Maneuver Center of Excellence (MCoE) at Fort Benning, Ga.

“The Russians have aggressively pursued this, as have the Chinese, so I’m very happy our MCoE understands the problem,” Sadowski says. “The U.S. is very good at aggregating technologies and figuring out the best way to fight and win with these systems. The question is, are we going to be playing catch-up or staying ahead?”

“The MRAS office is in the early steps, using simulation exercises to

help inform what they want, how to incorporate RAS [robotics and autonomous systems] within the infantry and armored brigade combat teams. They are staffing an initial capabilities document, probably to be released in the next couple of months,” Sadowski continues. “They will then have an operational view of what they think will be their needs across the spectrum, from logistics to leader-follower, engineer support, remoting lethality so the robot, not the soldier, is in harm’s way.”

Basically, all the military services are examining the proper employment of robotic systems, with security and cyber control, for each warfighting option, which Sadowski calls real progress.

“The MRAS strategy document was very high-level, while this gets down to the domain level, how to actually fight with robots, developing the right technologies to make these robotic systems members of the team,” Sadowski says. “We’ve been working that for a while, but this is a more formal process on how to survive on the very lethal battlefield of the future. This is robotics at a much higher, more intense level than what we used in Iraq and Afghanistan.

“Those concepts then will become part of the requirements for future UVs, incorporating real-time processing of video feeds to provide effective perception in a complex electromagnetic environment and synthesized so the commander can make decisions quickly,” Sadowski says. “The goal will be to do reasoning at the tactical level, making the mechanical platform part of the team.”

Human/machine interfaces

“There is a lot of work that needs to be done on human/machine interface, cognitive load — these are things under



The goal of the DARPA Fast Lightweight Autonomy (FLA) program is to find ways to develop algorithms for minimalistic high-speed navigation in cluttered environments and fit through windows.



Military parachute rescue men practice a personnel recovery mission during the PJ Rodeo Competition near Patrick Air Force Base, Fla. DARPA's Fast Lightweight Autonomy program is developing autonomous drone technology to give these highly trained specialists better situational awareness.

active pursuit in the labs now," Sadowski continues. "The goal is how to do real-time updates, advanced situational awareness, solving the perception and prediction problems. Most of what we're working on now is more deterministic systems. AI is less deterministic.

"Some amazing things are being done in that space. Start off with perception: Is that a car, a person, a bicycle? Then prediction, taking stuff between frames and stitch together a temporal message, which leads to planning," Sadowski says. "Prediction has not yet been done by neural nets. With cameras all around my military vehicle, looking 360 degrees, you can train a system now to identify another vehicle that will be getting into your path, predict its path and location, and react accordingly. However, the contextual cues humans use on a daily basis are not yet there — identifying whether an object is someone holding a shovel or holding an AK-47."

An autonomous system can pick out potential dangers constantly, passing

that information back from a forward position to a squad.

"That is something we haven't had before," Sadowski points out. "We also need to give natural language speech to the robot that it can understand, respond to, and get back to me in natural language, not ones and zeroes. That

heterogeneous teaming of man and machine in a tough environment is what we must have to make this relevant. Using robotics to create a protective bubble in the reconnaissance effort is where we're really trying to go, to give smaller forces better situational awareness and do so affordably," Sadowski says.

The multi-domain battle concept is being developed in concert with the Marine Corps. The Army has done a lot of automation of heavy ground logistics, especially leader-follower technology, and so doesn't need 100 percent autonomy. That is now being taken to the next level, building two medium truck company sets, 30 trucks each, to be delivered in a year or so.

"The Marines are looking at delivering 3,000 pounds of cargo autonomously, ground-to-ground or sea-to-ground. The Army likes the idea, but isn't investing in it," Sadowski says. "There are some unique Marine characteristics, such as dealing with very heavy sand and surf, so they probably want something with tracks, where the Army is actively trying to develop small 'mules' that can go for 72 hours." ◀

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Power electronics pursue goals in SWaP and efficiency

New designs and open-systems architectures are enabling power device manufacturers to provide small, lightweight, and power-efficient devices for a wide variety of land, aircraft, and space applications.

BY **John Keller**

Power electronics technology that controls and conditions electric power for complex aerospace and defense integrated systems is relying on new architectural approaches to achieve ever-smaller size, weight, power consumption, and cost (SWaP-C).

Enhanced power efficiency, thermal management, and resistance to the effects of electromagnetic interference (EMI) in power electronics devices like AC-DC and DC-DC converters is helping spawn new military electronics systems that are smaller, more lightweight, more tightly integrated, and easier to cool than ever before.

These small-size, power-efficient devices hold promise for new aerospace and defense electronics applications in unmanned vehicles, surveillance radar, electronic warfare (EW), missiles and missile defense, infrared sensors, wearable electronics, and perhaps even space-based energy harvesting.

One way power electronics designers are achieving their SWaP goals is



VPT Inc. is looking to commercial off-the-shelf (COTS) power technologies to give customers plenty of power performance at a reasonable cost.

by improving efficiency. Engineers at Vicor Corp. in Andover, Mass., are moving beyond traditional power bricks to a different approach in the company's DCM products, which is enabling them to design devices that are two to three times smaller than the company's previous-generation power bricks.

Power efficiency

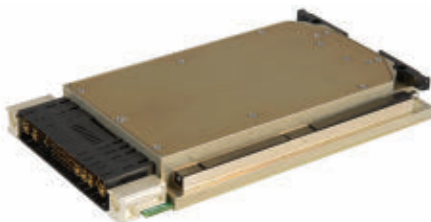
"Efficiency is key," says Kai Johnstad, senior product marketing manager at Vicor. "The more useful power you are converting, the less waste heat you are generating. A lot more of the power

is being converted, but it is easier to cool." Vicor DCM products are not really bricks, but are power components that are in a much smaller package, he says.

"That also means that if we are providing more delivered power, designers can add more features to their products, or add more functions because they have power available," says John Sturm, vice president of sales in the Americas for Vicor.

"What Vicor does differently is our switching topology," Sturm says. "We can switch our converters at a much higher frequency, and it enables us to reduce the size of our magnetic components. That translates into much smaller size and weight than our competitors."

This is different from the company's older power brick designs. "Originally with our brick products, we took advantage of a frequency modulation technique using a switching element — a MOSFET [metal oxide silicon field-effect transistor] — that chops current. Still, switching is something that can cause noise and loss, and we focused on zero voltage and current switching to ensure there is zero current going through the device. The switch only



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turns on or off at zero current to produce nearly a lossless switch.”

Cobham Semiconductor Solutions in Colorado Springs, Colo., specializes in power products for manned space and satellite applications — an environment where power efficiency is a crucial consideration.

“Wide-bandgap technology is a fundamental enabler to achieving that,” explains Tim Meade, staff applications engineer at Cobham Semiconductor. “Size, weight, power, and cost: all those attributes are critical for satellites and this small-sats revolution. To get there we need to be increasing power density,

increasing efficiency, getting smart power, and energy harvesting.”

Energy harvesting

Energy harvesting refers to extracting electrical energy from the environment. Solar arrays and photovoltaics are examples. On Earth, harvesting power from wind power and the kinetic motion of moving waves are obvious applications for energy harvesting, but in space the challenge is more tricky.

Wide-bandgap devices like GaN have smaller gate capacitance and lower gate charge than silicon, Meade explains. The benefit is you can achieve better power density because you can switch the device more quickly and keep it regulated at the target voltage.

“In space, even more exciting, is the prospect of extracting the energy from antennas through RF, and from electromagnetic fields like the Earth’s polar spheres. These have the potential for energy harvesting,” Meade says. “The challenge is how much you can extract from that environment.”

Crucial to achieving the kinds of power efficiencies necessary for new generations of space-based energy harvesting are wide-bandgap technologies like gallium nitride (GaN) and silicon carbide (SiC) semiconductor technologies. Although GaN and SiC technologies still are relatively new, “I do see a lot of interest in the space community to get away from standard silicon and take advantage of these wide-bandgap devices,” Meade says.

Wide-bandgap technologies have to do with voltage, Meade explains. “Wide-bandgap devices have three electron volts, and it has to do with how well-defined the transition is from conduction to non-conduction.”

Wide-bandgap technologies are not the only key to enhancing power

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electronics efficiencies in space. "A satellite is in-itself its own power ecosystem; it generates its own power, conditions it, converts, and distributes it," Meade explains. "It's a wide-open environment for growth and advancement."

Electromagnetic interference

Part of how efficiently a power electronics device operates involves the amount of electromagnetic interference (EMI) it generates. This is particularly crucial as the number of electronic subsystems aboard spacecraft, military planes, ships, and land vehicles increases, which poses the threat of cross-system EMI.

"More power, more systems on aircraft and ground vehicles, and those systems interfering with one another is a big concern," says Brian Paul,

business development manager at Milpower Source Inc. in Belmont, N.H. "EMI has become a major driver for us."

Milpower Source engineers have integrated an EMI filter onto power electronics modules not only to



Cobham is targeting high efficiencies in power electronics for size- and weight-sensitive space applications.

help reduce size and weight, but also to offer open-architecture power devices to save costs and promote component interoperability. "We are one of the few suppliers that can integrate the EMI filter on to the card, so we can produce a product with more capability in a smaller package," Paul says.

Milpower Source offers power modules in the standard 3U and 6U VPX form factor. "MILVPX is our trade name, and as a product family it provides building blocks that our customers can built to, and that are tailorable," Paul says. "This is very powerful within our industry. It's designed from the ground-up for military applications."

Paul says Milpower's gains in efficiency are from the company's

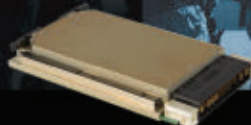
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power circuit designs. “We don’t design bricks; we design with our own power circuits,” he says. “We have a more powerful, efficient design.” This helps the company’s products not only increase in power, but also in their ability to cool waste heat.

“In the 3U form factor, we are seeing growing power levels,” Paul says. “We have more than a 600-watt capability in a 3U form factor. Moving toward conduction cooling — sending heat out through the rails — is a first step. We work with our customers on where they place the power supply, and fundamentally we look at heat early in the process. We have a new VPX product that will be

conduction-cooled, for when you want to move heat more rapidly.”

Architectural designs

Part of Milpower’s success comes from the flexibility of the VPX open-systems architecture, Paul says. “It all comes down to the form factor; if VPX meets the customer’s form factor needs, then we can be flexible in the other aspects of the standard. The standard gives us some direction in the market.”

Using open standards like VPX also enables power electronics suppliers to help their customers control costs. “In the traditional mil/aero market, many programs are getting more pressure to

control their costs,” says Leonard Leslie, vice president of engineering at VPT Inc. in Blacksburg, Va.

“It depends on the customer’s needs,” Leslie says. “Some will demand full-temperature-range hermetic designs because those are the program requirements. But where those requirements have been relieved for cost, then the COTS [commercial off-the-shelf] parts can be a good alternative to save the program money with similar performance — electrically and mechanically — but at a lower price point.”

VPT specializes in power electronics for space, aircraft, and military land vehicle applications. The company offers

COMPANY LIST

Advanced Energy Industries Inc.

Fort Collins, Colo.
www.advanced-energy.com

Aegis Power Systems Inc.

Murphy, N.C.
www.aegispower.com

AMETEK VTI Instruments

Irvine, Calif.
www.vtiinstruments.com

Analytic Systems Ware Ltd.

Delta, British Columbia
www.analyticsystems.com

Anaren Inc.

Syracuse, N.Y.
www.anaren.com

Astrodyne TDI

Nashua, N.H.
www.astrodynetdi.com

AVX Corp.

Fountain Inn, S.C.
www.avx.com

Behlman Electronics Inc.

Hauppague, N.Y.
www.behlmanpower.com

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Concord, Calif.
www.calex.com

Cobham Semiconductor Solutions

Colorado Springs, Colo.
www.cobham.com

Coilcraft Inc.

Cary, Ill.
www.coilcraft.com

Comdel Inc.

Gloucester, Mass.
www.comdel.com

ConTech

Concord, Calif.
www.contech-us.com

Cornell Dubilier Electronics Inc.

Liberty, S.C.
www.cde.com

Crane Aerospace & Electronics

Redmond, Wash.
www.craneae.com

Crystal Group

Hiawatha, Iowa
www.crystalrugged.com

D6 Industries Inc.

Lawrence, Mass.
<https://d6industries.com>

Data Device Corp. (DDC)

Bohemia, N.Y.
www.ddc-web.com

Energy Technologies Inc.

Mansfield, Ohio
www.ruggedsystems.com

Falcon Electric Inc.

Irwindale, Calif.
www.falconups.com

Gaia Converter Inc.

Le Haillan, France
www.gaia-converter.com

General Atomics Electromagnetic Systems Group

San Diego
www.ga.com/ems

GE Aviation Systems

Grand Rapids, Mich.
www.geaviation.com

Infineon technologies (formerly International Rectifier)

El Segundo, Calif.
<https://www.infineon.com>

Interpoint, a Crane Co.

Redmond, Wash.
www.interpoint.com

Keysight Technologies Inc.

Santa Rosa, Calif.
www.keysight.com

Maxim Integrated Products Inc.

Chelmsford, Mass.
www.maximintegrated.com

Murata Power Solutions

Mansfield, Mass.
www.murata-ps.com

North Atlantic Industries

Bohemia, N.Y.
www.naii.com

Panasonic Automotive & Industrial Systems Europe

Hessen, Germany
<https://eu.industrial.panasonic.com>

Pico Electronics Inc.

Pelham, N.Y.
www.picoelectronics.com

Rantec Power Systems Inc.

Los Osos, Calif.
www.rantec.com

Raycom Electronics Inc.

Dover, Pa.
www.raycomelectronics.com

Renesas Electronics Corp. (formerly Intersil)

Milpitas, Calif.
www.intersil.com

Solitron Devices, Inc.

West Palm Beach, Fla.
www.solitrondevices.com

SynQor

Boxborough, Mass.
www.synqor.com

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Hackettstown, N.J.
<http://tdipower.com/>

TDK-Lambda Americas Inc.

San Diego
www.us.tdk-lambda.com

Vicor Corp.

Andover, Mass.
www.vicr.com

VPT Inc.

Bothell, Wash.
www.vptpower.com

full mil-spec hermetic devices, as well as the VPT and VXR COTS power converters, which operate in temperatures from -55 to 100 degrees Celsius.

"The obvious difference is the COTS parts don't cover the full temperature range, so you lose temperature on the top end," Leslie says. "The VXR series are newer parts that have much wider operating capability with a wider input range for operation on aircraft databuses without surge protection."

Among VPT's primary target markets is so-called "new space," which involves relatively inexpensive communications satellites with limited life spans.

"It's a healthy business already with traditional military and commercial space applications, and right now there is a huge interest in new



Vicor Corp. is looking beyond the traditional power brick module to offer new designs that are two to three times smaller than previous-generation power products.

space — all these ventures that are trying to put up large constellations of low-Earth-orbit satellites for Internet coverage.

"There is an interim period where these companies try to put up satellites that need to last five to seven years to be economically viable," Leslie continues. "They can't afford the full-rad-hard, space-qualified parts traditionally sold into a long-duration geosynchronous satellite or military satellite, but they are trying to fill a need."

Can COTS parts fill the needs of these future medium-duration satellites? Perhaps, but the real answer isn't clear yet.

"We are looking at our COTS parts for that need, but we don't have an answer for it yet," Leslie says. "It's still up in the air with customers, but they are looking at compromises to make their builds viable from a cost perspective." ◀

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Is Trump first president to protect electric grid from EMP and cyber attacks?

President Donald Trump may be the first national leader to call for protecting the U.S. electric and communications grid against an electromagnetic attack. Deep in his new national security strategy, Trump made good on a campaign promise to move quickly to make the fixes that proponents of electromagnetic pulse (EMP) and cyber attack have long called for. Two of the chief advocates, William R. Graham and Peter Vincent Pry, executives of the nation's first Congressional EMP Commission, said in a statement, "President Trump understands, even if everyone in his administration does not, that strategic stability and longstanding strategic relationships with Russia or China are best maintained — not by a policy of mutual vulnerability — but by a policy of Peace Through Strength. Protecting the nation from all missile threats and EMP should be the cornerstone of a 'Peace Through Strength' policy." The duo claim that protecting the grid would not be expensive and could be done fast and with commercial products, a solution Trump endorsed in his strategy.

GaN-on-SiC transistor for C-band radar applications introduced by Integra Technologies

RF and microwave specialist Integra Technologies Inc. in El Segundo, Calif., is introducing the IGT5259L50 fully matched gallium nitride (GaN) on silicon carbide (SiC) transistor for pulsed C-band radar applications that require immediate full power and high gain. The IGT5259L50 high-power GaN-on-SiC HEMT transistor offers 50 watts at 5 to 6 GHz, and matches to 50 ohms and supplies 50 watts of peak pulsed output power at 50-volt drain bias. This product covers the frequency range 5.2

Lockheed Martin wins order for Navy shipboard electronic warfare (EW)

BY John Keller

WASHINGTON — U.S. Navy surface warfare experts are ordering additional advanced shipboard electronic warfare (EW) systems for surface warships like aircraft carriers, amphibious assault ships, cruisers, and destroyers under terms of a \$119.6 million order.

Officials of the Naval Sea Systems Command in Washington are exercising options with the Lockheed Martin Corp. Rotary and Mission Systems segment in Liverpool, N.Y., for full-rate production of AN/SLQ-32(V)6 Surface Electronic Warfare Improvement Program (SEWIP) Block 2 subsystems.

SEWIP Block 2 is an evolutionary acquisition and incremental development program to upgrade the existing AN/SLQ-32(V) electronic warfare system.

SEWIP provides enhanced shipboard EW for early detection, analysis, threat warning, and protection from anti-ship missiles. SEWIP Block 2 will enhance the shipboard EW system's receiver and antenna group to meet the latest threats.

SEWIP Block 2 expands on the receiver and antenna group necessary to keep capabilities current with the pace of the threat and to yield improved system integration, Navy officials say.

Lockheed Martin won a \$98.5 million order in March 2017 for full-rate production of AN/SLQ-32(V)6 SEWIP Block 2 subsystems. In October 2017, the company won a \$148.9 million contract AN/SLQ-32A(V)6 and AN/SLQ-32C(V)6 SEWIP shipboard EW systems. Before that, Lockheed Martin won a Navy award for SEWIP Block 2 in late 2009, leading a team of ITT Electronic



Lockheed Martin is providing the Navy with SEWIP shipboard electronic warfare systems.

Systems (now Harris Corp.), Cobham Defence Electronic Systems, Research Associates Syracuse, and Azure Summit Technology of Fairfax, Va.

The Lockheed Martin Block 2 SEWIP design is based on its integrated common electronics warfare system (ICEWS), which enables rapid reconfiguring of the system with commercial technology.

Mercury Systems in Andover, Mass., is providing advanced radio frequency microwave tuners and intermediate frequency products for SEWIP Block 2. Lockheed Martin chose the Mercury Echotek series microwave tuner and digital receiver, which are optimized for fast tuning and high performance.

Lockheed Martin will do the work in Liverpool, Frankfort, and Hauppauge, N.Y.; Lansdale and Lancaster, Pa.; Andover and Brockton, Mass.; Hamilton, N.J.; West Yorkshire, England; Minneapolis; and Huntsville, Ala., and will be finished by December 2019.

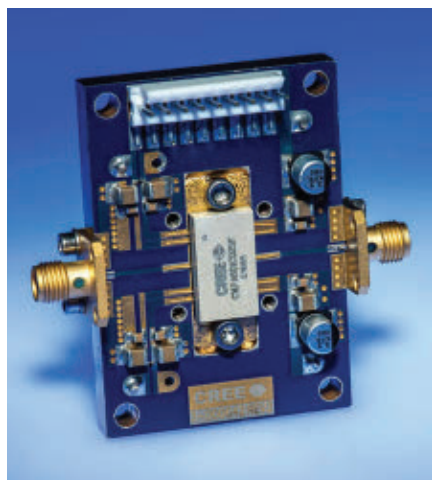
For more information, visit **Lockheed Martin** online at www.lockheedmartin.com/us/rms.

Navy weapons researchers ask for industry's ideas in advanced MMIC ASICs and circuit boards

BY **John Keller**

RIDGECREST, Calif. — U.S. Navy weapons researchers are asking for industry's help in designing complex monolithic microwave integrated circuit (MMIC) application-specific integrated circuits (ASICs) and printed circuit boards for advanced RF and microwave applications like radar, munitions guidance, and electronic warfare (EW).

Officials of the Naval Air Warfare Center Weapons Division (NAWCWD)



Navy weapons researchers are looking for new complex MMIC ASICs and printed circuit boards for radar, munitions guidance, and electronic warfare.

at China Lake Naval Weapons Station in Ridgecrest, Calif., have issued a sources-sought notice (N6893618R0050) for the Advancements in Integrated Circuit Technology Areas project.

Navy researchers are asking industry for white papers on MMIC ASIC integrated circuit signal integrity, packaging, and related topics.

White paper submissions should address advancements in IC technology

areas like ASIC and MMIC design, physical layout, modeling, characterization, fabrication processes, and materials.

Navy researchers would like white papers that address:

- packaging and assembly techniques at the IC and system level;
- printed circuit board design, physical layout, and modeling of prototype design methodology, including circuit boards of 20 layers or more, wiring dimensions of 76 microns or smaller, and boards with micro-via and via-in-via interconnects;
- packaging design technologies such as circuit board construction materials, performance-enhancing layout techniques, and cooling systems;
- signal integrity, power integrity, and thermal integrity analysis techniques at the IC, circuit board, and system level;
- AC and DC power delivery network capabilities including frequency-based impedance at the IC and circuit board level;
- system-level architecture and design at various levels of complexity and integration;
- system level modeling for performance predictions; and
- non-disclosure agreements.

Companies interested should e-mail questions, concerns, and white papers to the Navy's Janet Campbell at janet.campbell@navy.mil with a copy to Sierra Trepanier at sierra.trepanier@navy.mil. ◀

More information is online at <https://www.fbo.gov/notices/fba7f075ad99964695ffbf15beae463>.

to 5.9 GHz with instantaneous response, and features 14 dB of gain, and 43 percent efficiency at 1 millisecond at 15 percent pulse conditions. The device is housed in a RoHS-compatible metal/ceramic flange-mount package with gold metallization. It provides thermal dissipation, and measures 0.8 inches wide and 0.4 inches long. It is 100 percent high-power RF tested in a 50 ohms RF test fixture and meets all specifications of MIL-STD-750D. Internal assembly is with a chip and wire approach by expert certified assemblers. For more information, visit Integra Technologies online at www.integratech.com.

U.S. Army's electronic warfare capabilities hit the ground in Europe

U.S. Army soldiers with the 2nd Cavalry Regiment, 173rd Airborne Brigade and 2nd Armored Brigade, 1st Infantry Division are the first to receive new electronic warfare (EW) prototype systems that enable them to contest and challenge near-peer adversaries. Soldiers can use the equipment to implement electronic protection and electronic warfare (EW) for their own formations, as well as to detect and understand enemy activity in the electromagnetic spectrum and disrupt adversaries through electronic attack effects. Provided in response to an Operational Needs Statement from U.S. Army Europe, the technologies are interim solutions designed as a bridge to enduring EW programs of record that are still in development. The Army Rapid Capabilities Office and the Project Manager for Electronic Warfare & Cyber teamed with 2CR and other receiving units on a rapid prototyping approach to drive system design, performance, functionality and training to meet operational needs in the near- and mid-term. ◀



UNMANNED vehicles

Navy considers ship-based, long-range Marine Corps UAV for EW, cargo, and reconnaissance

BY **John Keller**

PATUXENT RIVER NAS, Md. — U.S. Navy and Marine Corps aviation experts are thinking about a future ship-based multi-mission unmanned aerial vehicle (UAV) able to operate at extended range and endurance that could be operational as early as 2028.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., have issued a request for information (N00019-18-NORFP-PMA-266-0126) for the Marine Air Ground Task Force (MAGTF) Unmanned Aircraft System (UAS) Expeditionary (MUX) project.

Experts are interested in the future MUX unmanned helicopter or tiltrotor for battlespace awareness; electronic warfare (EW); command, control, communications, and computers (C4); logistics; and fire support to complement the Marine Corps manned MV-22 tiltrotor, F-35B fighter-bomber, and Future Vertical Lift (FLV) cargo aircraft.

Marine Corps leaders intend the future MUX unmanned aircraft to have an unrefueled combat radius with payload of 350 to 700 nautical miles; cruise speeds between 200 and 300 knots; time on station of 8 to 12 hours; internal payload capability of 3,000 pounds; external payload capability of 3,000 to 9,000 pounds; and the abilities to operate from ships and austere fields, to receive aerial refueling, to operate in all weather, and to operate in national air space.

The MUX should be able to handle early-warning missions and support

over-the-horizon networked identification, cueing, and defense against enemy aircraft, cruise missiles, and indirect fires. It also should be able to handle long-range, wide-area persistent air reconnaissance and surveillance while providing overlapping and cross-cued data from several different sensors.

This unmanned aircraft should be able to conduct long range penetrating airborne electro-magnetic spectrum operations against threats in the air, on land, on the ocean, and in cyberspace. Navy and Marine Corps leaders also want this aircraft to handle communications relay, aerial escort, and transport cargo.

The MUX should be able to fly autonomously from start-up to return from amphibious assault ships — including en-route flight, conducting



Navy and Marine Corps leaders are considering a future unmanned aircraft for battlespace awareness, electronic warfare, battle management, logistics, and fire support.

missions, and operating from austere landing fields. This will involve supervisory control and full autonomy.

Companies interested should send responses no later than 7 May 2018 to the Navy's Bradley Lysaght at Building 441 Room 117, 21983 Bundy Road, Patuxent River, MD 20670-1547, with electronic copies to Bradley.lysaght@navy.mil and Michael.treglia@navy.mil.

More information is online at <https://www.fbo.gov/spg/DON/NAVAIR/N00019/N00019-18-NORFP-PMA-266-0126/listing.html>.

DARPA adds two companies to OFFSET swarm reconnaissance drone research project

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are adding defense contractors to an effort focused on developing ways to swarm unmanned vehicles inside cities and towns to enhance reconnaissance capabilities and identify threats to U.S. and allied military forces from standoff ranges.

Officials of the U.S. Defense Advanced Research Projects Agency

(DARPA) in Arlington, Va., are choosing Lockheed Martin in Bethesda, Md., and Charles River Analytics in Cambridge, Mass., to take part in the Offensive Swarm-Enabled Tactics (OFFSET) program.

Lockheed Martin and Charles River Analytics join OFFSET phase-one contractors Raytheon BBN Technologies in Cambridge, Mass., and Northrop Grumman Corp. in Linthicum, Md., on the

project to develop a game-based open architecture to develop and test swarm tactics for specially designed swarming unmanned systems in the air and on the ground for urban operations.

Lockheed Martin won a \$363,505 based contract with a \$135,286 op-



Military researchers are expanding a project to develop enabling technologies for future swarming unmanned aerial vehicles.

tion, and Charles River Analytics won a \$488,063 base contract with a \$148,947 option.

The two companies are considered to be OFFSET “sprinters,” or experiment participants in the OFFSET program, which are doing rapid technology development and integration of unmanned swarm technologies.

Raytheon BBN and Northrop Grumman, meanwhile, serve as OFFSET systems integrators, and are designing open-systems, game-based architectures to run swarm tactics application scenarios. These game-based architectures will have immersive interfaces for collaboration among teams of humans and swarm systems, and a physical testbed to validate developed capabilities.

Lockheed Martin and Charles River, as OFFSET sprinters, will work with Raytheon BBN, Northrop Grumman, or

both, to create and test their own swarm tactics and enabling technologies.

DARPA researchers expect that such swarm systems may lead to new enabling technologies for swarming unmanned vehicles, such as distributed perception, robust and resilient com-

munications, dispersed computing and analytics, and adaptive collective behaviors.

Swarming unmanned vehicles may increase standoff distances for detection and identification of potential dangers, offer increased safety and surveillance, and enhance intelligence preparation of the battlespace, DARPA officials say.

The OFFSET program focuses on two key areas to increase the effectiveness of small-unit combat forces operating in the urban environment: swarm autonomy for agile, complex, collective behaviors for intelligent movement, decisions, and interactions with the environment; and human-swarm teaming, enabling swarm commanders to infer, interact with, and influence swarm system behaviors.

Emphasis is on open software and systems architectures, game software design and game-based community development, immersive interactive technologies, and robotic systems integration and algorithm development for distributed robotics. ◀

For more information, visit **Lockheed Martin** online at <https://lockheedmartin.com>, **Charles River Analytics** at www.cra.com, or **DARPA** at www.darpa.mil.

Lightweight hyperspectral imagers bring sophisticated imaging capability to drones

Researchers have used 3D printing and low-cost parts to create an inexpensive hyperspectral imager that is light enough to use onboard drones. They offer a recipe for creating these imagers, which could make the traditionally expensive analytical technique more widely accessible. Hyperspectral imagers produce images like a traditional color camera but detect several hundred colors instead of the three detected by normal cameras. Each pixel of a hyperspectral image contains information covering the entire visible spectrum, providing data that can be used, for example, to automatically detect and sort objects or measure ocean color to map harmful algae blooms.

China reportedly begins testing effectiveness of unmanned main battle tanks

Images have emerged showing an unmanned People's Liberation Army (PLA) Type 59 main battle tank being remotely operated, an indication that China has begun trials of unmanned tanks as part of a push to modernize its armed forces. The images, which stem from video footage released around mid-March by state broadcaster China Central Television (CCTV), show a Type 59 tank equipped with additional antennas being driven at an undisclosed location by a soldier sitting at a nearby remote operating station. The move marks the first time a Chinese unmanned tank has been unveiled to the public, according to the state-owned *Global Times* newspaper. Many the PLA's 2,500 obsolescent Type 59 tanks could be converted into unmanned vehicles if equipped with artificial intelligence, says Liu Qingshan, the chief editor of *Tank and Armored Vehicle*. ◀

Revolutionary metalens can focus all visible light on one point

Researchers have created the first metalens that can focus the entire visible spectrum of light onto a single point in high resolution. The breakthrough brings metalenses one step closer toward replacing bulky camera lenses with much smaller chips, PetaPixel reports. Instead of using solid pieces of curved glass to focus light, meta-material lenses are covered with an array of "titanium dioxide nanofins" that helps focus light on a point in exactly the same way. The latest metalens is able to eliminate chromatic aberration, a common issue in modern camera lenses. This is when lenses fail to focus all colors on the same point, causing colored or rainbow edges to appear in areas of contrast in photos. Prior to this development, eliminating chromatic aberration has only ever been achieved in conventional lenses by stacking multiple lenses, experts say.

Has invisibility material been created?

Researchers have developed a material that could make people or objects invisible to infrared night-vision tools. The primary application would be military use. The counter-infrared material is based on fictional dinosaurs and squids. While these fantasy elements add a touch of the esoteric, the resultant technology has a practical use and it could be used to protect soldiers and structures. Devised at University of California at Irvine, the material rapidly alters how it reflects heat. This makes the material invisible to infrared night-vision sensors. The research shows how thin swatches of material can speedily alter how they reflect heat. This is by smoothing or wrinkling their surfaces in less than one second, following an activity like being stretched or being subject to an electrical trigger.

Raytheon to provide multispectral targeting sensors for unmanned aircraft

BY **John Keller**

WRIGHT-PATTERSON AFB, Ohio—U.S. Air Force electro-optical surveillance experts needed next-generation multispectral targeting systems for the MQ-9 Reaper attack unmanned aerial vehicle (UAV) and other reconnaissance aircraft. They found their solution from the Raytheon Co.



Raytheon is building multispectral targeting systems with high-definition cameras, a diode pump laser designator and rangefinder, laser spot search and track, and three-mode target tracker.

Officials of the Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, announced an \$87.1 million contract to Raytheon Space and Airborne Systems in McKinney, Texas, for 44 AN/DAS-4 multispectral targeting system (MTS) Model B high-definition and target location accuracy turrets.

The AN/DAS-4 offers four high-definition cameras covering five spectral bands; a three-color diode pump laser designator and rangefinder; laser spot search and track capability; automated sensor and laser bore sight alignment; three mode target trackers; and built-in provisions for future growth.

The AN/DAS-4, the latest variant of the Raytheon MTS family of sensors,

incorporates greater fire control and target location accuracy technology than previous MTS versions for precise coordinates.

The AN/DAS-4 MTS enables mission commanders to use high-definition data from an airborne tactical sensor to identify and engage targets with greater accuracy. This sensor system

also is going aboard the U.S. Navy MQ-4C Triton long-range maritime patrol UAV.

This advanced electro-optical and infrared (EO/IR) system provides tracking and laser designation for the Griffin and Paveway missiles, as well as all tri-service and NATO laser-guided munitions. MTS sensors offer several fields of view, electronic zoom, and multi-mode video tracking.

This contract also includes one lot of production support and capacity increase; one lot of initial spares and shop-replaceable units; and one lot of associated data. The contract also involves foreign military sales to France.

L-3 Technologies Advanced Laser Systems Technology (ALST) in Orlando, Fla., is providing the eye-safe laser rangefinders for the Raytheon MTS.

On this contract Raytheon will do the work in McKinney, Texas, and should be finished by November 2019. ◀

For more information, visit **Raytheon Space and Airborne Systems** online at www.raytheon.com, or the **Air Force Life Cycle Management Center** at www.wpafb.af.mil/aflcmc.

Navy asks Lockheed Martin to build 69 new open-architecture shipboard electronics displays

BY **John Keller**

WASHINGTON — U.S. Navy shipboard electronics experts are asking Lockheed Martin Corp. to build 69 open-architecture enterprise displays for Navy surface warships, submarines, and aircraft under terms of a \$8.9 million order.

Officials of the Naval Sea Systems Command in Washington are asking the Lockheed Martin Rotary and Mission Systems segment in Manassas, Va., to provide technical insertion (TI) 16 Common Display System (CDS) variant A air-cooled production consoles.

The TI-16 CDS is a set of open-architecture watch station three-eyed horizontal display consoles. This order is for the U.S. Navy and for the government of Japan.

The CDS family is designed to be compatible with commercially available hardware and software; to conform to open-architecture computers and standards; and to incorporate human systems integration design principles, Navy officials say.

This order is a modification to an \$8.1 million contract the Navy awarded to Lockheed Martin in April 2016 for the Technology Insertion 16 production portion of the CDS program.

Lockheed Martin effectively is taking over from DRS Technologies,

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., in 2012. Lockheed Martin was a key partner to DRS on that and 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.

Lockheed Martin will do the work in Johnstown, Pa., and Manassas, Va., and should be finished April 2019. ◀

For more information, visit **Lockheed Martin** at www.lockheedmartin.com/us/rms.html.



Lockheed Martin is building 69 new open-architecture shipboard electronics displays for Navy surface warships, submarines, and aircraft.

Marines developing JLTV air-defense system with laser weapon

The U.S. Marine Corps is putting together a new, mobile air-defense weapon system that's mounted on a Joint Light Tactical Vehicle (JLTV) and could be armed with lasers to bring down enemy threats from above. Marine Lt. Gen. Robert Walsh, deputy commandant for combat development and integration, talked about the laser weapon called Ground Based Air Defense Future Weapon System at a hearing before the Senate Armed Services Committee's subcommittee on sea power. Air defense is a key priority for the Corps as well as the Army, and lawmakers say neither service should be tackling this problem alone. Walsh says the Marine Corps has been focused on countering threats from unmanned aerial systems but is starting to shift focus to longer-range threats, such as aircraft and cruise missiles.

Navy requests \$300 million to develop shipboard defensive laser weapons

The U.S. Navy proposed spending \$299 million in Fiscal Year 2019 on laser systems to protect ships against current and anticipated future threats, as part of a rapid prototyping, experimentation, and demonstration initiative. Navy officials consider laser weapons technology to be a more cost-efficient and effective tool to protect ships from emerging threats, such as unmanned aerial vehicles (UAVs) and small patrol craft that could swarm a surface ship. The Navy wants to purchase four ship-mounted Surface Navy Laser Weapon Systems (SNLWS), which include a High Energy Laser with an integrated low-power laser dazzler, to provide ships with a new means of countering UAVs, fast inshore attack craft, and adversary intelligence, surveillance and reconnaissance assets. ◀

PRODUCT applications

DIGITAL DATA LINKS

L-3 to provide airborne digital data link to connect helicopters and Navy surface warships

U.S. Navy helicopter avionics experts needed a digital data link to enable helicopters to share sensor information in real time with Navy surface warships. They found their solution from L3 Communications-West in Salt Lake City.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a \$25.6 million contract to L3 to build, test, and support AN/SRQ-4 Hawklink common data link systems for the Navy MH-60R Seahawk helicopter.

The AN/SRQ-4 is a situational awareness system that links the MH-60R helicopter with surface warships in the area. It provides command and control (C2), sensor data transfer, data link operation, and built-in test.

The system provides real-time use of aircraft sensors to extend situational awareness over the horizon by enabling surveillance helicopters to data-link radar, video, networking, and acoustic data to Navy Arleigh Burke-class destroyers, Ticonderoga-class cruisers, and other surface warships. Its control systems run on modern open-systems architectures, L3 officials say.

The AN/SRQ-4 supports anti-submarine warfare (ASW) and anti-ship surveillance and targeting (ASST) missions; receives and distributes full-motion video; is IP-enabled and built to work with future network-centric applications; is compatible with the SAU7000 digital messaging interface; and has ruggedized construction and modules that are qualified to Navy shock and environmental standards.

The system is interoperable with the CDL family of airborne terminals not only on the MH-60R, but also on the Fire Scout unmanned aerial vehicle (UAV), the P-3 Orion surveillance turboprop aircraft, and the P-8 Poseidon maritime patrol jet.

It has a touchscreen graphic user interface for control and status, and a growth path to dual-link operation, L3 officials say. The system is interoperable with the Navy SQQ-89 anti-submarine warfare system and shipboard



Navigation Sensor System Interfaces (NAVSSI). It is software-configurable for Common Data Link (CDL) waveforms.

For this contract, L3 will do the work in Salt Lake City; Atlanta; Mountain View, El Cajon, Oxnard, Sunnyvale, and Salinas, Calif.; Exeter and Dover, N.H.; Derby, Kan.; Boise, Idaho; York Haven, Pa.; Bohemia, N.Y.; Littleton and Stow, Mass.; Providence, R.I.; Fort Worth and Cedar Park, Texas; Minnetonka, Minn.; Phoenix; and Toronto, and should be finished by August 2020. For more information, visit **L3 Communications-West** online at www2.l3t.com/csw, and **Naval Air Systems Command** at www.navair.navy.mil.

TEST AND MEASUREMENT

Air Force chooses Marvin Test to provide flightline test and measurement for A-10C aircraft



U.S. Air Force aircraft maintenance experts needed chassis and instrumentation for flightline test and measurement gear necessary to keep the A-10C Warthog ground-attack jet aircraft flying. They found their solution from Marvin Test Solutions Inc. in Irvine, Calif.

Officials of the Air Force Materiel Command at Hill Air Force Base, Utah, awarded an \$8.6 million contract to Marvin to provide chassis and instrumentation to produce PATS-70A test sets used for O-Level and I-Level maintenance of A-10/C aircraft.

The contract includes upgrade kits for existing PATS-70 test sets to the PATS-70A configuration. The contract calls for Marvin to deliver 83 PATS-70A upgrade kits; 35 chassis, portable automated test sets; 153 high-current relay cards; 35 digital multi-meter cards; 118 field-programmable gate array (FPGA) cards; 118 programmable resistive modules; and 118 precision DC sources.

Marvin Test partnered with the Air Force's Ogden Air Logistics Complex at Hill Air Force Base, Utah in 2014 to design, produce, and deploy the PATS-70 test set based on the commercial off-the-shelf (COTS) Marvin Test-207 rugged field test set which replaces the obsolete PATS-30.

The PATS-70A program will enhance the capabilities of the PATS-70 test set to support additional armament and weapon systems, and will support existing avionics test functionality, Marvin officials say.

The Marvin Test-207 is a state-of-the-art portable PXI-based test and measurement platform

for field testing and data acquisition systems. Its proven architecture has been deployed worldwide on several programs like the Marvin Test-206 Maverick Field Test Set, the Marvin Test-235 F-35 Alternate Mission Equipment Test Set, the Marvin Test-209 Common Armament Test Set, and the AN/TSM-205B Hellfire system test set.

It combines the capabilities of the modular PXI architecture in a compact, ultra-rugged, flightline-qualified enclosure. The Marvin Test-207 is for test and data acquisition applications requiring operation under harsh environmental conditions including flightline, back-shop, or airborne applications.

On this contract, Marvin Test will do the work in Irvine, Calif., and should be finished by mid-2019. For more information, visit **Martin Test** online at www.marvintest.com, or the **Ogden Air Logistics Complex** at www.hill.af.mil.

AIRBORNE COMPUTERS

Sikorsky chooses Curtiss Wright for helicopter air data computer and windshield anti-ice controller

Avionics designers at Sikorsky Aircraft Corp. in Stratford, Conn., needed an air data computer and windshield anti-ice controller for several variants of the U.S. UH-60 Black Hawk helicopter. They found their solution from the Curtiss-Wright Corp. Defense Solutions Division in Ashburn, Va.

Sikorsky, a Lockheed Martin company, has awarded a contract to Curtiss-Wright to provide the Curtiss-Wright air data computer (ADC) and windshield anti-ice controller (WAIC) technology for variants of the Black Hawk helicopter delivered to the U.S. Army and foreign military sales customers.

Aircraft use air data computers to provide airspeed and altitude parameters for safe and efficient operation. Helicopters like the Black Hawk can experience changes in their airspeed and altitude measurements when rotor downwash affects the accuracy of pressure measurements. As a result, helicopter fleets often consist of different aircraft that can create additional logistics overheads.

The Curtiss-Wright air data computers seek to alleviate the effects of rotor downwash with



digital filtering that reduces the pneumatic noise in air pressure without adding weight like mechanical solutions. This enables engineers to outfit several different kinds of helicopters with identical air data computers, as long as the computer can hold several sets of configuration data to match the host aircraft.

Curtiss Wright manufactures the Enhanced Software Configurable Air Data Unit (ESCADU) that can hold as many as 15 different aircraft configurations, the Air Data Computer Module (ADCM) that relies on low-drift sensors, and the Computer Controlled Air Data Test Set (CCADTS-2) that calibrates cockpit instruments in situ.

Windshield anti-ice controllers use sensors to detect icing conditions and relay ice-detection information to the helicopter flight crew. Pilots then can use electrical heating elements of de-icing chemicals to prevent ice buildup on the aircraft's windshield.

Curtiss-Wright is manufacturing the air data computers covered by this agreement at its facility in Bournemouth, England, and the windshield anti-ice controller in Santa Clarita, Calif. For more information, visit **Curtiss-Wright Defense Solutions** online at www.curtisswrightds.com, and **Sikorsky** at www.sikorsky.com.

UNDERSEA BATTERIES

Navy looks to BST Systems and EaglePicher for silver-zinc battery technology for undersea systems

U.S. Navy underwater warfare experts are working with two battery companies to provide rechargeable 750 amp per hour silver-zinc battery cells for a deep submergence application on various undersea vehicles.

Officials of the Naval Surface Warfare Center Crane Division in Crane, Ind., announced a potential \$12.5 million contract to BST Systems in Plainfield, Conn., and EaglePicher Technologies in Joplin, Mo., for undersea batteries and support equipment.

BST and EaglePicher will compete for battery orders over the next five years collectively worth \$12.5 million. The companies will provide rechargeable 750 amp per hour silver-oxide zinc battery cells, spare parts kits, and engineering support services related to the silver-oxide zinc cells.

A silver-oxide battery is a primary cell with a very high energy-to-weight ratio. It is available as a button cell, or in large custom-designed version where the superior performance of the silver-oxide chemistry outweighs cost considerations.



These large silver-oxide cells typically are in military applications like torpedoes, submarines, and other undersea uses. Large silver-oxide battery cells also are aboard manned and unmanned spacecraft as reserve batteries.

A silver-zinc battery uses a variation of silver-oxide chemistry, and can deliver one of the highest specific energies of all known electrochemical power sources, and typically can be found in military specialized applications.

On this contract, BST Systems will do the work in Plainfield, Conn., while EaglePicher will do its work in East Greenwich, R.I. The companies will be finished by February 2023. For more information, visit **BST Systems** online at www.bstsys.com, **EaglePicher** at www.eaglepicher.com, and the **Naval Surface Warfare Center Crane Division** at www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Crane. ◀



COMPUTER BOARDS

VME and VPX single-board computers for military uses introduced by Kontron

Kontron Modular Computers in La Garde, France is introducing the Layerscape family of single-board computers with NXP Layerscape Arm-based processors for compute-intensive



aerospace and defense embedded computing applications. The computer board product family has multi-core scalability and will come in versions ranging from low-power dual-core up to eight-core processor variants and beyond on VME and VPX architectures. These boards are for high-performance embedded computing (HPEC), low power dissipation, and longevity. The Layerscape family challenges established solutions in enabling developers of high-performance embedded computing (HPEC) systems. For more information, visit **Kontron** online at www.kontron.com.

ELECTRONIC WARFARE

Wideband transceiver for electronic warfare introduced by Mercury

Mercury Systems Inc. in Andover, Mass., is introducing the SpectrumSeries RFM3101 ultra-wideband microwave transceiver for advanced electronic warfare (EW), electronic protection, and electronic attack applications. Designed in accordance with OpenVPX standards, Mercury's product integrates OpenRFM-compliant receiver and transmitter building blocks with local oscillator (LO) circuitry to deliver phase noise and

high dynamic range performance. The rugged RFM3101 transceiver, which provides affordable full-spectrum coverage, is Mercury's first OpenRFM product in a compact 3U form factor.



OpenRFM is a modular open-systems architecture for the analog domain. By introducing standard electromechanical, control plane, thermal interfaces, and software, it can help streamline the design and integration of digital and analog capabilities in the same device for EW applications. For more information, visit **Mercury Systems** online at www.mrcy.com/RFM3101.

COMPUTER BOARDS

FPGA-based embedded computing board for EW, radar, and digital beamforming introduced by Abaco

Abaco Systems in Huntsville, Ala., is introduc-



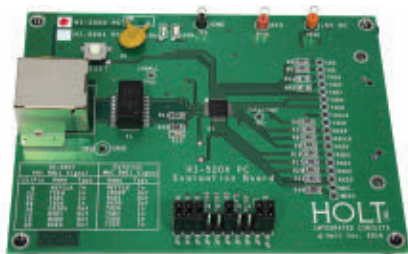
ing the VP889 high-performance field-programmable gate array (FPGA) embedded computing board for electronic warfare (EW), radar and sonar processing, satellite communications systems, multi-channel digital transmission and

reception, and advanced digital beamforming. The VP889 has the latest Xilinx Ultrascale+ FPGA and Zynq Ultrascale+ technology for advanced security, and is a form, fit, and function upgrade for the Abaco VP881. Next-generation signal processing systems require bandwidth, low-power processing capability, and small size on an open COTS platform. With FMC+, customers have as much as 300 gigabits per second digital serial bandwidth to and from modular I/O devices. Integration is simplified, and time to market reduced, via the VP889's Board Support Package which enables engineers to get started quickly and focus on their value-added and proprietary IP rather than hardware implementation details. The embedded Zynq ARM Processor included on the VP889 eliminates the need for a single-board computer in many systems, reducing system size, cost, and power consumption. For more information, visit **Abaco Systems** online at www.abaco.com.

DATA COMMUNICATIONS

Development kits for 10Base-T/100Base-TX Ethernet PHY applications in extended temperatures offered by Holt

Holt Integrated Circuits in Mission Viejo, Calif., is introducing two 10Base-T/100Base-TX Ethernet PHY application development kits — the ADK-5200 and ADK-5201 — that feature the Holt HI-5200/ HI-5201 PHY transceiver family for use in extended temperatures for military and aerospace applications. The ADK-5200 application development kit provides access to all PHY configuration pins and includes a readily accessible MII or RMII interface using HI-5200, which can be connected to an external MAC via the on-board connector. Other features include an RJ-45 Jack for Fast Ethernet cable connection, programmable LEDs for reporting link status and



activity, and a manual reset button for quick reboot after reconfiguration of strapping pins.

The ADK-5201 application development kit is identical but features HI-5201, a 10Base-T/100Base-TX PHY which has an enhanced RMII interface to generate a 50 MHz RMII reference clock output for the MAC. For more information, visit **Holt Integrated Circuits** online at www.holtic.com.

EMBEDDED COMPUTING

Rugged compact PC for embedded computing in manned and unmanned vehicles introduced by Aitech

Aitech Defense Systems Inc. in Chatsworth, Calif., is introducing the A172 low-power, high-performance rugged compact PC (RCP) for embedded computing in manned and unmanned ground vehicles (UGVs) and unmanned aerial



vehicles (UAVs). The computer has a removable storage module that meets DoD 5220.22-M for quick/secure erase. The 1-terabyte, secure, solid-state drive offers MLC and SLC NAND Flash as well as a sustainable read/write speed as fast as 400 megabytes per second. The A172 measures 10.24 by 7.09 by 1.8 inches and features an Intel Core i7 or Xeon processor, several standardized modules, and customizable I/O, CPU, storage, and operating system. In addition, the

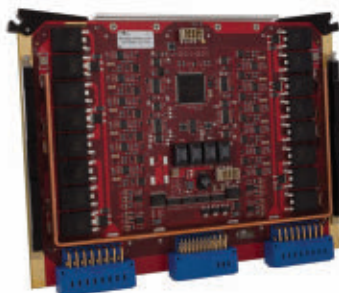
www.militaryaerospace.com

RCP offers added design flexibility with DVI and RS-170A RGBHV video output options, optional WiFi and frame grabber video inputs, as well as trusted platform management (TPM) and a 50-microsecond holdup option for increased system reliability. Available with three Intel processor options and two standard I/O versions, the modular A172 can be configured to handle several data processing environments, especially in high-impact, space-constrained applications that need high throughput and secure storage. For more information, visit **Aitech** online at www.rugged.com.

POWER CONTROL

270-volt 150-amp solid-state power controller for military land vehicles introduced by DDC

Data Device Corp. (DDC) in Bohemia, N.Y., is introducing the RP-28001000N0 MIL-STD-704F-compliant, 12-channel, 270-volt DC, 150-amp solid-state power controller for vetronics in military land vehicles. The RP-28001000N0 offers programmability, system health diagnostic and prognostic data, and high power density in a compact and rugged form factor. Available as a standard off-the-shelf product, the RP-28001000N0 offers time-to-market advantages, while eliminating the costs and risks associated with a custom-developed solution. One of the many benefits of using a COTS solid-state power controller, like the RP-28001000N0, is the high technology readiness level (TRL) solution that it offers systems designers to ensure reliable, SWaP-optimized operation without the need for time-consuming customization and subsequent qualification efforts. The



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RP-28001000N0 employs DDC's technology, with more than a million nodes installed on military and aerospace systems since 1988, including on the Joint Light Tactical Vehicle (JLTV). DDC solid-state power controllers have a 25X improved mean time between failures compared with mechanical switches, breakers, and relays that have moving parts which are more prone to failure. For more information, visit **DDC** online at www.ddc-web.com.

POWER SUPPLIES

AC-DC power supply with transient protection for robotics and machine control introduced by TDK-Lambda

TDK-Lambda Americas Inc. in San Diego is introducing the ZWS240RC-24 AC-DC power supply for robotics and other machine control that require protection from incoming input voltage line transients. The ZWS240RC-24 is rated at 240 watts output power. Certification to over voltage category (OVC) III enables direct connection to the incoming AC distribution panel, saving the cost and space of an isolation transformer. The ZWS240RC-24 accepts an 85 to 265 volts AC input and can operate convection cooled in ambient temperatures as high as 70 degrees Celsius, derating linearly above 50 C by 3.5 percent per degree Celsius. The 24-volt output is adjustable from 21.6 to 26.4 volts to



accommodate non-standard voltages. Overall product dimensions are 84 by 42 by 180 millimeters. Typical hold-up times are 31 milliseconds, providing additional protection against extended input voltage dips. The power supply is certified to IEC/EN62477-1 OVC III, IEC/EN/UL/CSA 60950-1 with CE marking for low-voltage, EMC, and RoHS2 directives. For more information,

visit **TDK Lambda Americas** online at www.us.tdk-lambda.com.

RADAR PROCESSING

3U VPX embedded computing carrier board for FMC and FMC+ modules in radar introduced by Pentek

Pentek Inc. in Upper Saddle River, N.J., is introducing the JadeFX model 5983 3U VPX embedded computing carrier board for FPGA Mezzanine Card (FMC) and FMC+ modules based on the high-performance Xilinx Kintex



Ultrascale field-programmable gate array (FPGA). The model 5983 includes a VITA-57.4 FMC site, and when combined with any of Pentek's Flexor FMCs to create a FlexorSet, it becomes a complete multichannel data-conversion and -processing subsystem suitable for connection to IF, HF, or RF ports of a communications or radar system. The model 5983 is the carrier foundation for a series of FlexorSets capable of hosting FMC and FMC+ modules. The check-off for enhancements include 1.5 times higher performance using 15 percent less power with the Kintex Ultrascale FPGA; 2.8 times increase in FMC bandwidth potential with the FMC+ standard; 1.5 times faster memory transfer rate with 9 gigabytes of DDR4 SDRAM; optional GPS for precise data tagging for time and position; optional 12 gigabytes per second VITA-66.4 optical backplane I/O; and Navigator BSP and FDK for streamlined IP development. For more information, visit **Pentek** online at www.pentek.com

DATA ACQUISITION

Data-acquisition unit for flight test applications like telemetry introduced by Curtiss-Wright

The Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va., is introducing the next-generation, compact Axon data-acquisition unit for flight test applications like aircraft flight test instrumentation, airborne telemetry, flight data monitoring, and space data handling. Axon combines flexibility and scalability with high speed and reliability for demanding flight test applications. The modular Axon data-acquisition device is optimized for size, weight, and power (SWaP) and reduces volume by 55 percent and weight by 41 percent compared to a standard KAM-500 chassis. Axon's hardware-based acquisition engines eliminate data loss, support deterministic operation, and ensure immediate recovery in the case of power brownout. Axon's 1-gigabit-per-second serial backplane enables engineers to place off-the-shelf data acquisition



modules in ultra-miniature Axonite housings and locate them remotely, separated from the chassis by as far as 20 meters. Locating data acquisition closer to the sensors can decrease the installation time and cost of the instrumentation while simultaneously reducing wiring weight. Axonite housings are smaller than eight cubic inches in volume to enable flight test engineers to place their data acquisition hardware in space limited locations. For more information, visit **Curtiss-Wright Defense Solutions** online at www.curtisswrightds.com. ←

919P Series IR Thermal Detectors



The Newport 919P Thermopile Detector Series provides a full range of sensors to meet the power measurement needs for CW or pulsed lasers up to 10.6 μm wavelength. They offer broadband, spectrally flat response, with the maximum power range up to 5000 Watts. These sensors are compatible with Newport 843-R series, 1919-R, 843-R-USB, and 1936-R/2936-R power meters. Fiber adapters are also available.



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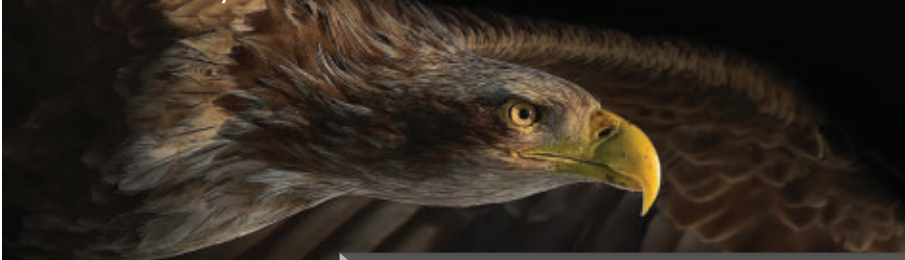
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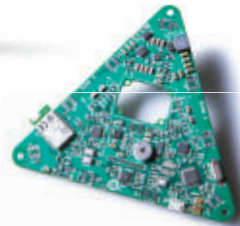




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