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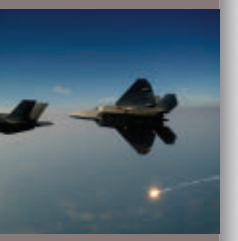
JUNE 2019
VOL. 30, NO. 6

Military & Aerospace Electronics

COVER STORY



Military & Aerospace Electronics® (ISSN 1046-9079), Volume 30, No. 6. Military & Aerospace Electronics is published 12 times a year, monthly by Endeavor Business Media, LLC. Periodicals postage paid at Fort Atkinson, WI 53538 and at additional mailing offices. SUBSCRIPTION PRICES: USA $185 1yr., $327 2 yr., $466 3 yr.; Canada $280 1 yr., $479 2 yr., $618 3 yr.; International $335 1 yr., $638 2 yr., $834 3 yr. POSTMASTER: Send address corrections to Military & Aerospace Electronics, P.O. Box 3257, Northbrook, IL 60065-3257. Military & Aerospace Electronics is a registered trademark.

BY **JOHN KELLER**, EDITOR IN CHIEF ↘

New Website launched for Military & Aerospace Electronics; more changes in-store

THE MIL & AERO COMMENTARY We have launched our redesigned Military & Aerospace Electronics Website — one of many upcoming enhancements we are making to our online presence, electronic newsletters, print magazine, Webcasts, and other features to help our readers.

In case you don't know what I'm talking about, head over to www.militaryaerospace.com, and see the changes we've made. It has a cleaner look and feel, easier navigation, and others to help readers get what they need from our Website, fast, and get back to their jobs.

This is the first major overhaul of the Military & Aerospace Electronics Website in years — perhaps even decades — and our changes are engineered to keep with the times. This includes faster page loads so you no longer have to get up for another cup of coffee as that big photo file loads.

Not only is it easier for you to bring up our latest content at Military & Aerospace Electronics, but behind the scenes it's now easier and faster for us as editors to create and post relevant content to keep you up to speed in your industries. Over the next several weeks and months, expect to see us experiment with new kinds of content — and more of it — to keep you abreast of the defense and aerospace electronics industry.

Our upgrades are not coming without hiccups, however. It's still a work in progress. We're cataloging necessary changes as quickly as we can, and are getting them fixed. It will seem like no time before we're up and running smoothly, and are ready for even more improvements.

This is the first major overhaul of the Military & Aerospace Electronics Website in years — perhaps even decades — and our changes are engineered to keep with the times. This includes faster page loads so you no longer have to get up for another cup of coffee as that big photo file loads

Why the upgrades, you might ask? It's part of the transition of Military & Aerospace Electronics from our former parent company, PennWell, to our current owners, Endeavor Business Media, based in Nashville. At Endeavor Business Media, business-to-business media initiatives are the top priority. In the end, we expect to make our readers the biggest winners.

The same kind of improvements you see to the Military & Aerospace Electronics home page you also will see on our sister Website, Intelligent Aerospace, at www.intelligent-aerospace.com: cleaner look, faster read, and more relevant content.

The changes won't stop there, either. Look to see improvements reflected in future print editions of Military & Aerospace Electronics, which you still can see online at https://www.militaryaerospace.com/magazine/573444.

Improvements also are coming for our twice-weekly electronic newsletters, as well as our Defense Executive, Embedded Computing, Unmanned Vehicles, and Trusted Computing monthly topic-specific electronic newsletters. Soon our enewsletters also will have a cleaner look and feel, and will give you a faster read, as well as more content.

It's all part of our efforts to make Military & Aerospace Electronics a must-read for you and your colleagues. Cleaner look, faster reads, more content, and anything else we can do to make your business lives easier and more productive.

Take a moment, if you like, to tell us what you like and don't like about our new Website design. Email me at jkeller@pennwell.com to give me your opinions. We'll do everything we can to make your most pressing concerns a reality. ←

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news

Sikorsky to build 12 CH-53K heavy-lift helicopters in $1.13 billion order

Engineers at Sikorsky Aircraft Corp. in Stratford, Conn., will build 12 new CH-53K King Stallion heavy-lift helicopters and integrated avionics systems for the U.S. Marine Corps under terms of a $1.13 billion order announced in May. Officials of the U.S. Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking Sikorsky, a Lockheed Martin company, to build 12 Lot II and Lot III low-rate initial production CH-53K helicopters, including logistics and support equipment. These helicopters are part of 200 planned for the Marines. The CH-53K King Stallion is a large heavy-lift cargo helicopter designed to replace the Marine Corps fleet of CH-53E heavy-lift helicopters to help move Marines and their equipment from ships offshore onto attack beaches. The CH-53K is a general redesign of the CH-53E. The CH-53K sea-based, long range, heavy-lift helicopter is designed to provide three times the lift capability of its predecessor. The CH-53K will conduct expeditionary heavy-lift transport of armored vehicles, equipment, and personnel to support distributed operations deep inland from a sea-based center of operations.

B-52 missiles could disable enemy military electronics with high-power microwaves

The U.S. Air Force has deployed at least 20 missiles that could zap the

Researchers ask industry to determine system risk in software assurance

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are turning to industry to find ways of automating the process of software assurance to enable certifiers rapidly to determine whether software system risk is acceptable.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have released a solicitation (HR001119S0057) for the Automated Rapid Certification of Software (ARCOS) project.

The goal of ARCOS is to automate the evaluation of software assurance evidence to enable certifiers to determine rapidly that system risk is acceptable. The process of determining that a system's risk is acceptable is referred to as certification, DARPA officials say.

Current certification practices are antiquated and unable to scale with the amount of software deployed by the U.S. Department of Defense (DOD), researchers say. Two factors prevent scaling: human evaluators to determine if the system meets certification criteria; and little way to decompose evaluations.

Using humans to evaluate software assurance evidence, moreover, results in superficial, incomplete, and unacceptably long evaluations, DARPA researchers say.

The amount of evidence necessary from test and measurement to determine software conformance to certification can be overwhelming to human subject matter experts, who have biases that influence their approach to evaluations. Because certification requirements may be vague or poorly written, evaluators often must interpret what is intended. Combined, these factors result in inconsistencies over time and across evaluations. In addition, there is no means today to compose principled and trustworthy evaluations.

Composed evaluations, however, could enable experts to evaluate software subsystems or components independently, capitalize on the results of those evaluations as assurance evidence. This would amortize the effort of evaluating any component over all systems using that component.

Current practice requires re-evaluation of components and their assurance evidence in every system that employs them. The inability to use a divide-and-conquer approach to certification of large systems increases wastes money and time.

Two factors can help speed software certification through the automation of evaluations. First, DOD leaders

Military researchers want industry to automate the process of software assurance to assess software system risk rapidly.

they want their contractors to modernize their engineering processes in the DOD Digital Engineering Strategy, which seeks to move away from document-based engineering processes and towards design models that are to be the authoritative source of truth for systems.

Such a future does not lend itself to current certification practices, but it will facilitate the automated evaluation of assurance, DARPA officials say.

Second, advances in several technologies suggest that automated evaluation of assurance evidence for software certification is possible. Model-based design technology, including probabilistic model checking, may help software certifiers quantify uncertainty.

So-called big code analytics can help apply semantic-based analytics to software and its artifacts. Mathematically rigorous analysis and verification can help develop software that demonstrably is correct and sound. Assurance-case languages help produce machine-readable arguments on how software fulfills its certification goals.

If successful, ARCOS technologies will move to military program offices that need to reduce certification costs, improve their software evaluations, and better understand their software risks. This technology also should be of interest to contractors who write software for program offices that have adopted ARCOS.

The project seeks to enable an app store approach to outfitting platforms for missions by assurance composition of apps that are added to a baseline platform. The ultimate goal: continuous certification and mission risk evaluation; a compositional certification is a

military electronics of North Korea or Iran with high-power microwaves, rendering their military capabilities virtually useless without causing any fatalities. The U.S. Air Force has deployed at least 20 missiles that could zap the military electronics of North Korea or Iran with high-power microwaves, rendering their military capabilities virtually useless without causing any fatalities. Known as the Counter-Electronics High Power Microwave Advanced Missile Project (CHAMP), the missiles were built by Boeing's Phantom Works for the U.S. Air Force Research Laboratory and tested successfully in 2012. They have not been operation until now. The microwave weapons are fitted into an air-launched cruise missile and delivered from B-52 bombers. With a range of 700 miles, they can fly into enemy airspace at low altitude and emit sharp pulses of high power microwave (HPM) energy that fry computer chips to disable any electronic devices targeted by the missiles with causing any collateral damage.

Boeing ready to deliver first F-15EX jet fighters to Air Force by 2020

The Boeing Co. is ready to deliver at least two developmental versions of the F-15EX jet fighter to the U.S. Air Force as soon as 2020. Boeing officials say the similarities of the military aircraft to the Advanced F-15 — a fighter it is producing for Qatar and Saudi Arabia — means it can be turned out quickly from Boeing's active production line. The proclamation comes as necessary first step.

ARCOS seeks develop the capability to automatically evaluate evidence that software systems meet their certification criteria and generate assurance case arguments. Substantiation of these arguments comes from analysis of four types of evidence: test; simulation and emulation; analytical; and software quality assurance.

To develop trust in ARCOS, assurance arguments need to be compelling for a knowledgeable human evaluator by helping to assess the validity of the generated arguments. These approaches could help assist or automate validity assessments, which not only will check the logical validity of the argument, but also will increase confidence in these arguments, derived from the supporting evidence.

The ARCOS program has four technical areas (TAs): evidence generation; evidence curation; assurance generation; and quantitative assessment. Companies selected for TA4 cannot work in any other technical area.

Evidence curation will develop a common representation that can capture all forms of assurance case evidence. Assurance generation has two goals: developing technology that automatically builds assurance cases for certification criteria; and developing trustworthy technology for validating and assessing the confidence of an assurance case argument. Quantitative assessment will provide progressively challenging sets of artifacts of software systems to measure the progress of ARCOS technologies.

ARCOS is a four-year program, divided into three phases. The first and second phases will be 18 months each, and the third phase will be 12 months long for a total program length of four years. DARPA anticipates several awards for TA1 and TA3, as well as single awards for TA2 and TA4.

Companies interested were asked to submit abstracts no later than 24 May 2019, and full proposals no later than 9 July 2019, at the DARPA BAA Website at https://baa.darpa.mil.

Email questions or concerns to Raymond Richards, the DARPA ARCOS program manager at ARCOS@darpa.mil. More information is online at https://www.fbo.gov/spg/ODA/DARPA/CMO/HR001119S0057/listing.html.

The Army is upgrading the vetronics in its Stryker ECP fleet with new mission computers and network switches.

Wanted: companies to build vetronics computers for Stryker armored combat vehicles

WARREN, Mich. — U.S. Army vetronics experts are surveying industry for companies able to provide mission computers and network switches for the Stryker ECP armored combat vehicle.

Officials of the Army Contracting Command in Warren, Mich., issued a request for information (W56HZV-MissionComputerNetworkSmartSwitch) in mid-May for contractors able to provide a mission computer and network switch for the Stryker ECP vehicle platform.

The Stryker ECP's video display terminal and its replacement video display

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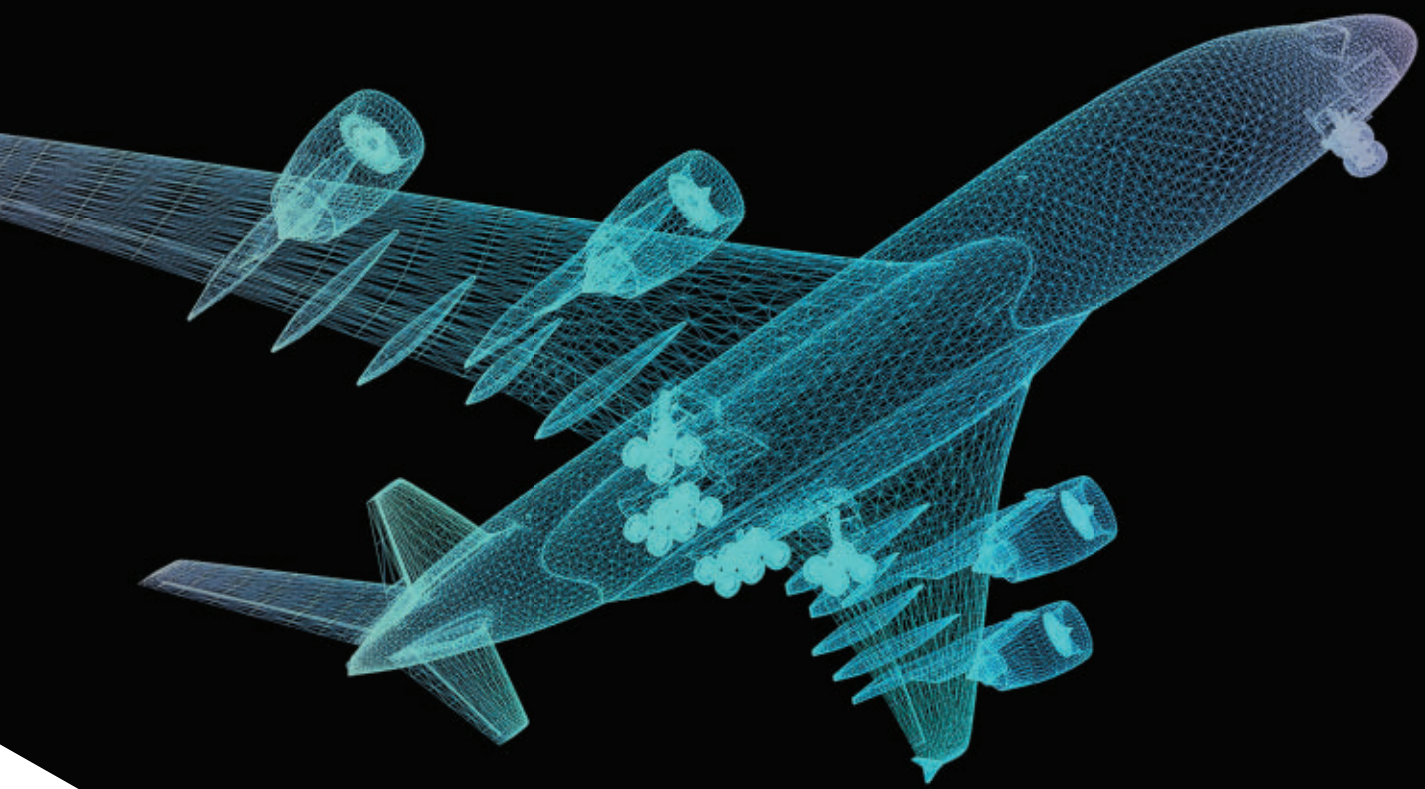

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the House Appropriations defense subcommittee included $986 million in a draft 2020 budget for eight F-15EX aircraft to replace aging F-15C/D jet fighters. The F-15EX is a slightly modified version of the Advanced F-15, which is not in the Air Force inventory. The service is interested in the fighter because its $29,000 per flight hour cost is cheaper than the Lockheed Martin F-35. Also, about 70 percent of the Air Force's existing inventory of F-15 spare parts already work on the F-15EX, and switching squadrons to the aircraft would be faster.

Intel to launch 7-nanometer chips in 2021, next-gen Ice Lake chips by June

For more than year, discussions about Intel Corp. and its microprocessor performance have revolved around delays to the company's 10-nanometer process. Intel's 10-nanometer node has been pushed back repeatedly. Now, Intel will offer 7-nanometer microprocessors by 2021. 10-nanometer chips like the Core i3-8121 are already available. We don't know how wide the 10-nanometer release will be (a recent leak implied 10-nanometer chips would be confined to mobile, with no desktop chips released on that node through 2020). The company announced it would begin shipments of Ice Lake microprocessors in June, promising "approximately 3 times faster wireless speeds, 2 times faster video transcode speeds, 2 times faster graphics performance, and 2.5 to 3 times faster AI performance over previous generation products."

electronic terminal are approaching obsolescence, Army officials say Secure classification separation has also become a concern.

Officials want to know the availability and cost of providing mission computer and network switch that can provide IEEE 1588-2008v2 PTP timing to all the vehicle's networked devices.

This should involve a configuration that can provide a 1-pulse-per-second (PPS) signal, a key-fill interface in accordance with (IAW) IS-GPS-164, and a GPS antenna interface IAW IS-GPS-164 for Stryker ECP armored combat vehicles.

Officials want to know the target cost for baseline and expanded-configuration products in product lots of 1, 100, and 300 units per year. Companies also should identify risk areas that inhibit product development.

The mission computer must be able to drive two independent displays through DVI, accept USB commands from the independent displays, and must be able to read and write CAN and Ethernet messages.

The computer and network interface must include three physically isolated USB 2.0 and 3.0 interfaces; three CAN interfaces; two RS-170 inputs; two RS-232 interfaces; two DVI interfaces; one 100 baseT Ethernet interface; at least 8 gigabytes of RAM; at least 16 gigabytes of data storage; TPM 2.0; and a microprocessor capable of a floating-point base rate greater than 23 when tested using the SPEC CPU 2017 benchmark.

Officials want a description of the product detailing its interfaces, performance specifications, environmental performance, design architecture, size, weight, power, cooling, cost, lead time for initial units, and lead time and delivery schedule for production units.

Responses should identify the proposed product; list its capabilities;

Northrop Grumman is building 42 6U VME-based conduction-cooled Gen III mission computers for the U.S. Marine Corps AH-1Z Viper combat helicopter.

identify its operating temperature ranges, resistance to vibration and shock, its explosive environment suitability, and resistance to sand, dust, and contamination fluids; a list of supported interfaces; ability to drive two independent crew stations; whether TPM 2.0 is supported; its size, weight, power consumption (SWaP), and cooling; lead time for initial and production units; procurement and life cycle support costs over 10 years; and a maintenance approach.

Companies interested were asked to email responses by 12 June 2019 to the Army's Jenelle Vickberg at Jenelle.L.Vickberg.civ@mail.mil. Email questions or concerns to Jenelle Vickberg at Jenelle.L.Vickberg.civ@mail.mil.

More information is online at https://www.fbo.gov/notices/b054a5d3826a8caa724e04f5e-356abc1.

Northrop Grumman to build avionics mission computers for AH-1Z combat helicopter

PATUXENT RIVER NAS, Md. — Avionics and flight computer experts at Northrop Grumman Corp. will provide FlightPro Gen III scalable mission computers for the U.S. Marine Corps AH-1Z Viper attack helicopter under terms of a $7.2 million order announced recently.

Officials of the U.S. Naval Air

Systems Command at Patuxent River Naval Air Station, Md., are asking the Northrop Grumman Mission Systems segment in Woodland Hills, Calif., to provide as many as 42 technical refresh mission computers for the AH-1Z, including trainer units and spare units.

The Northrop Grumman Gen III mission computers are the heart of the company's integrated avionics system that powers the glass cockpit avionics of the Bell AH-1Z and UH-1Y helicopters.

The conduction-cooled Gen III mission computer has a ruggedized 6U VME PowerPC-based single board computer. Interfaces include Fast Ethernet, four serial ports, parallel I/O, and built-in-test. It has a standard partitioned real-time operating system called INTEGRITY-178 tuMP for multicore architectures from Green Hills Software in Santa Barbara, Calif., with ARINC 653 and POSIX support.

The AH-1Z Venom mission computer's standard configuration also includes a quad channel 1553 mezzanine card, high-speed serial card, digital I/O module with eight channels of opto-coupled discrete inputs, eight channels of opto-coupled discrete outputs, and 16 channels of general-purpose bi-directional discretes that can be programmed individually as embedded computing outputs or inputs.

The flight computers use 28-volt DC or 115-volt AC three-phase 400 Hz input power, measure 13.61 by 11.5 by 7.55 inches, and weigh 30.4 pounds. The computers have rated 3,200 hours mean time between failures.

The Gen III computer software is RTCA DO-178C compliant, has ARINC-653 partitioning for safety and security, and complies with the Modular Open Systems Architecture (MOSA) standard. The software is aligned with the Future Airborne Capability Environment (FACE) technical standard, has hardware-independent application software developed to MIL-STD-498, under MIL-STD-882C safety program environmental qualification.

Flight computer hardware is designed to MIL-STD-461D for electro-magnetic compatibility, and is tested to MIL-STD-462 and MIL-STD 810E. FlightPro is conduction cooled, and represents "Quiet Cockpit Technology," Northrop Grumman officials say.

The H-1 Upgrade program is replacing aging AH-1W and UH-1N helicopters with upgraded UH-1Y and AH-1Z aircraft to enhance commonality, reliability, and maintainability. The upgraded helicopters have 100 percent software commonality through Northrop Grumman's IAS and the same operational flight program.

For more information contact Northrop Grumman Mission Systems online at www.northropgrumman.com, or Naval Air Systems Command at www.navair.navy.mil.

Navy asks defense contractors for EA-18G jet electronic warfare (EW) low-band jammer pod

PATUXENT RIVER NAS, Md. — U.S. Navy aerial electronic warfare (EW) experts are reaching out to prime U.S. defense contractors to see who could develop a complete pod solution for low-band tactical RF jammers intended to enable Navy EA-18G Growler carrier-based aircraft to foil enemy counter-stealth radar systems.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., issued a request for information (NGJLBINC2_RFI_051519) in May related to the Next Generation Jammer Low Band (NGJ-LB) program.

The NGJ-LB program is a Department

of Defense (DoD) program intended to replace the aging ALQ-99 tactical jammer pod on the EA-18G Growler carrier-based airborne electronic attack jet. The Navy wants to develop a low-band tactical jammer as soon as possible.

The Government seeks information from potential NGJ-LB prime contractors on their abilities to develop a complete NGJ-LB pod solution.

Naval Air Systems Command wants technical and budgetary information to refine the Government's requirements for Next Generation Jammer Low Band (NGJ-LB) initial operational prototypes.

Two companies, L-3 Technologies Communications Systems-West in Salt Lake City; and the Northrop Grumman Corp. Mission Systems segment in Bethpage, N.Y., already are working on the Navy's low-band NGJ-LB project through contracts announced last month.

L-3 and Northrop Grumman are working on the NGJ-LB Increment 2 Demonstration of Existing Technologies (DET) project, which aims to increase the Navy's knowledge and understanding of existing technologies able to support an airborne wideband low radio frequency (RF) band jamming application where significant SWaP and cooling constraints exist.

Navy combat aviation experts are looking for a U.S. prime defense contractor to manufacture a low-band electronic warfare jamming pod for the EA-18G Growler carrier-based jet.

The NGJ-LB program is an urgent effort to develop low-band tactical radar jammers using existing technologies for low size, weight, and power consumption (SWaP) applications on the EA-18G Growler EW jet.

The NGJ-LB Increment 2 Demonstration of Existing Technologies (DET), which L-3 and Northrop Grumman are working on, aims to increase the Navy's knowledge and understanding of existing technologies able to support an airborne wideband low radio frequency (RF) band jamming application where significant SWaP and cooling constraints exist, such as those on the EA-18G.

Low-band anti-stealth radar can be useful for detecting stealth aircraft like the U.S. F-35 joint strike fighter.

L-3 and Northrop Grumman also are helping the Navy use open-systems architectures — particularly the ability to upgrade tactical jammer subsystems easily — to enhance the long-term system viability of a future low-band tactical jammer — and upgrade the system as necessary to keep pace with evolving threats. Navy officials say they want to develop and field a SWaP-optimized low-band tactical airborne jammer as soon as feasibly possible.

Specifically, L-3 and Northrop Grumman are demonstrating a low-SWaP transmitter in a pod that will fit on Station 6 of the EA-18G; enhance the performance of frequency coverage, effective isotropic radiated power, spatial coverage, spectral purity, and polarization; obtain existing contractor data related to transmitter group performance; and assess the potential to deploy an open-systems interim pod solution rapidly.

This next step now seeks to determine which U.S. prime contractor could develop a pod-level solution for the NGJ-LB aboard the F/A-18G Navy EW jet. Only prime U.S. contractors with classified facility clearances can participate in this program.

Navy officials say they plan to spend $14 million in 2020, $95 million in 2021, and unspecified amounts from 2022 to 2025. From interested companies, the Navy now wants statements of technical capabilities and budget estimates.

Companies interested were asked to notify the Navy of their interest by emailing the Navy's Sara Littleton no later than 22 May 2019 at sarah.littleton@navy.mil.

Responses concerning schedule and technical data were due by 17 June 2019, while responses on budgetary estimates are due by 8 July 2019. Send unclassified responses by post or by courier to Contracting Officer Marisa Scruggs care of 47123 Buse Road, Bldg. 2272, Suite 453, Patuxent River, MD 20670.

Send classified responses by post or by courier with the outer envelope addressed: Department of the Navy, Program Executive Officer PMA 234, Tactical Aircraft Programs, 48183 Shaw Road Bldg. 2806, Patuxent River, MD 20670-1547. The inner wrap should read DEPARTMENT OF THE NAVY, PROGRAM EXECUTIVE OFFICER PMA 234, TACTICAL AIRCRAFT PROGRAMS, ATTENTION: ANTHONY CHING, M/F NGJ LOW BAND (INCREMENT 2), 48183 SHAW ROAD, BLDG 2806, PATUXENT RIVER, MD 20670-1547.

For questions or concerns contact the Navy's Sarah Littleton by email at sarah.littleton@navy.mil, or by phone at 301-757-5522.

More information is online at https://www.fbo.gov/spg/DON/NAVAIR/N00019/NGJLBINC2_RFI_051519/listing.html.

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The Atlas 5 rocket, shown above, is one of today's primary launch vehicles for U.S. military satellites.

Technology and politics of the new U.S. Space Force

If Congress gives the go-ahead, the new Space Force could transform the way U.S. aerospace companies develop enabling technologies for space, and will be a gate keeper for the emerging private launch industry.

BY **J.R. Wilson**

President Donald Trump's effort to create a Space Force as a new, independent branch of the U.S. military is based largely on concerns about the future of Chinese and Russian efforts in military space, which all three nations recognize as a warfighting domain, alongside air, land, sea, and cyber.

Both potential adversaries have proclaimed their intent to surpass U.S. capabilities in space, with many seeing China's programs as initiating a new "space race" reminiscent of the U.S. and Soviet competition to put men on the moon in the 1960s.

While the moon once again is a factor, operations in low-Earth orbit (LEO) and geosynchronous orbit (GEO) are foremost in the minds of U.S. military planners and would be the primary domain of the proposed Space Force.

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"China has expanded by orders of magnitude. The Russians have newly invested in space and developed some relatively exquisite capabilities," Kenneth P. Rapuano, assistant secretary of defense for homeland defense and global security, told the Senate Armed Services strategic forces subcommittee in March. "But the scale of the Chinese investment is the lead in terms of everyone else out there, including Russia. They have more rocket launches this year than the United States. They are the lead rocket-launch nation in the world."

Space is pivotal in U.S. military thinking, Rapuano told subcommittee members. "Our targeting, our communications, positioning, timing, location for GPS. All of the ... capabilities in terms of surveillance and reconnaissance that we get from space. Real-time situational awareness of adversaries' locations and activities. To lose those capabilities would be very significant and that is why we are so focused on defending and protecting them."

Whether or not the politically charged effort to create a Space Force comes to fruition — and, if so, in what format — the basic technology needs for military space through the 2020s will remain the same: upgrading and replacing legacy systems launched into orbit in the past half century, and defending U.S. space assets from attack, either physical or cyber.

As of now, the U.S. Air Force Space Command handles most spaceflight jobs for the U.S. military services. The new U.S. Space Command eventually may take on most of those tasks.

Yet creating a new bureaucracy in the form of a Space Force, in and of itself, is not sufficient to the task, says Fred Kennedy, director of the newly created Space Development Agency (SDA).

"Near-peer and peer competitors have figured out that we gain incredible advantage from our space-based systems and so are investing heavily in ways to directly negate our advantage in space or develop ways to interfere with those capabilities," Kennedy says.

"The problem is the legacy U.S. organizations have become very good at building out very large, expensive capabilities that take a decade or more to build, which is not within the turning radius of our adversaries," Kennedy continues. "To move to something that is quick, agile, and responsive is asking a lot of the legacy organizations and culture, so our thesis is to stand up something new, with a new culture dedicated to speed and rapid upgrades, leveraging commercial developments on an 18-to-24-month cycle."

Dramatic change

That is a dramatic change in procurement and deployment times, but Kennedy says SDA also will incorporate what the legacy organizations do best.

"We will pull from the best practices of all organizations, including DARPA's term-limited appointments for folks who come in and special hiring authorities to get the best and brightest from industry and academia. DARPA has managed to stay fresh for the past six decades by virtue of its quick turnarounds of personnel."

"SDA is not a technology development activity," Kennedy says. "It is a production house. I want to keep SDA fairly small, never more than 100 or so military and government employees. I would like to hold to a one-to-one government to contractor ratio, which

Along with the Atlas rocket the Delta launch vehicle, shown above, has been a workhorse in placing U.S. military satellites in orbit. Privately funded rockets soon may take the lead.

patterns us after the Air Force Rapid Capabilities Office, using a small number of highly expert personnel."

Marco Caceres, senior space analyst for The Teal Group Corp. in Fairfax, Va., not only agrees, but says he believes the growing commercial aspect of U.S. military space will keep America ahead of all competitors without the need for a dedicated Space Force.

"There has been a trend for the last 10 or 20 years that commercial launch technologies are outpacing those strictly used by the military. The difference between a commercial imaging satellite and a military satellite is much closer than ever before," Caceres says. "The military is weighing the options of owning their own satellites versus using commercial. There doesn't seem to be any willingness on the part of Congress to provide huge amounts more money for military space. Even if there is a separate Space Force, I'm not sure that necessarily means the U.S. military will own and operate its own rockets — or what that rocket would be, at this point."

The 2018 version of the Big Falcon Rocket (BFR) - Starship Super Heavy - at stage separation.

"I doubt the launch vehicle situation will change, primarily because of cost," Caceres continues. "As launch prices

come down and the you see the development of new vehicles catering to the entire launch market, I think the military will continue to buy launch services from two or three providers. On the satellite side, there will be a move by the military to develop cutting edge technologies in terms of imaging and early warning, etc., but those satellites will be extremely expensive to develop and build. So, unless Congress allocates a lot more money, there will be pressure on the military to look to private industry to host their payloads — or just lease capacity on commercial satellites."

Caceres and Kennedy agree that this is not a negative but rather a significantly positive approach that will keep the U.S. ahead of its non-capitalist opponents.

"The Chinese and Russians are catching up in terms of their space capabilities," Caceres says. "We're still ahead, but there was such a huge gap that we could only continue for a limited amount of time. But they're still behind and, with our commercial efforts, we're doing a lot more than either. The Russians are using technologies developed in the 1960s and '70s. The Chinese are only doing what we did decades ago. And once you get the ability to reuse your rocket and relaunch in a couple of days, how can the Russians and Chinese compete with that?"

Constellations replace big satellites

The U.S. Air Force Space Command (AFSC) today handles the majority of military space efforts on behalf of the other services and joint operations. AFSC Chief Scientist Joel Mozer believes his legacy organization has learned the lessons upon which Kennedy plans to build SDA — especially moving away from big, expensive satellites to a dispersed constellation of small satellites that can be replaced quickly as new technologies evolve.

The United Launch Alliance's Atlas V rocket launches an advanced weather satellite for the U.S. National Oceanic and Atmospheric Administration.

"The capabilities we have in orbit today were designed, in many cases, for 20-year lifetimes. That isn't to say we won't be upgrading some, such as GPS. We have big GEO satellites going up today that will be around for a while," Mozer acknowledges. "But the trend is to go away from those big, billion-dollar single assets to smaller, distributed capabilities in orbit."

Air Force Lt. Col. Thomas Niday, AFSC's chief of advanced concept requirements & transition, adds a critical key to greater reliance on commercial systems is to ensure they have the level of assurance required for military missions that often far exceed commercial needs. Military-level operations also will require a greater implementation of artificial intelligence (AI).

"AI and machine learning will be critical to rapid, effective decision-making," he tells says. "Without that, the amount of data and the speed required will overwhelm the capacity of unaided operators. So, to quickly assess what is happening will require AI. That is not the same as autonomy, but in support of the operators, assisting them in making rapid decisions."

"AFSC has a lot of innovative S&T [science and technology] efforts underway, a lot of that with industry and academia and government labs, not just AFRL, but DIU [Defense Innovation Unit] and many more," Niday says. "We are looking to help AFRL influence what those organizations are doing in space and help foster those technologies to benefit the joint warfighter in the future."

Servicing legacy satellites

DARPA is launching a new research effort called Robotic Servicing of Geosynchronous Satellites (RSGS) to keep the large legacy GEO satellites functioning,

updated, refueled, and even moved to new orbits. RSGS Program Manager Joseph Parrish says on-orbit servicing is in a transformational stage, building on two decades of DARPA and commercial technology development to be on the cusp of actual deployment, sometime in the early 2020s.

"Most of our targets will be legacy satellites and we are well aware of the limitations and capabilities that RSGS will have in dealing with them," Parrish says. "We're looking at an operational system to service 20 to 30 spacecraft — a combination of government and commercial — in GEO over a multi-year lifetime."

"Robotic manipulators are at the heart of the system, but we're also applying machine vision to approach target spacecraft so the robot can identify the object and where to reach out and touch it without having a human directing the operation," Parrish continues. "We also have technologies associated with self-protection, to keep it from running into the client spacecraft, and to limit the pressure exerted. We have two manipulator arms, one to grasp the client spacecraft while the other does the operations. The target satellite has its own attitude control system that needs to be inhibited so we're not fighting it. The command to inhibit actually comes from the ground control station in cooperation with the client."

The tools, fuel, and other components that RSGS will need to repair or upgrade a target spacecraft will be launched into GEO separately in pods, with which the repair satellite will rendezvous before working on a specific satellite.

"That eliminates the need to launch the RSGS with every possible tool or item it might need in the future," Parrish says.

The RSGS will be designed to handle four types of operations:

- close inspection, or grappling to the client and using cameras on the RSGS to look for micrometeorite damage down to a centimeter in diameter;
- anomaly resolution, or at launch the spacecraft has solar arrays, communications antennas and anything

The SpaceX Falcon Heavy uses the company's upgraded Falcon 9 side boosters.

Flight-scale manipulator arms on the robotic operations test-bed (ROTB) for the RSGS robotic payload are on display during the preliminary design review in July 2018.

else that on orbit folds out from the spacecraft;

- orbit adjustment, or grappling to the target and moving it around GEO to another location or out of GEO to a "dead" orbit; and
- installation of upgraded capabilities, or attaching boxes or other items to the client spacecraft using the robotic manipulators.

"It doesn't happen often, but sometimes something will get in the way of that deployment," Parrish explains of the anomaly resolution segment. "So at the beginning of its life, at its highest value ever, it can't come out of the starting block if the solar arrays or the communications antennae don't deploy. Sometimes it only takes a pound or two of applied force to fix that, which most GEO satellites do not have themselves."

The RSGS also will be designed to upgrade itself, using components launched into orbit in pods.

Keeping GEO satellites in orbit

While it will employ special techniques to replace or repair components or perform on-orbit refueling on legacy satellites not designed for those, DARPA will be working with the producers and users of future GEO satellites to make docking and accessing the areas and components being updated or repaired much easier.

A major point of debate for almost any new technology that U.S. Department of Defense leaders plan to put into space will be international agreements against weaponizing space. Teal's Caceres says even RSGS could be seen as offensive by other nations — or converted to offensive capabilities.

"The Air Force has been wanting to develop laser communications technology for a decade or more," Caceres continues. "Laser capability in general for space and the ability to refuel and repair satellites in orbit are considered relatively benign technologies, but if you can scoot up to a satellite to repair it, you have the ability to destroy it."

SDA is focused on deploying new space technologies in capability layers. Key areas include navigation; countering GPS denial with alternate navigation capabilities; and creating disaggregated apertures in radio frequencies that would not rely on large antennas.

"Something else of critical importance is autonomous, perhaps AI-enabled, battle management," Assistant Defense Secretary Rapuano told lawmakers. "If we have to defend against high-speed weapons, such as hypersonics, we will only have seconds to minutes to respond, which will require a lot of the tactical edge to be on orbit. That is only in development now by DARPA," Rapuano told Congress, adding that future space technologies must be capable of offensive and defensive operations.

"Missile defense technology, for example, and maintaining knowledge of adversary assets; constant custody of time-sensitive targets worldwide, which could include hundreds of targets, 24-7 — we can't wait for a picture to be taken and examined and then have the information to act an hour later," Rapuano told Congress. "An advanced navigation network that will allow us to put extremely precise clocks aboard spacecraft will be important and portions of the AI/military element to enable rapid, autonomous battle management will be critical.

"We don't have to spend a lot of time working on advanced sensors for IR in advanced warning; most of the capability is available to us now, Rapuano continued. "Most of the sensor problems will be building out the quantity we need in a reasonable amount of time instead of only a couple in a number of years. That will be an interesting change to the mindset of the average payload developer."

New space technologies

A wide range of new and evolving technologies are expected to find a home

in military space in the next decade. Satellites will continue to get smaller — micro and nano satellites, even smaller. That has required an ongoing shrinkage in microelectronics.

"With the development of commercial systems such as Starlink [a SpaceX broadband Internet effort], with constellations of thousands of satellites covering the globe, the question is can the military equate or improve on that — or will they just lease capacity on those satellites," The Teal Group's Caceres says. "Everything is communications. Speed, capacity, whether it is targeting, navigation, timing, depends on communications sats. Keeping our GPS satellite system in good working order and as modern as possible is key."

"If we are fighting a war, in space or on Earth, we must be able to communicate," Caceres continues. "You can have a lot of other fancy stuff, such as lasers, but if you can't communicate quickly and have everyone on the same page, you won't have an edge. If you also can have access to space anytime you want by the use of reusable launch vehicles, you're ahead. Right now, we can't do more than one or two Delta or Atlas launches a month. If you can launch every few days, you have a huge advantage. And having reusable launch vehicles, such as SpaceX, is cutting edge technology."

In addition to being fully reusable, SpaceX is working on what will be the largest and most powerful launch vehicle ever built — the recently renamed (from Big Falcon Rocket or BFR) as the Starship Super Heavy. SpaceX CEO Elon Musk says the 387-foot two-stage rocket, set to begin initial testing this year, is designed to carry up to 100 people and 150 tons of food, water, and other supplies to Mars as part of colonization effort, beginning as early as the mid-2020s. In the interim, it will return humans to the moon.

"If Musk makes his BFR rocket real, it will make every rocket in the world obsolete overnight," Teal's Caceres says. "The U.S. military can't possibly match that — nor can NASA. If the new rockets being funded by all these multi-billionaires do what they're supposed to, there's no reason for the military or NASA to spend hundreds of millions of dollars to try to match that. The same is true with satellites. Why not just tap into the system and make sure there are safeguards?"

In addition to providing a technology capability no other nation, especially Russia and China, have or can match, relinquishing the future evolution of military space to private industry resolves the inherent problems of government programs that have kept humans from the moon for nearly half a century and forced U.S. astronauts to pay Russia for access to the International Space Station since the Space Shuttle's last flight in 2011.

"The only thing that has changed with the proposal for a Space Force is the idea of having a more independent body that supposedly can respond more quickly to developing technologies. But until you dramatically reform the procurement process, it doesn't matter if you have an independent Space Force or one under another service," Caceres says.

"The problem with procurement is every time you get ready to develop and set your goals and time lines, somewhere along the process somebody comes along and says a new technology has been developed and if it was put on the system we're close to finishing, it would add capability — but also would add cost and delay development. This keeps happening and is how these programs keep getting stretched out for years until ultimately Congress says we need to cancel them. So, having a new department won't make any difference by itself." ←

The DARPA Blackjack project seeks to develop low-cost space payloads and commoditized satellite buses with low size, weight, power, and cost (SWaP-C) with similar capabilities as today's military communications satellites.

Electronics in space: traditional market faces-off against new space

Spacecraft systems designs today are more cost- and time-to-market-sensitive than ever before, pitting large and expensive traditional designs against a new "good-enough" approach that promises low costs and access to the latest technologies.

BY **John Keller**

The world of radiation-hardened space electronics essentially falls into two camps: traditional space, which features the most costly, reliable, and long-lasting electronic components; and so-called "new space," which capitalizes on commercially developed components adapted for space with low costs and limited life cycles in mind.

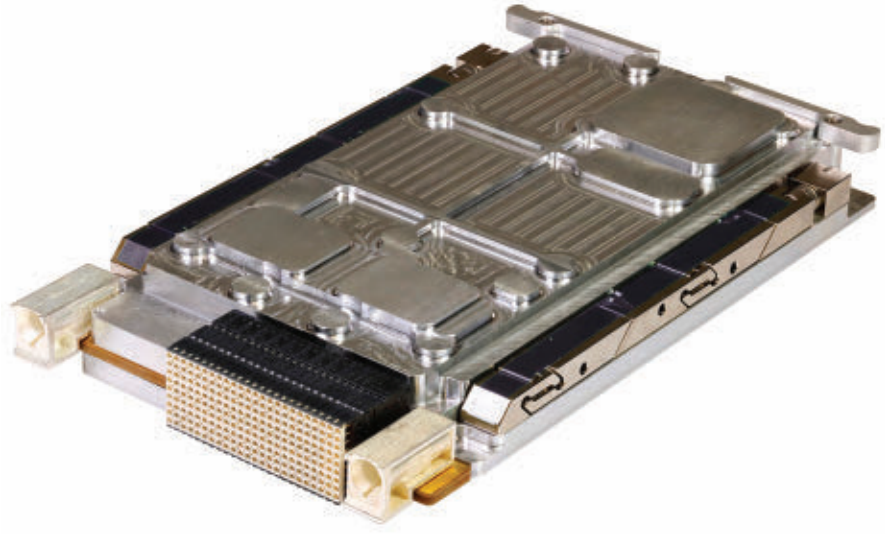
Traditional space has a relatively short list of suppliers, who have been in the radiation-hardened high-reliability electronics business for a long time. Historically it has been a small-but-stable market in which cost rarely is a driving concern, and high-reliability, longevity, and radiation hardness are driving factors.

New space, however, is a very different and quickly evolving animal. It seeks to lower costs, quicken design cycles, and capitalize on some of the latest electronic technologies, yet avoid any kind of over-design that could increase costs and slow development. New space components are designed to be just good enough for the intended application, and can feature relatively short life cycles.

New space represents an exploding market for future generations of large satellite constellations operating in low-Earth orbit (LEO), which hold the promise of blanketing the Earth's surface with wireless voice and data communications, access to the Internet, and new kinds of Earth-observing sensor data.

Those involved in new space rarely are over-concerned with component longevity and flawless performance, because the relatively low costs of this market allow for on-orbit spare satellites. If one spacecraft fails or degrades, another one is ready to take its place.

Overall, these factors make for a volatile space electronics market that is more cost-sensitive than ever before, is experimenting with limited-life-cycle components in large constellations with on-board spare satellites, and yet with enduring need for long-term reliability and radiation hardness — especially in the higher orbits.



Mercury Systems is designing radiation-tolerant 3U VPX solid-state drives for space-based data storage, with upgraded terrestrial-based technology.

Traditional space

Several companies specializing in radiation-hardened electronics have been in business for years. This market involves high-end systems for national defense, long-term NASA space missions, and high-revenue telecommunications.

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Cobham, a traditional rad-hard electronics supplier, also is participate in new space with the company's LeanREL family of radiation-tolerant microprocessors, microcontrollers, memory, and interface integrated circuits (ICs) for small satellite and non-traditional spacecraft applications.

Traditional space involves long-established government standards like the Defense Logistics Agency's MIL-PRF-38535 — the U.S. military specification that establishes performance and verification requirements of single-die integrated circuit devices.

Although demand today has become relatively soft, applications still exist for the most radiation-hardened electronics parts, despite their typically high costs, lag in technology, and long wait times. The market for large expensive satellites that must operate in high geosynchronous orbits (GEO) is stable, but not growing, says Anthony Jordan, senior director of business development for Cobham Advanced Electronic Systems in Colorado Springs, Colo.

"The GEO market is soft, and has been so for the past couple of years," Jordan says. "My sense is there is a little instability in the market where people don't want to invest in a GEO satellite if these large constellations are going to work," says Joseph Benedetto, president and CEO of VPT Components in Lawrence, Mass.

For the time being, however, the traditional space electronics industry is not seeing big changes — at least not yet. "The space market in general is incremental advancing," Benedetto says. "There is a lot of discussion of new space small satellites, but that is not having a lot of impact on the traditional space market. All in all, we are not seeing any huge changes in the industry on what actually are selling."

VPT specializes in some of the most stringently qualified space components, such as discrete components like transistors, diodes, and metal oxide silicon field effect transistors (MOSFETs). "Everything is qualified to JAN and JAN-S — the highest classification," Benedetto says.

Established suppliers

Among other providers of these parts for traditional space, which are designed from the ground-up to be radiation hardened, are the BAE Systems Electronic Systems segment in Manassas, Va., and the Honeywell Inc. Radiation Effects Center of Excellence in Clearwater, Fla.

The government also still needs systems that are hardened for weapons effects, such as the SBIRS [Space-Based Infrared Surveillance] system to monitor for weapons launches. The upcoming Global Positioning System (GPS) program to update the nation's navigation satellites also will electronic components able to survive and operate through nuclear events.

Traditional space, despite its adherence to established designed and technologies, however, is not immune to modern electronics trends. Traditional space still faces increasing needs for ever-smaller and more power-efficient electronics, as well as demands for increasing amounts of on-board processing and high-performance computing.

"Where we used to see a lander or a rover, now we treat them as robots," says Cobham's Jordan. "We don't want that human intervention because there is such a time lag. We just want them to go out and do their jobs and make decisions based on what they just saw and just sampled. Now we are talking about deep learning, machine learning, and artificial intelligence."

This growing demand for capability — in applications typically that have involved technologies that lag behind the state of the art — put traditional space electronics suppliers in a squeeze; now they must provide the best of both worlds. "We are seeing more demand for higher-performance systems, neural networks at the FPGA [field-programmable gate array] or microprocessor level," Jordan says. It's all based on the results you need, and your power budget."

VPT Components still specializes in the highest level of environmental screening for the company's space-qualified transistors, diodes, and metal oxide silicon field effect transistors (MOSFETs), which must meet Joint Army Navy (JAN) standards.

This translates into demand for

high-reliability radiation parts with the latest technologies. "We need more processors per square inch," Jordan says. "We need A/D converters and D/A converters because I want sensors to be as close to the compute engine as possible — especially on digital communications payloads."

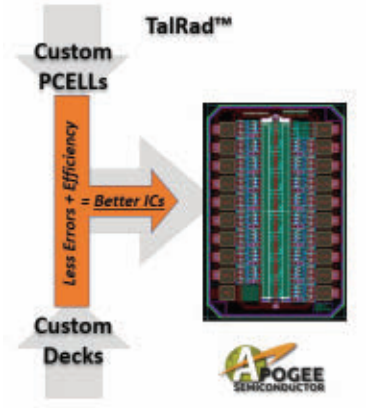
The challenge extends beyond processing and data conversion, and includes power products. "We are seeing new product development focused on additional and improved power products, more distributed power, and more power-hungry components," VPT's Benedetto says. "10 years ago we saw more power management at the input level, and now we see it distributed so that power moves to the components and point-of-load regulators. We're converting the power locally, rather than at one point on the spacecraft."

New space

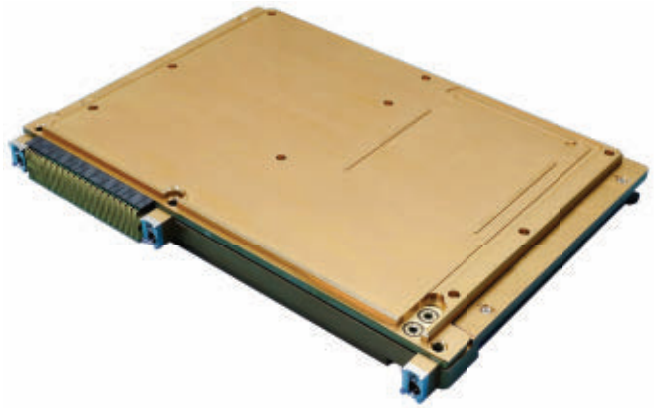
In today's space market, so-called new space is where the real action is. New space describes future large constellations of relatively low Earth orbit satellites with built-in redundancy and on-orbit spares to recover from spacecraft and system failures with few problems and at low costs.

Suppliers for new space applications often start with commercial off-the-shelf parts and alter them to enable the parts to tolerate the radiation and space environment for a limited amount of time, in the interests of relative low costs and access to some of the latest generations of computer technologies.

"We position ourselves as radiation-tolerant equipment for spacecraft in low-Earth orbit, and for launch vehicles that won't be up there for too long," explains Jerry Festa, program manager for space systems at the Curtiss-Wright



Apogee Semiconductor has developed a kit called TalRad — short for transistor adjusted layout for radiation — to attach the high costs of radiation-tolerant electronics.



Adapting commercial off-the-shelf (COTS) technologies for space use with a careful mix of upscreening, judicious use of rad-hard components, redundancy, and error correction is key to today's new space market.

Defense Solutions Aerospace Instrumentation segment in Newtown, Pa.

The challenges of today's radiation-hardened components have discouraged spacecraft designers, and served as barriers to entry for traditional ruggedized COTS vendors like Curtiss-Wright.

"Radiation-hardened equipment has been expensive, and a lot larger than commercial technology," Festa says. The space market, he says, "has kind of gone away from that — not for most of the critical systems, but for things that are not mission-critical, like instrumentation that could be lost momentarily, and no cause loss of life or loss of the mission."

As for the future of traditional space, "the majority of those large GEO satellites are going to go away, replaced by large LEO satellite constellations," Festa says. "You see it now, as people like Space-X are planning their constellations."

Even traditional rad-hard electronics suppliers like Cobham are entering the new space market. Cobham is introducing the LeanREL family of radiation-hardened microprocessors, microcontrollers, memory, and interface integrated circuits (ICs) for small satellite and non-traditional spacecraft applications.

LeanREL ICs are for space-flight, military, and aerospace applications that need to operate and survive in harsh environments while remaining cost competitive.

Based on the same QML pedigree and silicon as the

company's HiRel solutions, Cobham's LeanREL ICs can enable cost savings of as much as 60 percent, depending on quantities, to extend mission durations beyond that of typical off-the-shelf ICs and speed-up time to market for space applications through rapid prototyping.

Modified COTS for space

Curtiss-Wright offers design approaches that can accommodate space applications economically and with modern technology. "Where customers are worried about single-event upsets, we have a rad-hard backplane that goes on the back of stacks of data-acquisition modules," Festa says. It has radiation-hardened components, but the modules are COTS. If you have an upset, the current usually spikes, and we monitor for that. The customer can program those limits, and the backplane resets the power to clear the latchup. The modules can survive as many as 120 latchups with no degradation."

Mercury Systems in Phoenix takes a similar approach for the company's space-qualified solid-state drives (SSDs) for data storage. "We use all components that are rad-tolerant by design, put them into the drives, and then build a space version of the product," says Bob Lazaravich, director of secure storage at Mercury Systems.

Built-in redundancy is a key part of Mercury's space design approach. "In space you need triple-redundancy to make sure it works for as long as possible," Lazaravich says. "We use an FPGA that has all the gates triple-redundant." The FPGA is the RTG4 from Microchip Technology Inc. in Chandler, Ariz. "That is the heart of our space drives now, Lazaravich says."

Another step that Mercury has taken toward the space market is eliminating microprocessors entirely in their solid-state drives. "There is no C code at all on or drives," Lazaravich says. "That adds an order of magnitude more reliability because you don't have all those code bugs that can take years to detect and fix. Instead, we use VHDL code and tables to run our FPGAs."

Would Mercury's solid-state drives be appropriate for use in demanding geosynchronous orbits? Probably not; those environments do not represent the company's target market — at least not today. "Right now we concentrate on terrestrial radiation environments

and low-Earth orbit," Lazaravich says. "We do resistance to 30 or 40 kilorads total dose for most of our boards. We will work out to other orbits and deep-space missions as we have customers serving those areas."

Radiation tolerant

Microchip also is eying the radiation-tolerant new space market. In April the company introduced an Arm microprocessor-based microcontroller that combines the low cost and large ecosystem of COTS technology with space-qualified versions that have scalable levels of radiation performance.

Microchip, with its recent acquisition of Microsemi, provides radiation-hardened and radiation-tolerant solutions ranging from high-performance FPGAs, precise frequency and timing solutions with space-grade oscillators, mixed-signal integrated circuits, isolated DC-DC converter modules, custom power supplies, hybrid and solutions, MOSFETs, diodes, transistors, and RF components.

The latest electronics design trends in new space applications are expected to endure for years to come. "Satellites have been getting smaller and smaller — and small satellites, rather than just being university experiments, have become much more capable," says Anton Quiroz, CEO of Apogee Semiconductor LLC in Ache, Texas. "Not only government agencies, but also different prime contractors, are building more capable small satellites."

Apogee is taking a multi-prong approach to keeping costs down for radiation-tolerant parts. "What makes semiconductors expensive is where you design and build them; the processes where you would build power and analog components are not inherently rad-hard," Quiroz says. "We partnered with a commercial process foundry, and built a process design kit in that foundry."

The kit is called TalRad, which is short for transistor adjusted layout for radiation. "We are building automated back-end systems to do 100 percent testing that the industry would like to see, and keep costs down by keeping touch points down," Quiroz says.

Apogee focuses on analog, power, and mixed-signal devices for space applications. It's been a great couple of years," he says. "Demand for small satellites is continuing to grow, and I don't see any signs of that slowing." ←

Telephonics is providing AN/UPX-40 next-generation identification friend or foe interrogators for Saudi Arabian E-3 Sentry airborne warning and control system (AWACS) aircraft.

Telephonics to provide identification friend-or-foe (IFF) avionics for Saudi AWACS

BY **John Keller**

HANSCOM AIR FORCE BASE, Mass. — Military avionics experts at Telephonics Corp. in Farmingdale, N.Y., will build AN/UPX-40 next-generation identification friend or foe interrogators for Saudi Arabian E-3 Sentry airborne warning and control system (AWACS) aircraft under terms of a $12.6 million foreign military sales contract.

Officials of the U.S. Air Force Life Cycle Management Center at Hanscom Air Force Base, Mass., are asking Telephonics to provide interrogator shipsets and installation for the Royal Saudi Air Force's fleet of five E-3 AWACS aircraft. AWACS is based on the Boeing four-engine 707 single-aisle passenger jet airframe.

The AN/UPX-40 IFF avionics enables aircraft to identify and position aircraft or ships as friendly or unknown, as well as determine their bearing and range. In addition to Saudi Arabia, Telephonics provides IFF systems for AWACS operated by the U.S., United Kingdom, NATO, and France.

The Telephonics IFF and secondary surveillance radar systems help military and civil air traffic controllers direct traffic and protect friendly forces. In addition to AWACS aircraft worldwide, the company's IFF systems are deployed at airports, on aircraft carriers, on surface vessels, and aboard maritime patrol fixed-wing aircraft and helicopters.

The Telephonics AN/UPX-40 IFF avionics complies with Mark XIIA STANAG 4193, DOD AIMS 97-1000, DOD AIMS 03-1000 standards; performs Eurocontrol and homeland defense Mode S; has a 2,000-target capacity; incorporates advanced code correction algorithms, and has an open-systems architecture with plug-and-play upgrades to Mode S and Mark XIIA avionics.

The system has a 99.9 percent probability of detection; has 0.04 percent false target reports; code availability of 99.5 percent and code accuracy of 99.9 percent. It also offers jam resistance in electronic warfare (EW) scenarios.

For more information contact Telephonics online at www.telephonics.com, or the Air Force Life Cycle Management Center-Hanscom Air Force Base at www.hanscom.af.mil.

Army vetronics experts ask industry for rugged RF antennas for military vehicles

BY **John Keller**

ABERDEEN PROVING GROUND Md. — U.S. Army vetronics experts are reaching out to industry for two types of MIL-STD-810G-certified RF and microwave antennas able to operate at frequencies ranging from 600 MHz to 2.7 GHz for a variety of armored combat vehicles.

Officials of the C4ISR Center of the Army Combat Capabilities Development Command at Aberdeen Proving Ground, Md., have issued a solicitation (W56KGU-19-R-MULTIBAND) for the Multiband Antennas project.

Army experts are interested in receiving technical specifications for two rugged multiband antennas covering different frequency ranges for use on ground tactical platforms.

The first antenna for military vehicles should have two ports. The first port must operate at three frequency bands, 600 to 1,000 MHz, 1,40 to 2,025 MHz, and 2,100 to 2,700 MHz. The antenna on this port must have a directional radiation pattern, gain of at least 10 dBi at the horizon, have an N-type female connector.

The second port must operate at frequency bands from 2.4 to 6 GHz., have an omni-directional radiation pattern, gain of at least 0 dBi at the horizon, and have a TNC female RF connector.

This rugged antenna must be vertically polarized; have impedance of 50 Ohms; a voltage standing wave ratio (VSWR) of at least 2.5:1, with 3.0:1 preferred; port-to-port isolation of at least 20 dB; be no larger than 32 by 16 by 6 inches, and weigh no more than 15 pounds. The first port must have a power rating of 300 Watts continuous wave (CW), and the second port must have a power rating of 50 Watts CW.

Army vetronics experts are looking for rugged antennas to provide RF connectivity for military vehicles.

The second antenna also should have two ports. The first port must operate at three frequency bands, 600 to 1,000 MHz, 1,40 to 2,025 MHz, and 2,100 to 2,700 MHz. The antenna on this port must have a omni-directional radiation pattern, gain of 0 dBi at the horizon, and have an N-type female RF connector.

The second port must operate at frequency bands from 2.4 to 6 GHz, have an omni-direction radiation pattern, gain of 0 dBi at the horizon, and have a TNC female RF connector.

This antenna must be vertically polarized; have impedance of 50 Ohms; a voltage standing wave ratio of 2.5:1, with 3.0:1 preferred; be no higher than 12 inches, and weigh no more than six pounds.

Companies interested should email antenna specifications by 19 June 2019 to the Army's Mitchell Mayer at mitchell.s.mayer.civ@mail.mil, or Shuguang Chen at Shuguang.chen.civ@mail.mil.

Submissions should be no more than 10 pages, with RFI: MULTIBAND BAND Antennas for RFC – YOUR COMPANY in the subject line. Email questions or concerns to Mitchell Mayer at mitchell.s.mayer.civ@mail.mil, or Shuguang Chen at Shuguang.chen.civ@mail.mil.

More information is online at https://www.fbo.gov/notices/310987e1e77b38b540823b4899e-2fe65.

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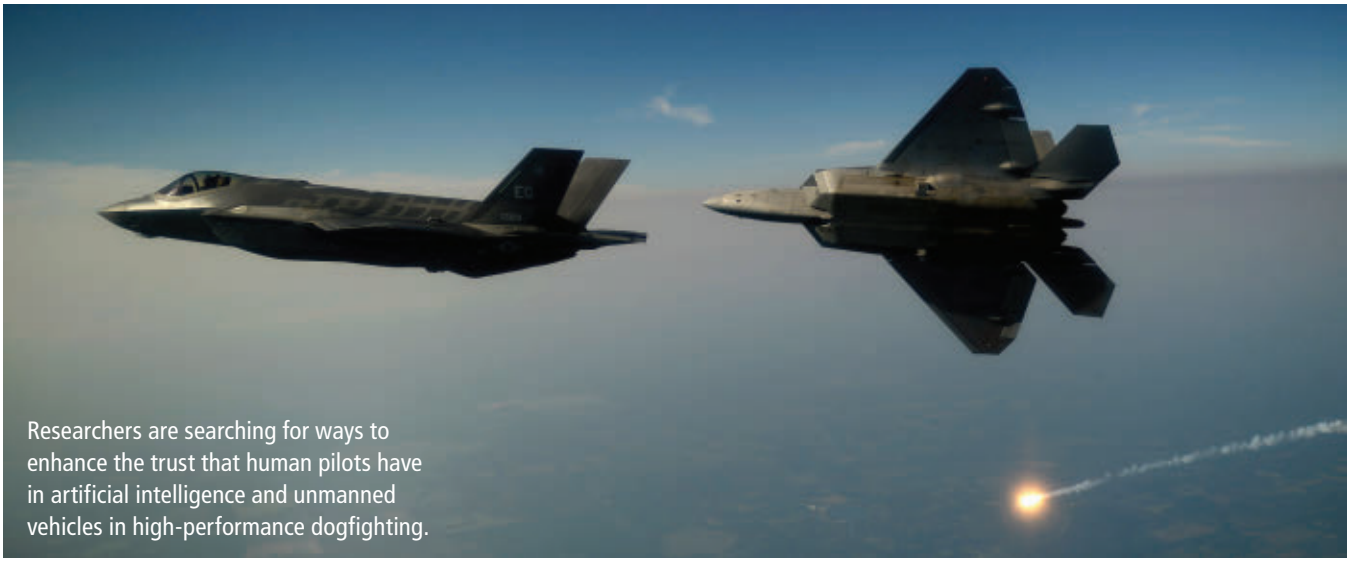


Researchers are searching for ways to enhance the trust that human pilots have in artificial intelligence and unmanned vehicles in high-performance dogfighting.

DARPA eyes artificial intelligence (AI) and unmanned aircraft in jet fighter dogfighting

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are considering heavier reliance on artificial intelligence (AI) and machine autonomy in complex air combat maneuvering that involves dogfights among manned aircraft and unmanned aerial vehicles (UAVs).

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., briefed industry last month on the upcoming Air Combat Evolution (ACE) project, which seeks to increase trust in combat autonomy using human-machine collaboration in aircraft dogfighting.

The ACE project also will develop enabling technologies to enhance collaboration among humans and unmanned combat aircraft in a variety of combat scenarios.

ACE will apply existing AI technologies to aircraft dogfighting in experiments of increasing realism. ACE also will develop ways to measure, calibrate, increase, and predict human trust in combat autonomy performance.

The program will scale machine automation in aircraft dogfighting to more complex, heterogeneous, multi-aircraft, operational level simulated scenarios informed by live data. These scenarios are expected to lay the groundwork for future live, campaign-level experiments.

The idea is to enable one human pilot to become a more deadly warfighter by leading several semi-autonomous artificially intelligent unmanned aircraft, all from his own cockpit. This would shift the human role from sole operator to system mission commander.

In particular, ACE aims to enable a pilot to handle a broad, global air command mission while his aircraft and unmanned aircraft team members attack enemy aircraft and ground targets.

ACE would have the human pilot handle complicated jobs like developing an overall engagement strategy, selecting targets, and choosing weapons, and enable the combat UAVs to handle aircraft maneuver and engagement tactics.

To achieve this, however, the human pilot must be able to trust his unmanned wingmen to conduct complex tactics in scenarios like dogfights where adversaries are within visual range.

Email questions or concerns to DARPA's Dan Javorsek at HR001119S0051@darpa.mil. More information is online at https://www.fbo.gov/spg/ODA/DARPA/CMO/DARPA-SN-19-46/listing.html. ←

DARPA's Air Combat Evolution project seeks to develop enabling technologies to enhance collaboration between humans and unmanned combat aircraft.

Navy asks Hydroid to build extra versions of MK 18 mine-hunting UUV for underwater reconnaissance

BY **John Keller**

INDIAN HEAD, Md. — Unmanned underwater vehicle (UUV) experts at Hydroid Inc. in Pocasset, Mass., will build MK 18 family of unmanned underwater vehicle (UUV) systems for the U.S. Navy under terms of a potential $47.9 million contract.

Officials of the Naval Surface Warfare Center (NSWC) Indian Head Explosive Ordnance Disposal Technology Division in Indian Head, Md., are asking Hydroid for additional MK 18 UUVs to detect, pinpoint, and neutralize underwater threats like sea mines.

The Navy Hydroid MK 18 UUV is a mine-hunting variant of the Hydroid REMUS 600, which Hydroid developed originally developed through funding from the Office of Naval Research (ONR) in Arlington, Va., to support the Navy's UUVs with extended endurance, increased payload capacity, and greater operating depth.

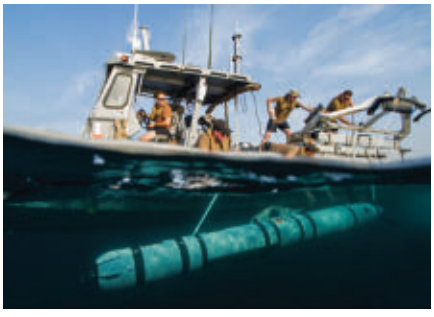
Navy officials are not releasing the number of MK 18 UUVs they are asking Hydroid to build. The contract, revealed in a 2 May justification and approval notice, is a one-year indefinite delivery, indefinite quantity deal with four one-year options.

The Mk 18 Mod 1 Swordfish UUV for underwater reconnaissance can perform low-visible exploration and reconnaissance in support of amphibious landing; mine countermeasures operations such as search, classification, mapping, reacquire, and identification; hydrographic mapping at depths from 10 to 40 feet.

The UUV can navigate via acoustic transponders in long-baseline or ultra-short-baseline mode or via P-coded GPS. Its upward- and downward-looking acoustic digital velocity log improves dead-reckoning accuracy.

The MK 18 Mod 1 Swordfish UUV achieved full operational capabilities in 2008. Follow-on block upgrades will combine two separate UUV programs into the MK 18 family of systems to deliver improved detection capability against buried mines in high clutter environments.

The REMUS 600, on which the MK 18 UUV is based, can dive to depths of nearly 2,000 feet, and can operate on one battery charge for as long as 24 hours. The UUV is for mine countermeasures; harbor security; debris field mapping; search and salvage; scientific sampling and mapping; hydrographic surveys; environmental monitoring; and fishery operations. REMUS is short for Remote Environmental Measuring Unit S.



U.S. Navy undersea warfare experts are ordering additional MK 18 unmanned underwater vehicles (UUVs) from Hydroid that are like the company's REMUS UUV, shown here.

The torpedo-shaped REMUS 600 UUV is nearly 13 feet long and two feet in diameter. The unit weighs 622 pounds. It has dynamic focus side look sonar (SLS), a Neil Brown conductivity and temperature sensor (CT), WET Labs beam attenuation meter (BAM) optical sensor, Imagenex 852 pencil beam sonar for obstacle avoidance, and a WET Labs ECO fluorometer and turbidity measurement sensor.

Its communications suite consists of long baseline acoustic communications, WiFi, Iridium satellite communications, and radio modem via gateway buoy. The UUV navigates by up- and down-looking acoustic Doppler current profiler; Doppler velocity log; Kearfott inertial navigation unit; compass; and GPS.

The REMUS 600 has a modular design to meet a variety of payloads. The UUV has a series of hull sections that can be separated for vehicle reconfiguration, maintenance, and shipping. It uses the Hydroid Vehicle Interface Program (VIP) for maintenance, checkout, mission planning, and data analysis. ←

Hydroid is a subsidiary of Kongsberg Maritime AS in Kongsberg, Norway. For more information contact Hydroid online at www.km.kongsberg.com/hydroid, or the NSWC Indian Head Explosive Ordnance Disposal Technology Division at www.navy.mil/local/nswciheodtd.

Elbit to buy Harris Night Vision goggles and thermal weapons sights business

Elbit Systems of America has agreed to buy the Harris Corp. Night Vision business for $350 million. Headquartered in Roanoke, Va., Harris Night Vision develops night vision goggles, monoculars, thermal weapons sights, and image-intensifier tubes for U.S. and allied ground forces and aircraft pilots. Elbit Systems of America provides high performance solutions and support services to the U.S. defense and homeland security markets, says Bezhalel (Butzi) Machlis, Elbit Systems President and CEO. The transaction is conditioned on the Harris proposed merger with L3 Technologies, as well as customary closing conditions, including receipt of regulatory approvals.

Laser weapons demand lots of power, yet systems integration plays a central role

When it comes to laser weapons on ships, land vehicles, and aircraft, it is integration, and not power, that represents today's biggest challenge. In addition to power, systems integrators must deal with beam control, targeting, and controls. If the laser weapon doesn't get targeting data from the ship's radars, it must rely entirely on its own built-in optics. Conversely, the laser's optics can't provide targeting data to any other weapon on the ship. Systems integration plays a big role.

L-3 to build electro-optical shipboard fire-control for surface warships

BY **John Keller**

WASHINGTON — Military electro-optics experts at L-3 KEO in Northampton, Mass., will provide shipboard sights to provide the fire control necessary for U.S. Navy and Coast Guard warships to hit enemy ships and aircraft with naval gun fire under terms of a $14.1 million order announced Wednesday.

Officials of the Naval Sea Systems Command in Washington, are asking L-3 KEO to produce additional MK 20 electro-optical sensor systems (EOSS), radar cross sections kits, shock ring kits, engineering support services, and spares for the Navy and Coast Guard.

The EOSS electro-optics system is a check sight and targeting sensor for anti-surface and anti-air warfare and naval gun fire support missions, Navy officials say.

The MK 20 EOSS is a major component of the MK 34 5-inch guns aboard Navy Arleigh Burke-class destroyers and Ticonderoga-class cruisers, as well as aboard the U.S. Coast Guard Offshore Patrol Cutter, for use against enemy ships, boats, and aircraft.

L-3 KEO has been building the EOSS since 2005. That year L3-KEO won a Navy contract to provide the EOSS for the Ticonderoga-class Cruiser Modernization Program.

Company electro-optical engineers built on the MK 46 Optical Sight System to blend new technologies into the MK 20 shipboard MOD 0 EOSS, as well as integrate the system into the MK 34 5-inch deck guns.

The MK 20 EOSS has digital stabilization with fiber-optic gyros, a separate eyesafe laser rangefinder with diode-pumped laser, enhanced built-in test, and improved sensor-to-sensor boresight alignment.

The EOSS meets MIL-S-901D heavyweight and large-displacement shock tests.

The MK 20 MOD 0 incorporates several technology improvements over the MK 46, and new features that support integration with the MK 34 Gun Weapons System (GWS).

To integrate with the MK 34 deck gun, the EOSS has a new interface electronics unit (IEU) that interfaces with as many as two deck gun computers and three deck gun consoles to provide video, target bearing and range, and system status data to all three, while taking commands from any one, L-3 officials say.

On this contract modification L-3 will do the work in Northampton, Mass., and should be finished by August 2021. For more information contact L-3 KEO online at www2.l3t.com/keo, or Naval Sea Systems Command at www.navsea.navy.mil.

L-3 KEO is building electro-optical fire-control systems to keep deck guns aboard U.S. Navy surface warships on target.

Raytheon to build lot-19 of AIM-9X infrared-gilded missiles for U.S. forces and allies

BY **John Keller**

PATUXENT RIVER NAS, Md. — U.S. Navy aerial warfare experts are asking the Raytheon Co. to build several hundred AIM-9X precision short-range infrared-guided air-to-air missiles for jet fighters and other combat aircraft under terms of a $419.1 million order announced in May.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking the Raytheon Missile Systems segment in Tucson, Ariz., to build lot-19 AIM-9X block II air-to-air missiles.

These air-to-air missiles are for the U.S. Navy, Air Force, and the governments of Australia, Belgium, Denmark, Finland, Indonesia, Israel, Japan, Kuwait, Malaysia, Morocco, Oman, the Netherlands, Norway, Poland, Qatar, Romania, Saudi Arabia, Singapore, Slovakia, South Korea, Switzerland, Taiwan, Turkey, and the United Arab Emirates.

The order is for lot 19 AIM-9X Block II and II+ all up round tactical missiles, captive air training missiles, captive test missiles, special air training missiles, advanced optical target detectors, guidance units (live battery), captive air training missile guidance units (inert battery), Block I and II propulsion steering sections, Block II electronic units, tail caps, containers, and spares.

These sophisticated short-range air-to-air weapons are for the U.S. Navy, Air Force, and military forces of Israel, Norway, Qatar, South Korea, the United Arab Emirates, Australia, and The Netherlands.

The AIM-9X is an infrared heat-seeking missile that equips most jet fighters, fighter-bombers, and other offensive combat aircraft in the U.S. arsenal, and is for shooting down enemy aircraft close-by. The AIM-9X works by homing in on an enemy aircraft's hot engine exhaust. Variants of the AIM-9 Sidewinder have been deployed since the 1950s.

The AIM-9X is among the latest versions of the AIM-9 missile family. It entered service in 2003 on the Navy F/A-18C Hornet fighter-bomber and on the U.S. Air Force F-15C jet fighter. It has an imaging infrared focal plane array seeker with 90-degree off-boresight capability for accuracy.

The missile is compatible with helmet-mounted displays such as the U.S. Joint Helmet Mounted Cueing System, and features 3-D thrust-vectoring control for increased turn capability. The AIM-9X also includes an internal cooling system.

This contract involves the latest version of the AIM-9X, called the AIM-9X Block II. This newest version has lock-on after launch capability for use with the F-35 Lightning II joint strike fighter and the F-22 Raptor advanced tactical fighter.

On this order Raytheon will do the work in Tucson, Ariz.; Andover and Amesbury, Mass.; Keyser, W.Va.; Santa Clarita, Valencia, Chatsworth, San Diego, San Jose, Goleta, and Claremont, Calif.; Hillsboro, Ore.; Ottawa; Sumner, Wash.; Hillsboro, Ore.; Cincinnati; Cheshire and Simsbury, Conn.; Keyser; Ontario, Canada; Heilbronn, Germany; Anniston, Ala.; and in other locations in the U.S., and should be finished by October 2022.

For more information contact Raytheon Missile Systems online at www.raytheon.com, or Naval Air Systems Command at www.navair.navy.mil.

the U.S. military is buying another lot of AIM-9X Sidewinder missiles, the most sophisticated version of the Sidewinder launching from an F-16 jet fighter, shown above.

PRODUCT applications

SECURITY AND ENCRYPTION

Air Force orders secure cryptographic IFF avionics from General Dynamics

U.S. Air Force avionics experts needed modern identification-friend-or-foe (IFF) systems for a variety of military aircraft. They found their solution from the General Dynamics Corp. Mission Systems segment in Scottsdale, Ariz.

Official of the Cryptologic and Cyber Systems Division of the Air Force Life Cycle Management Center at Joint-Base San Antonio, in San Antonio, Texas, has announced a $20.2 million contract to General Dynamics for KIV-78 mode 4/5 cryptographic applique IFF systems.

The KIV-78 is a Type 1 NSA-certified communications security (COMSEC) for identification friend or foe (IFF) in military aircraft avionics. It provides cryptographic and time-of-day services for a mode 4 and mode 5 Mark XIIA IFF combined interrogator/transponder, individual interrogator, individual transponder, or IFF system deployed to identify cooperative, friendly systems.

It is AIMS 04-900 compliant, offers simultaneous mode 4/5 interrogate and transponder support, and is software upgradeable. This contract includes KIV-78 units, Delorean circuit card assemblies, data and technical support for U.S. and foreign military sales.

The small appliqué design of the KIV-78, enables the IFF avionics unit to be removed and leaves its host equipment unclassified. It supports as long as three months of keys for mode 4 and mode 5 IFF and stores these keys in encrypted format, allowing black key recovery.

The unit can run by battery and by prime power, and accepts key loading via DS-101 serial protocols. It is compatible with the CYZ-10, PYQ-10, KIK-20, and other EKMS308/608-compliant DS-101 key load devices, and operates in three modes: storage; key-retention; and prime power.

Crypto-support tools include an emulator that performs mode 4 and mode 5 interrogate and transpond functions that comply with 04-900 option A for interface voltages, waveforms; and STE, which performs closed-box confidence testing to verify the unit is functional. The STE also can collect crypto status, verify QKEK, check for low battery, and confirm which image versions are loaded.

The unit measures 3.4 by 4.7 by 2.1 inches, and weighs 1.5 pounds. It operates in temperatures from -40 to 91 degrees Celsius, at altitudes to 78,000 feet. It can withstand 40 Gs of shock, and operates for 10,000 hours mean time between failures. It can operate on battery power for as long as six months under normal operating conditions.

For more information contact **General Dynamics Mission Systems** online at *https://gdmissionsystems.com*, or the **Air Force Life Cycle Management Center** at *www.wpafb.af.mil/aflcmc*.

AD-HOC NETWORKING

Textron chooses ad-hoc networking for Aerosonde UAV from Persistent Systems

Officials of the Textron Systems Unmanned Systems segment in Hunt Valley, Md. needed mobile ad-hoc networking (MANET) capability for the company's Aerosonde small unmanned aircraft system (SUAS). They found their solution from Persistent Systems LLC in New York.

Textron and Persistent Systems have has entered into a five-year agreement for Textron to join Wave Relay Ecosystem, an alliance of unmanned system and sensor companies that integrate the Wave Relay mobile ad-hoc network (MANET) into their products.

Installing Persistent's MANET communications systems on Aerosonde unmanned aircraft will enable Textron UAVs to join land-, air-, and sea-based networks to enable warfighters to share voice and data, including imagery, video, and text.

The Textron Aerosonde SUAS is for multi-mission expeditionary land- and sea-based operations. It for simultaneous day-and-night full-motion video, communications relay, and intelligence missions.

Aerosonde weighs 80 pounds, has an 11.9-foot wingspan, can carry a 20-pound sensor payload, can fly as high as 15,000 feet, has a maximum range of 75 nautical miles, and can fly for as long as 14 hours.

Ad-hoc networking enables warfighters operating in the same region to create RF networks on the fly to enable data networking in areas where no communications infrastructure exists. Each Persistent Systems radio acts simultaneously as a transmitter, receiver, and network node — similar to a cell phone tower.

By incorporating Persistent's MANET radios on their small UAVs, Textron can improve their capabilities in dense urban environments. Enhanced networking capabilities can provide the warfighter with real-time situational awareness to help them make quick, in-the-moment tactical decisions.

Joining the Wave Relay Ecosystem enables Textron UAVs to work seamlessly with all other Wave Relay MANET-enabled products. The Wave Relay MANET adapts quickly and continuously to fluctuations in terrain and other difficult

environmental conditions to make the most of connectivity and communications performance.

The Wave Relay MANET's proprietary routing algorithm enables users to incorporate vast numbers of meshed communications devices into the network in which the devices themselves form the communication infrastructure.

Persistent Systems Wave Relay radios each use three antennas instead of one to boost communications range and power, as well as to mitigate the effects of multipath and other interference to keep data communications open and operating at high bandwidth.

In addition to Textron, the other companies that are part of the Wave Relay Ecosystem are Hoverfly Technologies Inc. in Orlando, Fla.; Martin UAV in Plano, Texas; Boeing Insitu Bingen, Wash.; LGS Innovations in Herndon, Va.; Endeavor Robotics in Chelmsford, Mass.; QinetiQ North America in Waltham, Mass.; and Raytheon Co. in Waltham, Mass.

For more information contact **Textron Unmanned Systems** online at *www.textron-systems.com*, **Persistent Systems** at *www.persistentsystems.com*, or **AUVSI XPONENTIAL** at **www.xponential.org**.

TRUSTED COMPUTING

DARPA looks to Galois for trusted computing hardware design tools

U.S. military researchers are extending a trusted computing contract to Galois Inc. in Portland, Ore., to develop hardware design tools with built-in cyber security capabilities to counter software cyber vulnerabilities in military and commercial electronic systems.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced a $9.9 million contract modification to Galois for the for the System Security Integrated Through Hardware and firmware (SSITH) program.

SSITH aims to secure computer hardware that constrains and reduces vulnerabilities to cyber-attack and protects against software attacks that exploit hardware vulnerabilities.

The modification to Galois increases the company's DARPA SSITH contract, awarded originally on 7 Dec. 2017, to $16.6 million. Galois is one of nine defense companies and colleges involved in the SSITH trusted computing project.

In addition to Galois, the other SSITH contractors are Lockheed Martin Corp. Rotary and Mission Systems segment in Owego, N.Y.; The Charles Stark Draper Laboratory in Cambridge, Mass.; SRI International in Menlo Park, Calif.; Cornell University in Ithaca, N.Y.; University of California-San Diego in La Jolla, Calif.; Columbia University in New York City; Massachusetts Institute of Technology (MIT) in Cambridge, Mass.; and University of Michigan in Ann Arbor, Mich.

Electronic system security has become a critical area of concern for the U.S. Department of Defense (DOD) and the broader U.S. population, DARPA officials explain. Current cyber security efforts to provide electronic security largely rely on software, which can be inadequate if fails to address the underlying hardware vulnerability.

Creative hackers can develop new ways to exploit how software accesses hardware, which can start a continuous cycle of exploitation, patching, and subsequent exploitation. Instead, the DARPA SSITH program focuses on hardware security at the microarchitecture level.

DARPA scientists are working with the nine SSITH contractors on security approaches that will limit computer hardware to states that are secure while maintaining the system performance and power.

The nine SSITH contractors are developing architectures and design tools that enable system-on-chip (SoC) designers to safeguard hardware against all seven known common weakness enumeration (CWE) classes of hardware vulnerabilities that hackers can exploit through software.

Architectures and design tools that SSITH contractors develop may provide flexible solutions applicable to DOD and commercial electronic systems, DARPA officials say.

Security measures may include cryptography; metadata tagging; formal verification; verified state matching; anomalous state detection; secure multi-party computing; semi-homomorphic computing; and security through compartmentalization.

Systems designers might eventually be able to use SSITH security architectures so that existing application software can run on secure hardware without software modification; some software modification may be necessary, however, to exploit hardware security features fully. SSITH architectures are expected to be scalable such that they can be useful for architectures ranging from small, ultra-low power systems to large, high-performance systems.

The SSITH program has two technical areas: scalable, flexible, and adaptable integrated circuit security architectures that can be implemented easily in DOD and commercial SoCs; and ways to evaluate these architectures.

For more information contact **Galois Inc.** online at *https://galois.com*, or **DARPA** at *www.darpa.mil*.

MILITARY AVIONICS

Harris chosen to provide electronic warfare (EW) avionics to Kuwaiti military

Electronic warfare (EW) experts at Harris Corp. will provide sophisticated EW systems to the government of Kuwait that are designed to protect combat aircraft from incoming radar-guided missiles.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., on Friday announced a $43.3 million order to the Harris Electronic Systems segment in Clifton, N.J., for additional lot 16 AN/ALQ-214 A(V)4/5 EW jammers for F/A-18E/F Super Hornet fighter-bombers for the Kuwaiti military.

The AN/ALQ-214(V)4/5 is an electronic jammer component of the integrated defensive electronic counter measures system (IDECM) avionics, which is from a joint venture of Harris and BAE Systems. It protects fighter-bombers from radar-guided surface-to-air and air-to-air missiles by jamming the enemy missile guidance systems.

One year ago Boeing agreed to sell 28 Super Hornets to Kuwait worth as much as $1.2 billion. Of this order, 22 will be single-seat F/A-18E models and six will be F/A-18Fs — the two-seat version of the jet. The U.S. State Department approved the Super Hornet sale to Kuwait in November 2016.

The ALQ-214 component of the IDECM EW system has been delivered to the U.S. Navy and to the Royal Australian Air Force for contemporary versions of the Boeing F/A-18 combat aircraft. The system blends sensitive receivers and active countermeasures to form an electronic shield around the aircraft, Harris officials say.

Earlier this year Harris won a $168.8 million order to provide the U.S. Navy with 78 AN/ALQ-214 A(V)4/5 EW jammers for F/A-18C/D and F/A-18E/F combat jets.

The RF countermeasure system engages incoming missiles autonomously with a series of measures designed to protect the aircraft from detection. The AN/ALQ-214(V)4 a smaller and lighter version of its predecessors, and has an open-architecture design that is ready for integration on several different kinds of aircraft.

The system is designed to counter radar-guided anti-aircraft missiles with electronic countermeasures (ECM) techniques that deny, disrupt, delay, and degrade the enemy missile launch and engagement sequence. The system identifies, ranks, and counters incoming missiles, and displays engagements to the flight crew for situational awareness.

The AN/ALQ-214 originally was developed by ITT Avionics in Clifton, N.J. That company became Exelis in a 2011 spin-off, and Harris acquired Exelis in 2015.

On this order Harris will do the work in on this contract Harris will do the work in Clifton, N.J.; as well as in San Jose, San Diego, Rancho Cordova, and Mountain View, Calif., and should be finished by August 2022.

For more information contact **Harris Electronic Systems** online at *www.harris.com/es*, or **Naval Air Systems Command** at *www.navair.navy.mil*.

RUGGED TABLET COMPUTERS

DRS to provide rugged tablet computers for battlefield command and control

U.S. military command and control experts needed rugged computers to upgrade military vehicles and command posts. They found their solution from Leonardo DRS Land Electronics business unit in Melbourne, Fla.

Leonardo DRS officials announced their company's first production delivery order for the next-generation of U.S. Army mission command computing systems called the Mounted Family of Computer Systems (MFoCS) II.

The initial delivery order $132.1 million came from the Defense Information Technology Contracting Office of the Defense Information Systems Agency at Scott Air Force Base, Ill. The

original $841.5 million contract for the program was awarded to Leonardo DRS last May.

This delivery contract calls for Leonardo DRS to provide the Army with dismountable rugged tablet computers, vehicle-mount rugged computers, docking stations, keyboards, cables, and several sizes of ruggedized sunlight-readable multi-touch-screen displays.

The MFoCS II family of systems will support fielding and upgrades of the Army's Joint Battle Command-Platform (JBC-P) and features systems upgrades, cyber security improvements, and multi-touch displays.

MFoCS II also has performance enhancements of its computing server as the Army continues to improve the JBC-P systems for tactical situational awareness, global blue force tracking, and in-transit visibility logistics tracking.

A critical component of the MFoCS II system is the cyber-hardening technology inside the hardware called Edge-Assured that ensures that commanders are operating protected and trusted computing systems.

MFoCS II also retains components from the first-generation MFoCS, including a dismountable tablet, an expandable rugged computer, and 12-, 15-, and 17-inch sunlight-readable rugged displays with multi-touch functionality.

MFoCS integrates Force XXI Battle Command Brigade-and-Below and Joint Battle Command-Platform (JBC-P) capabilities into a common computing system. The MFoCS II program primarily is in response to U.S. Army battlefield computing requirements.

MFoCS supports situational awareness, command and control, and maneuver capability with next-generation rugged computers and displays that several different configurable levels. Systems include ruggedized tablet computers, processors, keyboards, removable solid-state disks, displays, and cabling.

JBC-P consists of ultra-rugged computers, software, and Suite B encryption security that enables warfighters to send and receive friendly force position location.

It JBC-P essentially is a follow-on to, or advanced component of, the Army's Force XXI Battle Command Brigade and Below (FBCB2) program, and will be interoperable with the current FBCB2 Blue Force Tracking (BFT) system.

The FBCB2 provides battlefield situational awareness to enable fast, well-informed decisions. The JBC-P is expected to enhance FBCB2 performance, and reduce the risk of fratricide.

For the remainder of this decade and into the 2020s, MFoCS is designed to push the leading edge of technology from inception to retirement in combat computing, whether in compliance with the Army's VICTORY (Vehicular Integration for C4ISR/EW Interoperability) initiative, security, or ruggedization.

The Army awarded the original MFoCS contract to DRS in 2013 in a potential $455 million deal. The contract called for DRS to build a variety of vehicle-mounted command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) equipment.

The foundational element of the MFoCS program is the rugged tablet that warfighters can mount in combat vehicles, as well as disconnect the tablets and continue using them while operating on foot. This enables warfighters in vehicles to share what they are seeing on their screens with warfighters operating on foot.

Battlefield commanders can work on a tablet in a combat vehicle, and then take the computer into a command post and dock it.

Under this delivery contract, Leonardo DRS will provide the Army with dismountable tablets, processor units, docking stations, keyboard units, interconnecting cables, and several sizes of ruggedized sunlight-readable multi-touch-screen display units.

For more information contact **Leonardo DRS Land Electronics** online at *www.leonardodrs.com*.

AIRBORNE NETWORKING

Silvus, Anduril join forces on ad-hoc networking to link unmanned vehicles over tactical radios

Ad-hoc networking expert Silvus Technologies Inc. in Los Angeles is working together with Anduril Industries Inc. in Irvine, Calif., to provide mobile networked-multiple input and multiple output (MN-MIMO) networking through Silvus StreamCaster 4200 tactical radios.

Silvus Technologies provides wireless communications systems that work in challenging conditions for military, law enforcement, and broadcast, applications in communications and unmanned vehicles control.

Mesh technology in Silvus radios helps with video and data transmission in urban, remote, mobile, high-scatter, and at-sea environments. Anduril is using this technology to control networks of unmanned vehicles in communications-challenged environments.

Anduril Industries specializes in autonomous drones and sensors for military applications, as well as in artificial intelligence and sensor fusion.

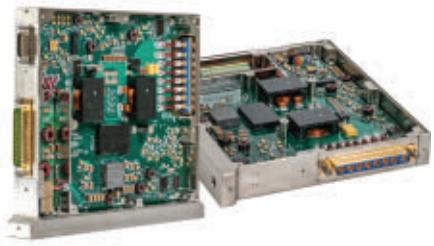
MN-MIMO is an RF waveform that operates in limited-range, poor-performance outdoor- and interference-laden environments. It is a blend of coded orthogonal frequency division multiplexing (COFDM), MIMO antenna techniques, and mobile ad-hoc networking (MANET) for digital communications.

Silvus provides enabling RF technologies for relaying information between its intra-tower and drone mesh network that is nearly unbreakable, company officials say. It is for long-range, mobile and non-line of-sight communications that can transmit large amounts of HD video, voice, and telemetry data.

For more information contact **Silvus Technologies** online at *https://silvustechnologies.com*, or **Anduril Industries** at *www.anduril.com*.

new PRODUCTS

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



SPACE ELECTRONICS

Radiation-hardened DC-DC converters to control power in space electronics introduced by VPT Power

VPT Inc. in Blacksburg, Va., is introducing the SGRB series of space-qualified DC-DC converters for a variety of satellites, manned spacecraft, and other space applications. Using advanced gallium nitride (GaN) technology, the SGRB offers efficiency to 95 percent, as well as radiation tolerance. Designed for applications facing the harsh radiation environments of space, the SGRB series has been characterized to total ionizing dose of 100 krad(Si), including enhanced low dose rate sensitivity, and single event effects performance to 85 MeV/mg/cm2. The SGRB series features an integrated electromagnetic interference filter, 100-volt input and 28-volt, 400-Watt output, and is rated for full power operation in temperatures from -35 85 degrees Celsius. These DC-DC converters "dramatically increases the power supply efficiency. This, in turn, greatly reduces the system size, weight, and cost," says Jeremy Ferrell, VPT's director of engineering. VPT is reviewing customer requests for custom orders of the SGRB series. For more information contact **VPT** online at *www.vpt-power.com*.

MOTION CONTROL

Linear voice coil motor to provide motion control in test and measurement introduced by Moticont

Moticont in Van Nuys, Calif., is introducing the LVCM-051-127-01 linear voice coil motor for motion control test and measurement, wafer handling, laser machining and drilling, scanning laser beam steering and filtering, and medical applications. With a stroke length of 3.75 inches, this 2-inch-diameter linear motor has a high force-to-size ratio of 5 pounds and a peak force of 15.8 pounds at 10-percent duty cycle. The motor features two 10 to 32 UNC-2B threaded mounting holes in the housing and two 10-32 UNC-2B threaded mounting holes in the coil end for integration into new and existing applications. An encoder and servo controller are available. There are 12 choices in this series of Moticont's LVCM linear motors based on diameter of the motor, and more than 50 models based on length of stroke and force. For more information contact **Moticont** online at *http://moticont.com*.

BOARD PRODUCTS

Rugged single-board computer for military C4ISR embedded computing applications introduced by Abaco

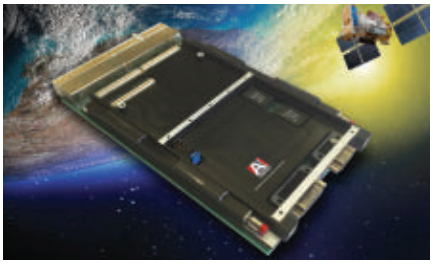
Abaco Systems in Huntsville, Ala., is introducing the SBC3511 3U OpenVPX rugged single-board computer for high-performance command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR). The SBC3511 embedded computing board is for aerospace, defense, and industrial applications that need a combination of high performance, advanced security, and leading-edge thermal management. The SBC3511's performance comes from its integrated Intel Xeon E-2176M 6-core/12-thread processor (formerly known as Coffee Lake) operating at 2.7 GHz with

TurboBoost to 4.4 GHz, 32 gigabytes of DDR4 RAM and as much as 256 gigabytes of NVMe solid-state drive memory. The rugged computer board also has a 40 Gigabit Ethernet data plane, delivering not only a high-speed interconnect, but also alignment with the Sensor Open Systems Architecture (SOSA) technical standard, which creates a common framework for switching sensor systems to an open systems architecture, based on key interfaces and open standards established by industry-government consensus. For more information contact **Abaco Systems** online at *www.abaco.com*.

RADIATION-HARDENED ELECTRONICS

Rugged single-board computer for space embedded computing applications introduced by Aitech

Aitech Defense Systems Inc. in Chatsworth, Calif., is integrating the NASA core Flight System (cFS) into the company's SP0-S space single-board computer for space applications. NASA's cFS is a platform- and project-independent reusable software framework and reusable software applications. It is composed of three aspects — a dynamic run-time environment, layered software, and a component-based



design — that combine to make the cFS suitable for reuse on NASA flight projects and embedded software systems. Aitech is working together with Embedded Flight Systems Inc. (EFSI) in Laurel, Md., on the job to integrate cFS in the Aitech SP0-S embedded computing" target='_blank'>embedded computing board for space. EFSI provides engineering services in satellite, payload, ground systems, automation, simulation, and flight software. Using the low power and high performance offered by the NXP MPC8548E PowerQuicc processor, along with the advanced Linux environment of Xenomai real-time Linux, Aitech's SP0-S space processor has been demonstrated to NASA running Linux 4.14 with Xenomai 3.0.6. For more information contact **Aitech** online at *https://rugged.com*.

COMPUTER BOARDS

Embedded computing for transmitting diagnostic information in harsh environments offered by VersaLogic

VersaLogic Corp. in Tualatin, Ore., is shipping the Swordtail Arm-based embedded computing boards for demanding industrial,

Military & Aerospace Electronics

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smart city, and transportation applications that need rugged, long life, power efficiency, wide-temperature operations. Swordtail boards are for transmitting diagnostic information without the need for a wired connection. Wi-Fi and Bluetooth radios are included on board, and a NimbleLink Skywire socket supports optional cellular and wireless plug-ins. Available with either the quad-core NXP i.MX6 Quad, or the dual-core i.MX6 DualLite processors, the Swordtail includes on-board Wi-Fi, Bluetooth, and a socket for plug-in cellular radios. At home in harsh environments, the compact 95-by-95-millimeter computer board is rated for operation in industrial temperatures from -40 to 85 degrees Celsius. VersaLogic's Swordtail is a board-level computer that does not require additional carrier cards, companion boards, connector break-out boards, or other add-ons to function. It is a production-ready product. For more information contact **VersaLogic** online at *www.versalogic.com.*

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