JULY 2019

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Space electronics

Air Force asks industry for relaxed space qualification for LEO satellites. PAGE 4

Electro-magnetic interference

Mitigating RF interference ranging from enemy jamming to leaky components on a board. PAGE 22

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Directed-energy weapons

Lasers promise pinpoint defenses, while microwave weapons target swarms of enemy UAVs. PAGE 12

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VOL. 30, NO. 7

Military & Aerospace Electronics

Military & Aerospace Electronics® (ISSN 1046-9079), Volume 30, No. 7. 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

Boom in LEO means there's never been a better time to be in the space market

THE MIL & AERO COMMENTARY The space electronics market is hotter than it's been in quite a while, and the real action is happening in low-Earth orbit (LEO) where companies are offering opportunities for relatively small and inexpensive satellites with communications, sensing, and navigation payloads.

First, the U.S. Air Force is reaching out to industry for ideas on new enabling technologies, materials, and manufacturing processes for next-generation large constellations of LEO military satellites.

Space electronics experts at the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, released a request for information on 29 May (FA8650-19-S-5021) for the Low-Cost Space Systems project, which seeks to use relatively high-risk commercial off-the-shelf (COTS) electronics technologies with relaxed space qualification requirements and radiation hardening in next-generation satellite buses and payloads with limited life cycles.

Current demand for LEO satellites indicates the need for greater responsiveness, lower cost, and new and disruptive spacecraft technologies for these kinds of space satellites, researchers say.

From industry, Air Force officials want new ways for spacecraft designers to reduce costs and build capable satellites with limited life cycles using relatively high-risk commercial technologies. In particular, researchers are interested in automation; state-of-the-art manufacturing techniques; standards and modularity; and non-traditional suppliers, materials, and space-qualification techniques.

It's clear that expensive space qualified components are yesterday's news when it comes to the new hot space market in LEO. Traditional space electronics suppliers are taking a cautious approach out of concern that the LEO market is moving so quickly that projects in higher orbits could become obsolete virtually overnight.

Systems integrators of satellites designed to operate at high altitudes like geosynchronous orbit are worried that their chief enabling technologies, often involving radiation-hardened components and radiation shielding, could diminish in importance as efforts center on small, inexpensive LEO satellites.

One big project confirming many of their fears is the Blackjack program of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va. Blackjack seeks to orbit a constellation of small, secure, and affordable military satellites that capitalize on modern commercial satellite technologies.

DARPA released a solicitation on 24 May that asks industry to find new ways of mixing and matching commercial satellite buses and military satellite communications (SATCOM) and reconnaissance payloads as late in the design process as possible.

DARPA officials want contractors to enable the Blackjack architecture to integrate several types of commercial satellite buses easily with a wide range of military payloads that involve not only SATCOM, but also sensors able to detect, identify, and track advanced missile threats; provide positioning, navigation, and timing (PNT); and provide space-based surface moving target indication.

The advantages of moving military reconnaissance, communications, and positioning satellites to lower-Earth orbits have been known for a long time: the ability to use best-of-breed commercial-grade electronics; quick and easy technology insertion; limited satellite life cycles to accommodate new technologies quickly; and the ability to use on-orbit spares to compensate quickly for spacecraft failures.

Now military experts are trying to push those advantage. Are specially designed radiation-hardened electronic components necessary at all for satellites that will operate only for a few years? Do we even need big expensive military GEO satellites anymore? Maybe, but time will tell if we can get by with a lot fewer of them. There has not been a better time to be in the space business perhaps since the Apollo program half a century ago. ←

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Air Force asks industry for relaxed space qualification for LEO satellites

BY **John Keller**

WRIGHT-PATTERSON AFB, Ohio — U.S. Air Force researchers are asking industry for ideas on new enabling technologies, materials, and manufacturing processes for next-generation large constellations of military satellites designed to operate in low-Earth orbit (LEO).

Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, released a request for information in late May (FA8650-19-S-5021) for the Low-Cost Space Systems project.

Among the goals of the Low-Cost Space Systems project are to use relatively high-risk commercial off-the-shelf (COTS) electronics technologies with relaxed space qualification requirements and radiation hardening in next-generation satellite buses and payloads with limited life cycles.

The Air Force is approaching industry for new enabling technologies and relaxed space-qualification standards for next-generation low-Earth-orbit satellites.

In addition, the project seeks advanced manufacturing technologies to improve spacecraft bus, payload, component, and subsystem costs, yields, and mass using automated manufacturing, integration, and testing.

Future Air Force space operations will require low-cost, proliferated, and resilient space systems and architectures to enhance warfighter capabilities and complement the capabilities of existing large, expensive, and high-orbit satellites, Air Force researchers explain.

Current demand indicates the need for greater responsiveness, lower cost, and new and disruptive spacecraft technologies for LEO satellites.

Air Force officials want to identify technologies and manufacturing processes that could help spacecraft designers reduce costs and build capable satellites with limited life cycles using relatively high-risk commercially available technologies.

Areas for consideration include automation; state-of-the-art manufacturing techniques; standards and modularity; and non-traditional suppliers, materials, and space-qualification techniques.

A new report released last month titled Science and Technology Strategy: Strengthening USAF Science and Technology for 2030 and Beyond calls for cheaper, smaller, and more distributed spacecraft with greater tech refresh rates to complement existing high-performance and costly space systems.

Low-cost space requires new practices that aim at designing to limited-life requirements, Air Force researchers say. These new low-cost constellations require an increased acceptance of risk; non-traditional application of materials; new qualification, and manufacturing processes; and the ability to design, build, and reconstitute more quickly.

Relevant missions for these new kinds of spacecraft include space situational awareness; communications; and geolocation and timing.

Air Force researchers are interested in advanced manufacturing technologies like automation and additive that could reduce touch labor, improve yield, reduce mass, minimize delivery time, and increase availability.

Air Force experts also are interested in commercial off-the-shelf (COTS) and government off-the-shelf (GOTS) adaptations; open-systems architectures; accelerating integration and test; modular, reconfigurable, and scalable concepts; direct write; additive manufacturing like 3D printing; flexible hybrid electronics; and multifunction structures.

From industry, the Air Force wants to receive statements on new technical approaches; previous experience; spacecraft bus and payload components and subsystems; space system cost, size, weight, power, and environmental tradeoffs; estimates of improvements over traditional spacecraft design approaches; projected costs; and lists of potential customers. ←

Companies interested were asked to email 15-page white papers by 1 July 2019. For questions or concerns contact the Air Force's Adrienne Schaab by email at adrienne.schaab.1@us.af.mil, or by phone at 937-904-4599. More information is online at https://www.fbo.gov/spg/USAF/AFMC/AFRLWRS/FA8650-19-S-5021/listing.html.

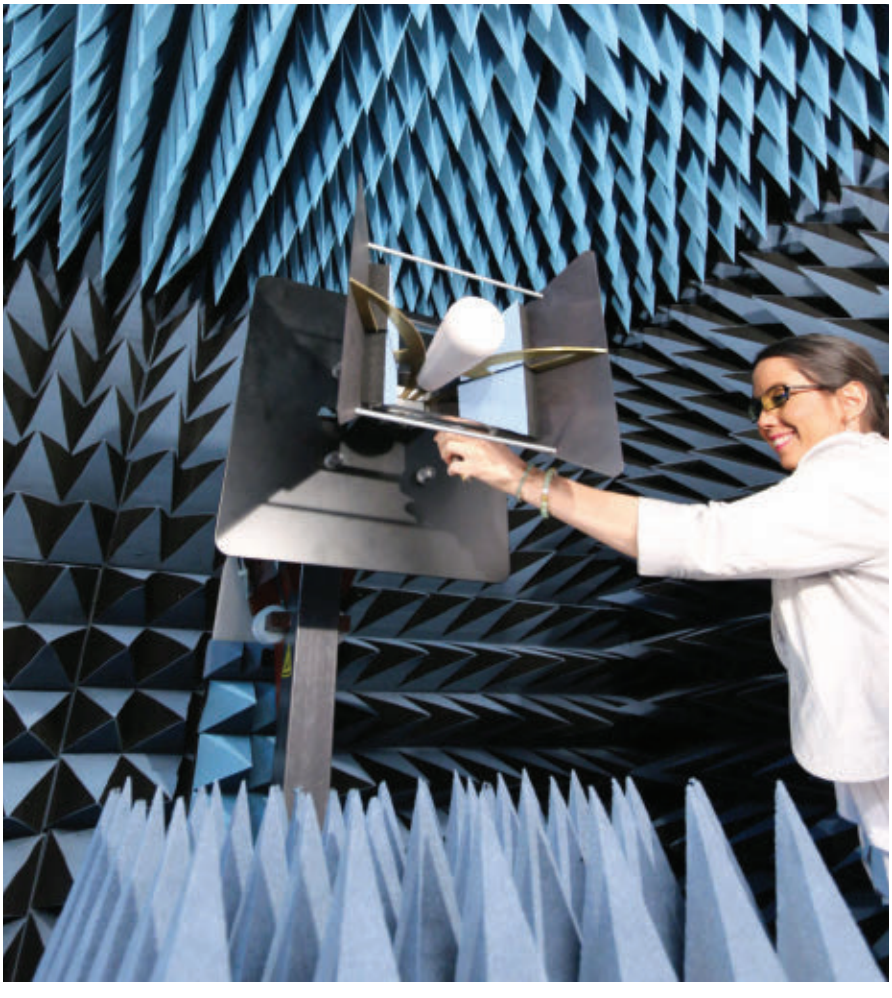
Three companies consider blended RF system to reduce electronics size on UAVs

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are involving three RF and microwave technology companies in $23.2 million effort to develop a blended RF system that combines radar, electronic warfare (EW), and communications components aboard medium-sized unmanned aircraft.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have awarded contracts to Perspecta Labs Inc. in Red Bank, N.J.; L-3 Mustang Technology Group in Plano, Texas; and the Northrop Grumman Corp. Mission Systems segment in Linthicum, Md. for phases 2 and 3 of the Converged Collaborative Elements for RF Task Operations (CONCERTO) program.

CONCERTO seeks to move away from collections of rigid and constrained RF systems to one converged approach that is scalable, agile, easily modified, facilitates technology insertion, and that makes the most of common RF apertures.



Engineers are three companies are looking for ways to consolidate radar, electronic warfare (EW), and communications components aboard medium-sized unmanned aircraft.

The program, moreover, will demonstrate this converged RF approach in an RF payload that fits aboard medium-sized unmanned aerial vehicles (UAVs) that weigh less than 1,320 pounds like the AAI RQ-7 Shadow, or the Boeing Insitu RQ-21 Blackjack.

Perspecta Labs won a potential $7.5 million contract on 10 May 2019; L-3 Mustang Technology won a potential $7.3 million contract on 10 May 2019; and Northrop Grumman won a potential $8.3 million contract on 10 June 2019 for integrating blended RF systems aboard medium-sized UAVs.

Dominance of the RF spectrum is critical to successful U.S. military operations, DARPA researchers explain. Today the military does this using discrete radar, EW, and communication payloads that are separately designed, procured, and integrated.

These payloads typically use dedicated apertures, have tightly coupled hardware and software, and are not well-coordinated in their use of the RF spectrum, which makes it difficult and time consuming to adopt new technology, adapt to rapidly changing threats, change RF functions quickly, and create compact RF systems.

Instead, the CONCERTO program is developing a modular architecture for adaptive, converged RF systems and using it for one converged RF payload that performs radar, EW, and communications.

CONCERTO systems could carry out multi-function operations in less space and power than the combined collections of discrete systems, increase the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capability of small- and medium-sized UAVs, and speed technology insertion by decoupling hardware from software and firmware.

The three CONCERTO phase 2 and 3 companies are focusing on four technology areas: converge, abstract, control, and integrate in advanced efforts to design, integrate, control, and test a demonstration CONCERTO payload on a medium-size UAV.

Converge seeks to blend RF front end and aperture to create a scalable wideband RF front end that includes radiating apertures and airframe integration, antennas, converting RF to digital signals.

Abstract seeks to create a converged heterogeneous RF processing engine for RF control and signal processing in a portable, easily upgraded, hardware-agnostic RF virtual machine.

Control seeks to create a system and sensor resource manager to coordinate disparate RF jobs in the converged system. Integrate, meanwhile, seeks to carry out the CONCERTO system architecture, mission analysis, integration, and flight testing, leading to demonstration of a converged system architecture.

The three companies participated in the first phase of the CONCERTO project to develop promising technologies. Now they move to phases 2 and 3 where they will continue development, leading to flight tests. Collins Aerospace in Cedar Rapids, Iowa, and Vencore Labs Inc. in Basking Ridge, N.J., also were involved in the first phase of CONCERTO. ←

For more information contact Perspecta Labs online at www.perspectalabs.com; L-3 Mustang Technology at www2.l3t.com/mustangtechnology; Northrop Grumman Mission Systems at www.northropgrumman.com; or DARPA at www.darpa.mil.

Six researchers attempt to connect human brains to computers

U.S. military researchers are working with six organizations to develop non-invasive or minimally invasive neural interfaces to connect the brains of warfighters to computers or other digital devices to enable fast, effective, and intuitive hands-free interaction with military systems. Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) are working with Battelle Memorial Institute in Columbus, Ohio; Carnegie Mellon University in Pittsburgh; Johns Hopkins University Applied Physics Laboratory in Laurel, Md.; Palo Alto Research Center (PARC) in Palo Alto, Calif.; Rice University in Houston; and Teledyne Technologies in Thousand Oaks, Calif. on the Next-Generation Nonsurgical Neurotechnology (N3) program. These wearable interfaces to connect human brains with computers ultimately could enable diverse national security applications such as control of active cyber defense systems and swarms of unmanned aerial vehicles, or teaming with computer systems to multitask during complex missions, DARPA officials say.

Boeing forecasts 10-year $8.7 trillion global commercial aircraft market

The Boeing Co. Market Outlook, released in June at the Paris Air Show, says the global market for commercial aircraft and service platforms would rise by 7.4 percent from last year's estimate to $8.7 trillion by 2028, with just over a third of that figure pegged to spending on commercial airplanes. The Street reports. Over the next 20 years, Boeing forecasts a $9.1 trillion market for commercial aircraft services with annual growth of 4.2 percent, Boeing says, and an aircraft market of $6.8 trillion.

Industry to create artificial intelligence (AI) algorithms for human-like reasoning

U.S. military researchers are working with industry to develop so-called third-wave artificial intelligence (AI), or brain-inspired and massively scalable computing for future military applications. Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a solicitation in June (DARPA-PA-18-02-08) for the Virtual Intelligence Processing (VIP) program. VIP seeks to explore radically new brain-inspired and massively scalable computing for machine-learning approaches. The goal is to develop algorithms based on mathematical models for next-generation processors that can aid third-wave AI, which involves human-like reasoning. Next-generation AI must be able to deal with incomplete, sparse, and noisy data, as well as unexpected circumstances with new computing models to create AI algorithms that are efficient and robust, can learn new concepts with very few examples, and can guide the future development of hardware to support them. DARPA researchers want computing models and processing architectures that can support massive parallelism like that of the human neocortex.

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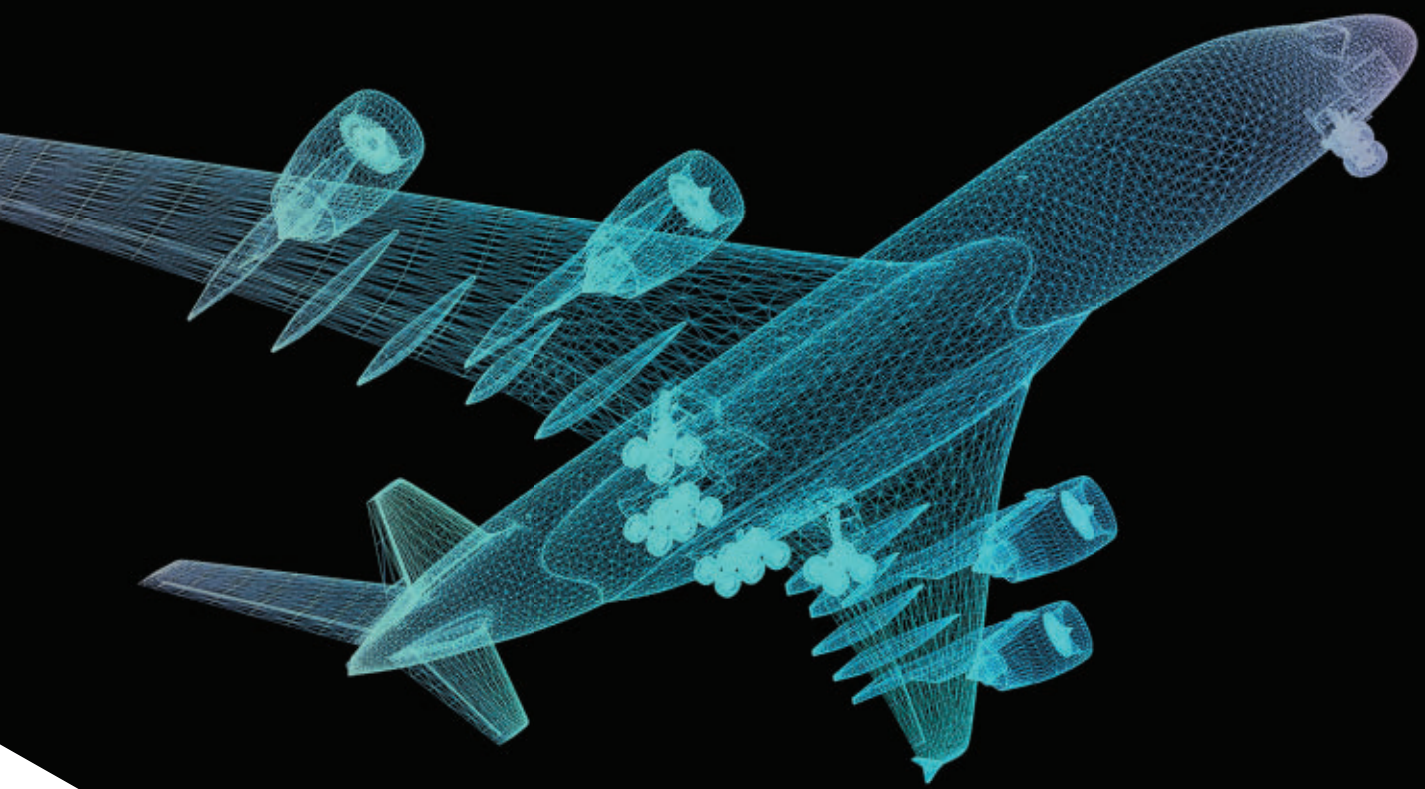

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ARROW

Delivering weapons and sensor payloads from future large unmanned submarines

BY **John Keller**

ARLINGTON, Va. — Undersea warfare experts at Northrop Grumman Corp. will build and test an advanced undersea payload delivery system for future extra-large unmanned underwater vehicles (XLUUVs) under terms of a $9.9 million order announced in June.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., are asking the Northrop Grumman Mission Systems segment in Linthicum Heights, Md., for the second phase of the Hunter program to develop a payload-delivery system for a large UUV. The Hunter program involves only the payload delivery system and not the extra-large UUV itself.

DARPA Hunter is a 45-month program in three phases: the first to design and build the payload delivery device to fit inside a government-provided payload module; and the second and third phases to support integration of the payload delivery device into the big UUV for testing. Technical details of the Hunter program are classified.

Northrop Grumman won a $5.8 million Hunter phase-one contract in December 2017. Northrop Grumman is integrating the XLUUV payload delivery system for persistent-surveillance sensors, weapons, as well as for other UUVs and unmanned surveillance aircraft.

The Boeing Co. Defense, Space & Security segment in Huntington Beach, Calif., won a $43 million order last February from U.S. Naval Sea Systems Command in Washington to build four Orca XLUUVs that could undertake long-endurance missions.

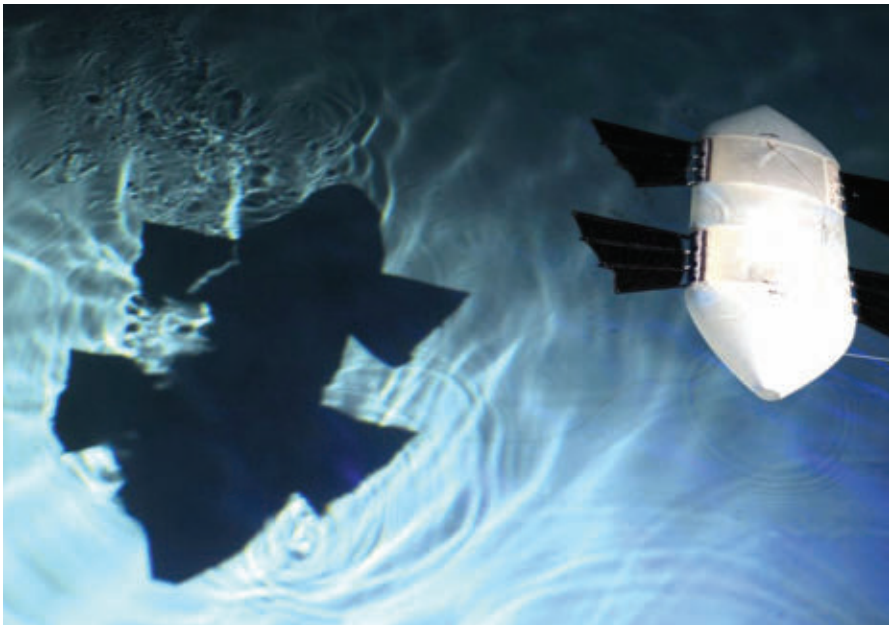
Extra-large UUVs typically are autonomous mini-submarines that measure about seven feet in diameter — sometimes larger. They are designed for launch from shore, from large military ships with well decks, or from large civil vessels with moon pools.

Now Northrop Grumman will integrate Hunter payload-delivery systems for large unmanned submarines like the Boeing Orca.

One of the U.S. military research projects leading to the Boeing Orca XLUUV and the Hunter payload-delivery system has been the Large Displacement Unmanned Undersea Vehicle (LDUUV) program of the U.S. Office of Naval Research (ONR) in Arlington, Va.

Several companies were involved in the LDUUV program, including Metron Inc. in Reston, Va., for machine intelligence; UUV designer Hydroid Inc. in Pocasset, Mass., for an autonomy testing system; and power and propulsion specialists Fuelcell Energy Inc. in Danbury, Conn.; Sierra Lobo Inc. in Fremont, Ohio; the Hamilton Sundstrand Corp. Sea Systems segment in Windsor Locks, Conn.; General Atomics in San Diego; Lynntech Inc. in College Station, Texas; and NexTech Materials Ltd. in Lewis Center, Ohio.

On the Hunter integration contract Northrop Grumman will do the work in Linthicum Heights, Md.; Reston, Va.; and Cambridge, Mass., and should be finished by May 2020. ←



Northrop Grumman is developing an advanced undersea weapons and sensor payload delivery system for future large unmanned submarines like the Boeing Orca.

For more information contact Northrop Grumman Mission Systems online at www.northropgrumman.com, Boeing Defense, Space & Security at www.boeing.com, or DARPA at www.darpa.mil.

Raytheon to merge with United Technologies to form Raytheon Technologies Corp.

Leaders of Raytheon Co. and United Technologies Corp. announced last month that they will merge their companies, creating a behemoth American aeronautics and defense company. The new company, Raytheon Technologies Corp., will be created via an exchange of shares between the two firms, with the merger expected to conclude in the first half of 2020, they said in a joint statement. Raytheon is best known for its Patriot air defense systems, which gained fame during the first Gulf War, and its Tomahawk cruise missiles, often the first weapons fired from U.S. Navy ships in recent conflicts. United Technologies (UTC) is a big player in the aeronautics industry with its Pratt and Whitney engines, which are used in civil and military aircraft, including the F-35 multi-role stealth fighter, considered one of the most advanced combat aircraft in the world.

Army to test truck-mounted hypersonic and laser weapons by 2022

The U.S. Army announced it will test a hypersonic weapon in 2020. In addition to the prototype hypersonic weapon, the Army plans to field combat vehicles with 50-kilowatt lasers on them sometime in 2022, Pentagon officials told reporters on June 4. Lt. Gen. Neil Thurgood of the Army's Rapid Capabilities and Critical Technologies Office (RCCTO) announced on Tuesday that RCCTO also will field a four-vehicle battery of Stryker combat vehicles with 50-kilowatt laser weapons by 2022. The hypersonic weapon — the term denotes a speed many times that of sound but typically it refers to Mach 5, or five times the speed of sound or higher — involves a "glide body" launched from a 30-foot device, called a transporter erector launcher, carried by four tactical trucks. The glide body is under development at the Sandia National Laboratories in New Mexico.

Directed-energy weapons taking big steps forward

Laser weapons and high-power microwaves dominate directed-energy weapons research, as lasers promise pinpoint defenses against small targets, while microwave weapons can take out swarms of enemy UAVs.

BY **J.R. Wilson**

The Demonstrator Laser Weapon System at White Sands Missile Range, N.M., is one example of high energy lasers being developed and tested by the Air Force Research Laboratory.

By the late 2020s, the nature of warfare between global powers will be moving from guns and bombs to new weapons that are silent, invisible, and operate at the speed of light. One of those — cyberwarfare — already is operational and changing the face of combat.

In the next decade, joining cyber will be weapons that have been a staple of science fiction since the late 1800s, are highly classified-yet-well-known, and will challenge the viability of nearly every current weapons system and platform.

Directed-energy weapons come in two basic forms: high-energy lasers (HELs) and high-power microwaves (HPMs). While those sound familiar, however, real-world laser weapons have little in common with Martian deathrays, Buck Rogers rayguns or Star Trek phasers and a combat-level HPM weapon has only the most basic science in common with household microwave ovens.

"The definition we are using for HEL is laser sources above 1 kilowatt of power to thermally degrade a target at range; HPMs are a radio wave source that degrades the source in some way," says Craig A. Robin, senior research scientist for directed-energy applications in the Army's newly created Rapid Capabilities and Critical Technologies Office (RCCTO) at Redstone Arsenal, Ala. "Other services may consider directed-energy in slightly different ways; there is no firm definition for that term."

Army directed-energy weapons

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The U.S. Army is accelerating the prototype fielding of the Multi-Mission High Energy Laser, or MMHEL, which provides 50 kilowatt-class lasers on a platoon of Stryker combat vehicles by late 2022.

"The Navy has had the LaWS [laser weapon system] program and HELIOS [High Energy Laser and Integrated Optical-dazzler with Surveillance], China has a company that will sell you a 10-kilowatt system, the Brits and Germans have a number of efforts, the U.S. Air Force has the SHiELD [Self-protect High Energy Laser Demonstrator] program — there is a significant amount of work across the departments and the world," Robin notes.

The timing and status of directed-energy weapon research and fielding by near-peer or peer adversaries is a growing concern and a spur to faster U.S. development. According to a recent U.S. Defense Intelligence Agency report on space threats, China is expected to deploy a HEL within the next year that could destroy U.S. satellites in low-Earth orbit — a particular threat to the GPS constellation on which the military relies for navigation, timing and precision targeting. While Russia also is working on satellite-killing weapons, China appears to be in the lead.

"China likely will field a ground-based laser weapon that can counter low-orbit space-based sensors by 2020 and, by the mid-to-late 2020s, it may field higher power systems that extend the threat to the structures of non-optical satellites," the unclassified report reads. "China and Russia, in particular, have taken steps to challenge the United States [and regard satellite attacks] as a means to reduce U.S. and allied military effectiveness."

In March 2018, Russian President Vladimir Putin announced a new HEL combat system — the Peresvet — about which he made somewhat grandiose claims without providing supporting evidence.

"We have achieved significant progress in laser weapons," Putin claimed. "It is not just a concept or a plan any more. It is not even in the early production stages. Since last year, our troops have been armed with laser weapons. We are one step ahead our rivals."

Nonetheless, while the degree varies, there is a general consensus that the U.S. continues to hold the lead in directed-energy weapon development, with much of the technology advancement coming from commercial applications. For example, the automotive industry's laser welder essentially is the same as a laser that can shoot down a missile.

The creation of the Army RCCTO earlier this year demonstrates just how seriously the Army is taking the development and deployment of directed-energy weapons.

"When RCCTO got the directive [from the Secretary of the Army] a couple of months ago, it was important not only to reduce duplication of effort across the Army, but also among the different services," Robin says. "Our mission is to do rapid prototyping with residual combat capabilities for the Army — technology developed to put into the soldiers' hands. Our definition of prototype is a unit of action — how will the Army use this to fight."

Getting directed-energy weapons technologies into the hands of warfighters is a driving concern. "We recognize pivots in national defense strategy, and the Army created RCCTO to recognize the emerging technologies that make sense and leverage the investment we have to get capability to the soldiers," Robin continues. "We're not an R&D 6.1 or 6.2 operation. We're also not a PEO [program executive office]. We will develop prototypes, make sure they are safe and suitable for soldiers to use, then transition those to the field."

Air Force efforts

While older than RCCTO by two decades, the Air Force Research Laboratory's Directed Energy Directorate at Kirtland Air Force Base, N.M., is working toward the same goals in its research into HELs and HPMs, says the directorate's Chief Scientist Dr. Don Shiffler.

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The Raytheon advanced high-power microwave and high-energy laser defeated dozens of drone targets in a U.S. Air Force demonstration at White Sands Missile Range, N.M. New Mexico.

the Directed Energy Directorate from older operations," Shiffler says. "Our charge is to take directed energy out to the warfighter by 2020. The service labs are organized very differently. The Air Force is unequivocally ahead in high-power microwave research, with the only active program. All have laser programs, each meeting a different need, so it's hard to say one is ahead or the other."

In January 2019, Directed-Energy Directorate issued a broad agency announcement for the Compact High Energy Laser Subsystem Engineering Assessment (CHELSEA) project as part of an effort to make more powerful and efficient laser weapons suitable for next-generation tactical aircraft.

Technologies developed for the Air Force SHiELD project and its laser subsystem — Laser Advancements for Next Generation Compact Environments (LANCE) — will help design and build a technology readiness level-5 (TRL-5) prototype by 2024.

The Navy also is stepping-up its efforts to move directed-energy weapons from research to combat readiness. The defense 2019 budget requested $299 million for the Navy Laser Family of Systems (NLFoS) — a rapid prototyping, experimentation and demonstration effort quickly to provide ship-based laser weapon capabilities.

The NLFoS projects of the U.S. Office of Naval Research in Arlington, Va., incorporates four major initiatives:

1. Surface Navy Laser Weapon System (SNLWS) — A ship-mounted weapon system, including an HEL with an integrated low-power laser dazzler to counter enemy unmanned aircraft, fast attack boats, and surveillance and reconnaissance sensors;
2. Optical Dazzling Interdictor, Navy (ODIN) — a near-term counter-surveillance capability, with two units installed on Navy guided missile destroyers in 2019;
3. Solid State Laser Technology Maturation (SSL-TM) — A 150-kilowatt HEL demonstrator to be installed on a San Antonio-class amphibious transport dock ship this year to support future laser development; and
4. Ruggedized High Energy Laser (RHEL) — an alternative 150-kilowatt system using a different laser architecture to pursue incremental increased capability

Defensive applications

Unlike other military weapons systems, there is a commercial aspect aimed at developing defensive directed-energy weapons — especially for major international airports.

"I'm pretty confident there will at least be a counter-UAV [C-UAV] system in the field in the next 5 to 10 years, if not by one of the services, then by commercial airports," the Air Force's Shiffler predicts. "Having a thousand-dollar drone shut down [London's] Heathrow Airport at a cost of millions is simply unacceptable, so that will be first because there is such a need for it."

Research also is underway at the U.S. Air Force Academy Laser and Optics Research Center (LORC) in Colorado Springs, Colo., where Senior Scientist Dr. Boris Zhdanov is pursuing diode-pumped alkali lasers, which he calls the most promising approach for various directed-energy applications.

In an interview with the Institute for Defense and Government Advancement (IDGA) in New York prior to that organization's Directed Energy Systems Summit in June, he said "it is very important to start extensive research aimed at development of a high-power laser source producing a high-quality beam from a single aperture that allows it to destroy targets at very long distances."

Threats to aviation safety

Countering the growing global threat to aviation safety and airport operations posed by cheap and easily acquired unmanned aerial vehicles — whether through operator incompetence or stupidity or malicious intent — is one of the prime goals of directed-energy weapon research.

Offensively, high-power microwaves are a serious threat to computer and other electronic systems on which every nation and military relies. high-energy lasers are more commonly seen as a way to drill a hole in a vital component — satellite, radar system, etc. — rendering the target inoperable. Defensively, high-energy lasers and high-power

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ENDEAVOR BUSINESS MEDIA

Raytheon's high-power microwave system defeats drones, even when they fly in swarms, by emitting powerful radio frequencies that disrupt the drone guidance systems, rendering them unable to fly.

microwaves are seen as ways to deter incoming UAVs or missiles from reaching their targets.

Being silent and invisible, both types of weapons also have a stealth component, in some ways similar to cyberwarfare; it can be extremely difficult, if not impossible, to determine the source of an attack.

"Generally speaking, lasers heat things up, which can cause damage. The best way to explain a high-power microwave is it scrambles the brain of electronics, but you can't always tell why your computer is scrambled — is it the operating system, hardware components, a network server, a piece of software or an HPM," the Air Force's Shiffler explains.

One directed-energy weapon application — intelligence, surveillance, and reconnaissance (ISR) is receiving much attention because is considered offensive and defensive, albeit not necessarily destructive.

"One of the great advantages is ISR," the Army's Robin says. "When you have the ability to track and target, it provides a great advantage on the battlefield. With lasers, you have great optics that allow you to target, track, and identify threats — usually before they can target you."

Laser power levels

High-energy lasers are being developed in a host of power ranges to deal with many different kinds of targets; lasers and high-power microwaves considered the best way to counter swarms of low-cost UAVs carrying explosives, drugs, or other offensive or illegal payloads.

"HEL gets talked about the most, with multiple missions from the 10-kilowatt class for C-UAV to incrementing up to 50 kilowatts to counter rocket-artillery-mortar [C-RAM]. You then scale up to the megawatt-class lasers for counter-ICBM," says Michael Hofle, HEL product line lead at Raytheon Space and Airborne Systems in McKinney, Texas.

"The technology [on which Raytheon is working] that is most effective against swarms is our Phaser. It beams out high-power microwaves in a wide conical shape that will interfere with the electronic systems on board. The range is classified, as is the size of the beam. We're working with the Air Force to deploy a Phaser system and our dune buggy system, which is on the cusp of transitioning from demonstrator to field ops within a year."

HEL technology is broadly scalable on a multitude of platforms, using the same technology from 10-kilowatt systems to output levels still in the early stages of development.

"As power goes up, range and your set of applications increase, so you'll be seeing higher-power lasers that will create new missions that weren't available at the lower end of the power spectrum, Hofle says. "Right now, the Army is looking at the 50-kilowatt systems as their entry level, but we'll be looking at higher and higher power through the 2020s."

Even more powerful laser weapons are on the horizon. "There are programs being funded in the 150-kilowatt class that are mobile platforms," Hofle says. "As the technology, not just for laser beams but power and thermal, continues to scale, 150-kilowatt lasers on large trucks are possible. As these lasers become more powerful and smaller, we'll see significantly more powerful lasers on mobile platforms. That scalability and SWaP [size, weight and power] advantage also will be very important for airborne operations."

Power always has been at the center of directed-energy weapon development, and resolving the complexities surrounding power remain vital to their future.

"There are two types of power: generating the laser and the power of the laser itself," points out the Army's Robin. "In the last 20 years, the science and technology community has improved the effectiveness of high-energy lasers by a factor of two. So we can now get militarily significant laser power onto a tactically viable platform."

Affordable laser weapons

Not only are laser weapons becoming more powerful, but they also are becoming more affordable. "It also gets you on the right side of the cost curve when dealing with low-cost, high-value systems like UAVs," Robin says. "You also don't have the logistics tail [of conventional weapons]. Military utility starts around 30 to 50 kilowatts and it makes sense to start prototyping at that power level.

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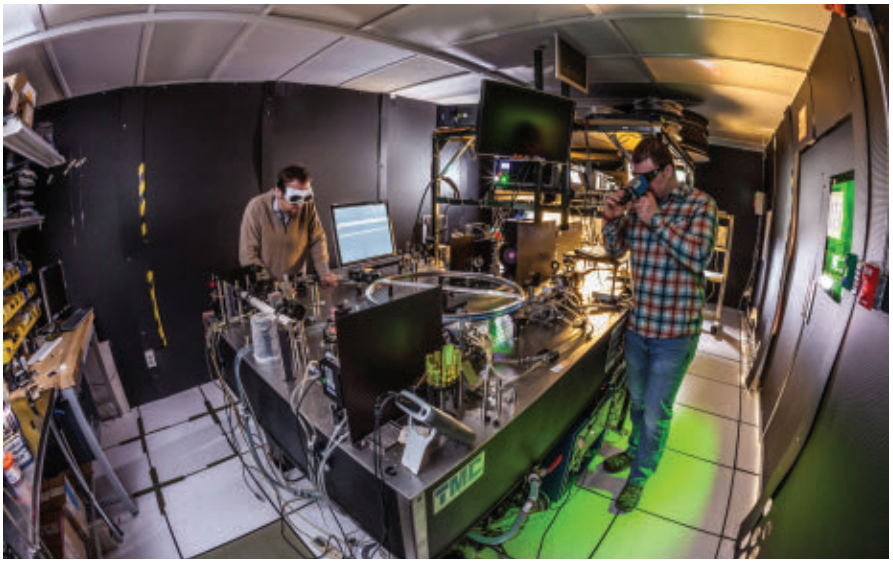

The Air Force Research Laboratory Directed Energy Directorate is developing technologies for future high-power microwave weapon concepts.

One of RCCTO goals is to demonstrate capability at that level in prototype demonstrators."

The Air Force Strategic Development Planning and Experimentation (SDPE) office at Wright-Patterson Air Force Base, Ohio, has tasked the 704th Test Group's Directed Energy Combined Test Force (DE CTF) at Kirtland Air Force Base, N.M., to lead a directed-energy experimentation campaign. The 704th is an operating unit of Arnold Engineering Development Complex, headquartered at Arnold Air Force Base, Tenn.

The directed-energy combined test force grew out of the Air Force directed-energy weapons flight plan, designed to move directed-energy weapons to operational users. Part of the Flight Plan is the directed-energy experimentation campaign.

The objective of the initial directed-energy experiment at White Sands Missile Range, N.M., last October was to understand the capabilities and limitations of existing high-power microwave and high-energy laser weapons against small UAVs, explains John Cao, director of the directed-energy combined test force. The longer-term goal is far more comprehensive and complicated.

"The Department of Defense has demonstrated that directed-energy weapons can negate threats," Cao says. "However, transitioning the directed-energy technology is a different story. We must also understand concept of operations, tactics, techniques and procedures, along with the potential implications to doctrine, organization, training, materiel, leadership and education, personnel, facilities and policy [DOTMLPF-P]."

High-energy lasers, once deployed, will provide several offensive tactical advantages. One potential application involves the Army AH-64 Apache attack helicopter in a special operations role of attacking power grids, high-value infrastructure, or moving vehicles.

Silent and invisible

"Those would be covert applications and the laser is well suited to that because you can't see or hear it," Raytheon's Hofle says. "It really comes down to being able to maintain aim point so a very small beam — about the diameter of a bullet — can remain focused. The better you can do that, the more effective your laser is."

Another big potential application for laser weapons is counter-UAV. Army officials are considering laser systems to protect fixed-wing aircraft like helicopters from shoulder-mounted rockets and rocket-propelled grenades.

"As we achieve higher powers, then we'll be looking at counter-hypersonics and anti-ballistic missile, Raytheon's Hofle says. "There also are some

COMPANY LIST

U.S. Army Rapid Capabilities and Critical Technologies Office (RCCTO)
Redstone Arsenal, Ala.
https://rapidcapabilitiesoffice.army.mil

U.S. Air Force Research Laboratory Directed Energy Directorate
Kirtland Air Force Base, N.M.
https://www.kirtland.af.mil/Units/AFRL-Directed-Energy-Directorate/

U.S. Office of Naval Research
Arlington, Va.
https://www.onr.navy.mil

U.S. Air Force Academy Laser and Optics Research Center (LORC)
Colorado Springs, Colo.
https://www.usafa.edu/research/research-centers/laser-optics-research-center/

Raytheon Co. Space and Airborne Systems
McKinney, Texas
https://www.raytheon.com/capabilities/sensors

U.S. Air Force Strategic Development Planning and Experimentation Office
Wright-Patterson Air Force Base, Ohio
https://www.wpafb.af.mil

Institute for Defense and Government Advancement (IDGA)
New York
https://www.idga.org

transitional applications, such as the ability to power beam — firing a laser across some distance and receiving that energy at the other end to power forward operating bases, for example, but those are still far off in the future."

Laser beams have straight trajectories, so they can't attack over-the-horizon targets. That also means laser weapons also could cause unintended damage beyond their targets.

"If we are doing range testing, we have to be cognizant of objects floating around in space, such as a satellite. Our laser system takes all that into account, so if we go through a zone where there is a known satellite, the system will automatically shut down in a test environment," Hofle adds. "It's a very low probability event, but is part of government policy. In a tactical environment, where we are actually shooting an attacking UAV, for example, that can be overridden."

In another interview with IDGA, Harry Sinsheimer, Deputy director of the Joint Directed Energy Transition Office, said key directed-energy weapon objectives for the next two to five years include deciding what's ready for deployment, and what are research and development priorities.

Early transition of HEL systems to the warfighter is vital to the mission of the entire directed-energy community, Sinsheimer says. The feedback, lessons learned, from the directed-energy system end-user (warfighter) must inform our direction for future investments in that regard.

Industry collaboration

DOD and government labs are working closely with industry, academia, and U.S. allies to quicken the pace of directed-energy weapon transition to the warfighter.

"We collaborate with our Five Eyes partners [Australia, Canada, New Zealand and the United Kingdom] and with other international partners. And it's moving faster than I can keep track," Shiffler says. "Each of our allies has their own strengths and weaknesses, but the UK has always had strong programs in these technologies."

As to the Buck Rogers raygun or Capt. Kirk phaser, man-portable, if not exactly hand-held, directed-energy weapons are not high on the military's wish list. "When it comes to lasers, the mantra has been more power. It's certainly possible to build a man-portable system, but the market is more targeted around power levels that require some vehicle platform at 10 kilowatts and up," Hofle says.

Many experts in the field agree that directed-energy weapons will be widely deployed for a range of missions by all the services — and a growing number of civilian facilities in another decade.

"By 2030, directed-energy will be hugely important. The soft, low-dollar, high-impact threats will only increase and we will need low-cost weapons to address that," Hofle says. "Lasers are not the end-all that will solve all problems, but will be a vital, primarily defensive, part of the toolbag." ←

Air Force Research Laboratory researchers test advanced optical fibers for high-energy laser systems at AFRL's Directed Energy Directorate at Kirtland Air Force Base, N.M.

Raytheon, in partnership with the U.S. Army and U.S. Special Operations Command, has mounted a high-energy laser on an AH-64 Apache attack helicopter.

RF and microwave equipment tacking the interference problem

Equipment manufacturers focus on mitigating a wide variety of RF interference ranging from enemy jamming to leaky components on a board.

BY **Jamie Whitney**

In the air, sea, or on the battlefield, RF and microwave technology is providing incredible amounts of information for command and control in addition to the "boots on the ground." Wireless communications through RF signals provides the clear, interpretable intelligence to those who need it most.

The presence of dense RF signal traffic on the battlefield today is constant; radio silence is no longer the norm. Today's military needs not only to deny capabilities of their adversaries, but also keep its own systems online at the same time.

The need to maintain contact radio communications on the modern battlefield elevates the need to fight intentional and accidental RF interference a necessity. Mitigating the effects of RF interference (RFI), electromagnetic interference (EMI), and electromagnetic compatibility (EMC) are just as important as battling opposing forces and achieving combat readiness.

RF and microwave technology experts in the industry must consider how to tackle co-site interference, jamming and countermeasures, and other factors, explains Rodger Hosking, vice president of Pentek Inc. in Upper Saddle River, N.J.

"This classic problem has been a challenge for mil-aero equipment from the beginning from three major sources," says Hosking. Co-site interference refers to the effect of multiple radars and radios operating on the same aircraft, ship, or vehicle. Jamming or countermeasures by the enemy intentionally disrupt reception of equipment to deny or reduce operational performance.

"Situational factors of the spectral landscape for a given location often present strong signals from commercial broadcast and telecom services that can interfere with radio and radar systems, and these can change over time and as the platform changes position," Hosking says.

Crowded neighborhood

Military vehicles and communications systems are filled with electronic components that emit electrical interference, and need RF protection from outside interference. In addition, the more information transmitted means more the RF spectrum is in use, creating more issues that manufacturers need to address.

This creates a two-pronged problem: how to keep the electronic components

The Mercury Systems DS-3000 synthesizer

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from interfering with one another while protecting them from outside interference, explains Dan Mor, general-purpose graphics processing unit (GPGPU) product manager at Aitech Systems Ltd. in Chatsworth, Calif.

"Emissions from the operational system itself on external equipment, which can be mission-critical, also can disturb the proper operation of peripheral systems," Mor told Military & Aerospace Electronics last year.

"The system should be immune from external noise and not produce noise to the outside word," Mor continued. "These are two main reasons why EMI/EMC is so important. Almost every new project we have — in avionics, ground fixed, ground mobile vehicles, etc. — requires EMI mitigation or EMC. Sometimes we need to prove that our products are designed and manufactured to meet these requirements and specifications."

Avoiding interference

With the growing use of electronic systems onboard ships, aircraft, and on the ground, available space on the RF band is becoming difficult to come by.

Fairview Microwave offers low-loss, pre-conditioned, high-reliability cables

"With increasing utilization of the already-crowded radio frequency spectrum and the increasing number of services and devices competing for its use, these interference problems are becoming more critical," Pentek's Hosking points out. "A very popular strategy to mitigate these problems is the use of phased-array antennas consisting of multiple elements.

"By precisely controlling the relative phase shift among the elements, these beamforming antennas can electronically steer the antenna beam pattern," Hosking explains. "This works equally well for both receive and transmit functions and operates for both elevation and azimuth angles. By doing so, the effect of an interfering signal arriving from one direction can be greatly reduced, while enhancing a desired signal receptivity from another direction."

RIGOL Technologies Inc. of Beaverton, Ore., recently released the newest member of its UltraReal family of real-time spectrum analyzers. The company aims to help RF engineers characterize most of today's complex RF modulation schemes, including quadrature amplitude modulation (QAM), quadrature phase shift keying (QPSK), amplitude-shift keying (ASK), minimum-shift keying (MSK), and frequency shift keying (FSK).

RIGOL's RSA5000 vector signal analyzer (VSA) enables engineers to use as many as 13 integrated measurement functions including I/Q waveform and RF envelope, constellation and vector diagrams, symbol level decode, time and frequency, and bit error analysis against known sequences by providing quick insight into signal behaviors.

"Engineers integrating these technologies need affordable, powerful and easy-to-use tools to quickly characterize their transceivers and identify communication errors," says Michael Rizzo, general manager of RIGOL North America. "We are pleased that the RSA5000 Spectrum Analyzer and the new VSA Measurement application can support this emerging need."

Officials of Micro Lambda Wireless Inc. of Fremont, Calif., say they are increasing production of their company's benchtop frequency synthesizers.

Alongside their yttrium iron garnet (YIG) RF and synthesizer components, their custom-tuned benchtop YIG synthesizer line now offers RF and microwave designers working at frequencies to 20 GHz the chance to upgrade their test benches.

The YIG synthesizers offer bandwidth as wide as -125 dBc/Hz at 10 kHz offset phase noise at a carrier frequency of 10 GHz. These frequency synthesizers produce low phase noise performance, and can tuning speeds up to 50 microseconds over wide bands, and offer output power levels of +15 dBm, with power leveling in frequency bands up to 10 GHz.

These synthesizers consist of a frequency synthesizer, AC power supply, heat sink with fan, keypad, tuning knob, frequency display. and driver circuitry all housed in a compact, durable bench top box measuring 4 by 10 by 13 inches. Units are tunable manually over the specified frequency range by a designer's choice of the mechanical knob, keypad, or via USB or Ethernet connection.

The best offense ...

On the power electronics side, dB Control Corp. in Fremont, Calif., has introduced a compact, lightweight, pulsed microwave power module (MPM) that operates in the 6-to-18-GHz frequency

range and provides 1 kilowatt peak power at 5 percent maximum duty cycle. The dB-3774B weighs 18 pounds and dimensions are 7 by 3 by 18 inches.

The dB3774B is suitable for electronic warfare (EW) applications like radar jamming, and features a conduction-cooled mini traveling wave tube (TWT) for power amplification and a solid-state driver amplifier for RF gain.

The high-voltage power supply section of the dB-3774B uses modular architecture and low-noise power supply topology. Additionally, the conduction-cooled dB-3774B MPM operates with 270-volt DC prime power, resulting in high efficiency in DC operation, and custom frequency bands are available.

The Micro Lambda Wireless yttrium iron garnet (YIG) RF and microwave synthesizer

... is a good defense

A great way sow chaos and confusion among military adversaries is to deny the use of expensive pieces of technology. Likewise, it is imperative to keep allied systems online to maintain an advantage.

Last month, Mercury Systems of Andover, Mass., unveiled its DS-3000 synthesizer, which is part of its SpectrumSeries line, and is a direct digital synthesis (DDS)-based synthesizer, as a way monitor wide bands to mitigate hazards.

"Today's announcement reinforces Mercury's ongoing commitment to commercializing innovative RF solutions that provide the U.S. warfighter and our allies the technical edge they need to meet their mission requirements," says Neal Austin, vice president and general manager of Mercury's Embedded Sensor Processing group on June 4.

"In an environment of rapidly emerging electronic threats, customers can count on our industry-leading synthesizer technology to provide the expanded performance and reliability needed by modern EW and ELINT systems so they can monitor wide bands of the electromagnetic spectrum in order to detect, analyze, and mitigate new threats."

The DS-3000 synthesizer offers phase noise of -121 dBc/Hz at 10 GHz with 10 kHz offset, and frequency coverage up to 20 GHz with 1 Hz resolution and is suitable for EW and electronic intelligence (ELINT) systems that monitor large radio frequency (RF) bandwidths through either a channelized architecture or wide instantaneous bandwidth (IBW).

Mercury's DS-3000 offers performance over a temperature range of -30 to 70 degrees Celsius, while minimizing the effects of microphonics. Additionally, users can control the hardware through either a PC-based graphical user interface (GUI) or an SPI-bus makes these products suited for benchtop operation and integration into ruggedized EW systems.

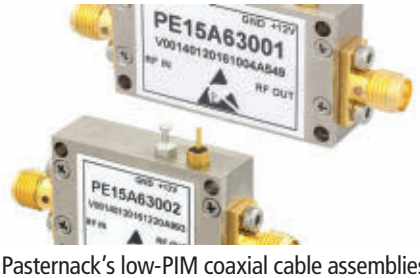
Cages and cables

One way RF engineers protect systems is by putting vulnerable components inside a ruggedized enclosure, particularly those of commercial off-the-shelf (COTS), which aren't purpose built to minimize electrical interference. A relatively inexpensive safeguard is to house components inside an enclosure with a Faraday cage lining which blocks RFI, though higher-tech solutions have been implemented.

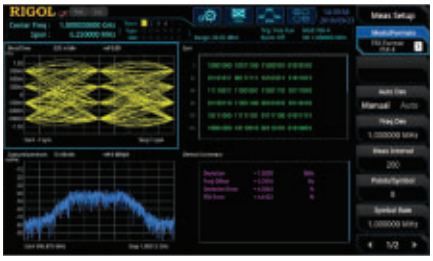
However, even if the components inside the chassis are shielded from interference and are not emitting interference, engineers also must consider the cables running outside of the enclosure.

This spring, Fairview Microwave Inc. in Lewisville, Texas, introduced a series of high-reliability, temperature-conditioned RF cable assemblies for military electronics, avionics, satellite communications, identification-friend-or-foe, and EW and similar mission-critical applications.

The low-loss, pre-conditioned, high-reliability cables cover operating frequencies to 18 GHz and deliver a voltage standing wave ratio (VSWR) as low as 1.35:1.



Pasternack's low-PIM coaxial cable assemblies



RIGOL Technologies Inc. real-time spectrum analyzers

This product line has 128 configurations built from three different types of cable, totaling more than 1,400 parts.

Pasternack Enterprises in Irvine, Calif., has launched a line of low-PIM coaxial cable assemblies that are suitable for distributed antenna systems (DAS) and are available in standard and custom lengths.

The cable assemblies consist of 18 standard configurations with PIM levels of less than -160 dBc. This product line is made with lightweight, flexible UL910 plenum-rated SPP-250-LLPL RF coaxial cable which can operate in temperatures from -55 to 125 C.

They are offered with the following connector types: 4.3-10, 7/16 DIN, 4.1/9.5 mini-DIN and Type-N, which also include right-angle connector options. In addition to distributed antennas, these cables are for indoor wireless systems, wireless infrastructure, multi-carrier communication systems, WISP networks, small cell installations and PIM testing applications.

"The launch of this product line not only gives us the opportunity to provide our customers with high-quality, low-PIM cable assemblies, but now we're also able to deliver them in standard and custom lengths with same-day delivery. The combination of the cables' features and in-stock availability makes this product launch a truly unique and exciting addition for our customers to take advantage of," says Pasternack Product Manager Steve Ellis.

Multi-faceted

Pentek's expertise in software-defined radio positions the company to minimize interference with products such as multi-channel data converters for receiving and transmitting signals, as well precise control of the phase shifts for antenna arrays, Hosking says.

Field-programmable gate arrays (FPGAs) are big contributors to this capability. "By combining both receive and transmit capabilities with advanced FPGA technology, Pentek products also support adaptive radio algorithms that can respond quickly to changing environments and countermeasures," Hosking says. "All of Pentek's latest products offer optical interfaces to minimize pickup of interference and maintain full dynamic range of RF and microwave signals."

When asked if there was a product Pentek offered that best showcased approach to minimizing interference in mil-aero applications, Hosking selected the Model 6001 QuartzXM Express Module.

"(It) is a highly integrated module that harnesses Xilinx's Zynq RFSoC (RF System-on-Chip). It includes eight multi-gigahertz sample rate A/D and D/A converters, UltraScale+ FPGA fabric, a multi-core ARM processor and dual 100 Gigabit Ethernet interfaces with available optical interfaces," Hosking says. "Single-handedly, the 6001 tackles all of the interference mitigation strategies (I) outlined. Only 2.5 by four inches in size, it can be easily integrated into highly SWaP-constrained equipment for applications such as unmanned vehicles, airborne pods, missiles, vehicles, and portable systems."

RF and microwave interference could mean the difference between mission success or failure and life or death, Hosking points out.

"The effect of RF and microwave interference ranges from a slight degradation of equipment performance to complete denial of operation. In a mil-aero platform, this can mean a loss of life, tactical advantage, equipment, platforms, and critical intelligence," Hosking says. ←

COMPANY LIST

Aitech
Chatsworth, Calif.
www.rugged.com

Crystal Group
Hiawatha, Iowa
www.crystalrugged.com

Curtiss-Wright Defense Solutions
Ashburn, Va.
https://www.curtisswrightds.com

dB Control
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Army mulls high-voltage power control for electric and hybrid military vehicles

BY **John Keller**

WARREN, Mich. — U.S. Army vetronics researchers are asking industry to develop a vehicle powertrain power controller that can handle voltages high enough to control power systems throughout next-generation electric and hybrid military armored vehicles.

Officials of the Army Contracting Command-Warren in Warren, Mich., have issued a request for information (W56HZV_Powertrain_Power_Controller) for the Powertrain high-voltage Power Controller project.

The Army wants industry to develop a physical prototype to evaluate the feasibility of developing a powertrain high-voltage power controller to support the electrified mobility of future military vehicles like main battle tanks, armored personnel carriers, and light tactical vehicles.

The Army Contracting Command is issuing this request for information on behalf of the Vehicle Electronics and Architecture branch of the Army Combat Capabilities Development Command's Ground Vehicle Systems Center in Warren, Mich.

The vehicular power controllers available today do not support the high-voltage power levels necessary to support the electrified drive trains of future ground vehicles, Army researchers point out. This notice is to obtain information on how an interested contractor could provide a powertrain high-voltage power controller for ground vehicles.

From industry, the Army wants a description of a powertrain high-voltage power controller that details 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.

Army researchers are planning today for handling the kinds of power loads they'll face in next-generation electric and hybrid military vehicles.

Increasing the capabilities of ground vehicles will require advanced, next-generation power controllers able to deliver high voltage to several channels at various currents within a wheeled or tracked vehicle.

The powertrain high-voltage power controller should have:

- at least six 900-amp channels;
- at least one 350-amp channel;
- a safety interlock for each high-voltage channel;
- at least one Controller Area Network (CAN) bus that meets the SAE J1939 industry standard for communication and diagnostics among vehicle components;
- at least one 28-volt control power input that meets MIL-STD-1275E;
- isolation of the high-voltage power bus from equipment chassis and control power by at least 10 mega-Ohms;
- controllability of the opening and closing of channels via CANbus command;
- the ability to monitor the voltage and current of each channel via CANbus; and
- the ability to be cooled by ethylene glycol and water at 105 degrees Celsius.

Companies interested were asked to email responses no later than 28 June 2018 to the Army's Andrew Greer at andrew.r.greer4.civ@mail.mil. For questions or concerns contact the Army's Andrew Greer by email at andrew.r.greer4.civ@mail.mil or by phone at 586-282-7356. Also email Jason Spina at jason.a.spina.civ@mail.mil.

More information is online at https://www.fbo.gov/notices/b8649b0cc8aa056bc64c400ab-0468daf.

SWrI to test for GPS spoofing vulnerabilities in unmanned vehicles

Engineers from the Southwest Research Institute have developed a trusted computing system that can test for vulnerabilities in aircraft and unmanned vehicles that use GPS receivers for positioning, navigation, and timing (PNT). "This is a legal way for us to improve the cyber resilience of autonomous vehicles by demonstrating a transmission of spoofed or manipulated GPS signals to allow for analysis of system responses," says Victor Murray, head

Raytheon to upgrade 1,000 radar-killing HARM missiles for U.S. allies

BY **John Keller**

ROBINS AIR FORCE BASE, Ga. — Aerial weapons experts at the Raytheon Co. will upgrade and refurbish about 1,000 radar-killing AGM-88B High Speed Anti-Radiation Missiles (HARMs) for U.S. allies under terms of a $355.5 million contract.

Officials of the U.S. Air Force Life Cycle Management Center at Robins Air Force Base, Ga., are asking the Raytheon Missile Systems segment in Tucson, Ariz., to provide HARM Control Section Modification (HCSM) work for legacy AGM-88B missiles for electronic warfare (EW) and electronic attack missions. This contract is for Qatar, Taiwan, and Bahrain.

The HCSM adds a GPS receiver and an improved inertial measurement unit (IMU) for precision navigation on the missile. The upgrade features a digital flight computer that merges targeting solutions from navigation and seeker systems to improve the missile's probability of hit, while controlling where the missile can and cannot fly, Raytheon officials say.

This contract provides for the refurbishment of live AGM-88Bs and conversion of AGM-88B into Captive Air Training Missiles (CATM-88B) for approved Foreign Military Sales countries. The CATM-88Bs are training missiles that simulate live HARM missiles for training purposes.

The AGM-88 HARM missile is for all variants of the F/A-18, Tornado, EA-18G, F-16, EA-6B, and F-35 (external) combat jets. It features an advanced, digital, anti-radiation homing sensor, millimeter wave radar terminal seeker, and GPS/INS guidance.

The missile provides the ability to engage and destroy enemy air defenses and time-critical, mobile targets. It can detect, attack, and destroy a radar antenna or transmitter with minimal aircrew input. It has a fixed antenna and seeker head in the missile's nose.

A solid-propellant rocket motor propels the missile at speeds faster than Mach 2.0. The HARM missile project was led by the U.S. Navy, and first was first carried by the A-6E, A-7, F/A-18A/B, and EA-6B aircraft. The U.S. Air Force (USAF) put the HARM onto the F-4G Wild Weasel aircraft, and later on specialized F-16s.

On this contract Raytheon will do the work in Tucson, Ariz., and should be finished by 2027. For more information contact Raytheon Missile Systems online at www.raytheon.com, or the Air Force Life Cycle Management Center-Warner Robins at www.robins.af.mil/Units/AFLCMC.

Raytheon is refurbishing about 1,000 radar-killing HARM missiles for U.S. allies under terms of a $355.5 million contract.

of SwRI's Cyber Physical Systems Group in the Intelligent Systems Division. GPS spoofing is a malicious attack — particularly dangerous for unmanned vehicles — that broadcasts incorrect signals to deceive GPS receivers, while GPS manipulation modifies a real GPS signal. GPS satellites orbiting the Earth pinpoint physical locations of GPS receivers embedded in everything from smartphones to ground vehicles and aircraft. SwRI designed the new tool to meet U.S. federal regulations. Testing for GPS vulnerabilities in a mobile environment had previously been difficult because federal law prohibits over-the-air re-transmission of GPS signals without prior authorization.

Researchers develop electronic skin able to feel warm touch, measure body temperature

Inspired by the behavior of natural skin, researchers at the Linkoping University Laboratory of Organic Electronics in Linkoping, Sweden, have developed a sensor that will be suitable for use with electronic skin. It can measure changes in body temperature, and react to sunlight and warm touch. Robotics, prostheses that react to touch, and health monitoring are three fields in which scientists globally are working to develop flexible electronic skin that has some form of sensitivity. A voltage arises in pyroelectric materials when they are heated or cooled. It is the change in temperature that gives a signal, which is rapid and strong, but that decays almost as rapidly.

Navy asks BAE Systems to build radar-equipped deck guns for littoral combat ships

U.S. Navy surface warfare experts are ordering three computer- and radar-equipped deck guns for Navy littoral combat ships and large U.S. Coast Guard offshore cutters under terms of a $22.7 million order. Officials of the Naval Sea Systems Command in Washington are asking the BAE Systems Platforms & Services segment in Minneapolis to build three 57-millimeter MK 110 Mod 0 gun mounts and related hardware. The MK 110 gun mount consists of a 57-millimeter gun, muzzle velocity radar, power distribution panel, barrel-mounted television camera, a ruggedized laptop computer gun control panel, and an ammunition hoist. The radar-equipped Mark 110 gun mount is a multi-purpose medium-caliber gun designed to destroy or disable hostile surface ships and boats, as well as aircraft and missiles. A 57-millimeter shell is more than two feet long and weighs between 13.4 and 14.3 pounds. For more information contact BAE Systems Platforms & Services online at www.baesystems.com.

Navy orders small UAVs with persistent surveillance sensor payloads

BY **John Keller**

PATUXENT RIVER NAS, Md. — Unmanned aerial vehicle (UAV) designers at Insitu Inc. in Bingen, Wash., will build 34 ScanEagle small UAVs for the governments of Malaysia; Indonesia; the Philippines; and Vietnam under terms of a $47.9 million U.S. Navy order in late June.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking Insitu to provide 12 ScanEagle UAVs for Malaysia; eight for Indonesia; eight for the Philippines; and six for Vietnam.

Insitu also will provide spare sensor payloads, spare and repair parts, support equipment, tools, training, technical services, and field service. Insitu is a subsidiary of the Boeing Co.

The Boeing Insitu ScanEagle small unmanned aircraft can be launched and recovered from a wide variety of surface vessels, as well as from unimproved launch sites on land.

The ScanEagle UAV is 5.1 feet long with a 5.6-foot wingspan. It weighs as much as 48.5 pounds and can carry a 7.5-pound sensor payload. The UAV can fly for more than 24 hours at altitudes as high as 19.500 feet, and at speeds to 80 knots. The unmanned aircraft can fly on gasoline or heavy fuels like jet fuel, diesel, or kerosene.

The mission of ScanEagle is to provide persistent surveillance and reconnaissance imagery on land or at sea at lower costs than other surveillance methods for military and agriculture missions.

ScanEagle can carry a sensor payload consisting of visible-light camera, medium-wave infrared imager, or both integrated in one turret. The UAV also has an analog digitally encrypted video data link, as well as encrypted or unencrypted command-and-control data link.

The UAV can be launched autonomously and uses a no-nets recovery system that recovers with its wing tip on a rope that hangs from a boom.

On this contract Insitu will do the work in Bingen, Wash., and at several shore and sea locations in Malaysia; the Philippines; Vietnam; and Indonesia, and is expected to be finished by March 2022. For more information contact Insitu online at www.insitu.com, or Naval Air Systems Command at www.navair.navy.mil.

Northrop Grumman to build three new MQ-4C unmanned surveillance aircraft

BY **John Keller**

PATUXENT RIVER NAS, Md. — Maritime aviation surveillance experts at Northrop Grumman Corp. are preparing to build three MQ-4C Triton long-range patrol unmanned aerial vehicles (UAVs) under terms of a $65.2 million advance-acquisition contract.

Official of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking the Northrop Grumman Aerospace Systems sector in San Diego to provide long-lead items for three low-rate initial production (LRIP) lot 5 MQ-4C Triton UAVs — two for the Navy and one for the government of Australia.

Northrop Grumman is building the MQ-4C Triton, also called the Broad Area Maritime Surveillance (BAMS) UAV, to fly maritime surveillance missions as long as 24 hours at altitudes of more than 10 miles to enable coverage out to 2,000 nautical miles. The UAV's suite of sensors can detect and classify different types of ships automatically.

Long-lead items either are difficult and time-consuming to obtain, and are funded early in the design process to keep overall production on schedule. Contracts to build the actual maritime patrol UAVs will come later.

The Triton will be a crucial component of the Navy's 21st century strategy for conducting surveillance of surface ship and submarine traffic in the vast Pacific and other oceans around the globe. The Triton UAV will work together with the Navy's P-8A Poseidon manned maritime patrol aircraft.

The MQ-4C Triton is a long-range unmanned maritime patrol aircraft that can remain aloft and relay situational awareness data to command authorities for as long as 24 hours per sortie.

The Triton's maritime search radar is called the Multi-Function Active Sensor (MFAS), and will provide the UAV and its operators with a 360-degree view of a large geographic area while providing all-weather coverage for detecting, classifying, tracking, and identifying points of interest. MFAS is separate from the Triton's air-to-air radar. The MFAS radar first flew on the Triton during testing in April 2015.

Along with the air-to-air and MFAS radar systems, the MQ-4C will carry an electro-optical/infrared (EO/IR) sensor that will provide still imagery and full-motion video of potential threats; an electronic support measures package to identify and geolocate radar threat signals; and an automatic identification system (AIS) that will detect and track vessels equipped with AIS responders.

Northrop Grumman has delivered two MQ-4Cs to the Navy's Unmanned Patrol Squadron (VUP) 19 detachment at Point Mugu Naval Air Station, Calif. The Triton originally was scheduled to reach early operational capability last year with a deployment to Guam, but the deployment was put on hold after one of the MQ-4Cs was damaged in a landing mishap at Point Mugu last September when the unmanned aircraft made a gear-up landing.

The Triton air vehicle is based on the U.S. Air Force RQ-4B Global Hawk, while its sensors are based on components and systems already fielded in the U.S. military.

The MQ-4C Triton's ability to perform persistent ISR within a practical range of 2,000 nautical miles enables the P-8A aircraft to focus on anti-surface ship warfare, anti-submarine warfare (ASW), and multi-intelligence.

Triton aircraft and support facilities are based domestically at Point Mugu Naval Air Station near Ventura, Calif., and at Jacksonville Naval Air Station, Fla. Triton UAVs also will be forward-deployed to Kadena Air Base, Japan; Andersen Air Force Base, Guam; Sigonella Naval Air Station, Italy; as well as at installations on the islands of Hawaii and Diego Garcia.

On this contract Northrop Grumman will do the work in San Diego; Salt Lake City; Baltimore; Waco, Texas; Bridgeport, W.Va.; Red Oak, Texas; and at other Continental U.S. locations, and should be finished by June 2020.

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

Sierra Nevada to build synthetic vision helicopter avionics for DVE conditions

BY **John Keller**

ROBINS AIR FORCE BASE, Ga. — U.S. Air Force helicopter avionics experts needed synthetic vision equipment to enable helicopter pilots to land and take off in degraded visual conditions like snow whiteout or dense clouds of dust. They found their solution from Sierra Nevada Corp. in Sparks, Nev.

Officials of the Air Force Materiel Command at Robins Air Force, Base, Ga., have announced a $74.9 million contract to Sierra Nevada to install degraded visual environment systems (DVES) on 85 HH-60G Pave Hawk helicopters to improve situational awareness for pilots and air crew operating in DVE conditions.

Sierra Nevada's DVES will add new helicopter avionics capabilities to the Air Force HH-60G. This contract provides for procurement, installation, and integration of the DVES on 85 HH-60G helicopters.

Landing a helicopter in choking dust or blinding snow can be particularly difficult because pilots can become disoriented easily near the ground as they lose view of the horizon and other visual cues.

Without help in these kinds of conditions, helicopter pilots can lose track of the horizon during critical moments in takeoff and landing. This can cause pilots to roll the aircraft while close the ground, which risks hitting the rotors on the ground or other nearby objects.

Sierra Nevada's degraded visual environment (DVE) avionics provide increased flight safety and operational capability by restoring pilot situational awareness in severe DVE. These sensor-agnostic, configurable systems use input from several different passive and active high-resolution and deep-penetrating sensors to provide real-time, multi-sensor fused imagery and command guidance symbology throughout, company officials say. Sierra Nevada makes DVE equipment for fixed-wing aircraft and helicopters.

Operating helicopters in snow whiteout or thick dust can deprive pilots of the visual cues they need to make safe takeoffs and landings.

In 2016 Sierra Nevada demonstrated advancements in the company's synthetic vision technology during demonstrations at Flight Trials in Yuma, Ariz., as part of the military DVE Mitigation (DVE-M) program — a multi-year U.S. Army research effort to test sensor, flight control, and cueing technology combinations on the ground and in the air to provide helicopter pilots with visual awareness in DVE environments.

For the DVE-M program, Sierra Nevada engineers focused on real-time fusion of multi-sensor data from millimeter wave radar, light detection and ranging (LIDAR) sensors, infrared cameras, and various a-priori digital terrain data, company officials say.

During the Yuma demonstrations, Sierra Nevada's DVE technology enabled pilots to conduct more than 86 safe approaches to hover and landing in dust and heavy brownout conditions.

In early 2017 Sierra Nevada demonstrated the company's DVE technology at the European NATO DVE Flight Trials, focusing on additional degraded visual conditions involving fog, rain, sand, and snow.

In mid-2013 the Aviation Applied Technology Directorate of the Army Research, Development, and Engineering Command at Fort Eustis, Va., awarded a contract to Sierra Nevada to integrate and test the company's Helicopter Autonomous Landing System (HALS) aboard an Army UH-60A/L helicopter as part of the AMRDEC DVE-M program.

The Sierra Nevada HALS helicopter avionics uses a 3D image-rendering 94 GHz pulsed radar, global positioning system (GPS), inertial sensors, and cockpit displays to help helicopter pilots view geographic features outside the aircraft during brownouts and whiteouts from dust, snow, or other visual impairments.

The HALS system uses radar data translated to color graphic representations on cockpit displays to help helicopter pilots control the aircraft's roll, pitch, and yaw based on radar-generated graphic representations of the ground and nearby geographic features in zero-visibility conditions.

HALS avionics enables helicopter pilots to take off, land, and fly in all degraded visual conditions, provides visual situational awareness to enable pilots to see and avoid wires, cables, and terrain, and well as follow landmarks in poor visibility.

The system also included Brownout Symbology Software (BOSS), precise guidance to landing in zero visibility, and safe transition from visual to instrument flying conditions. ←

On this contract Sierra Nevada will do the work in Sparks, Nev., and should be finished by May 2024. For more information contact Sierra Nevada Corp. online at www.sncorp.com, or the Air Force Materiel Command-Robins Air Force Base at www.robins.af.mil.

Boeing to upgrade AH-64 Apache attack helicopter flight simulators

BY **John Keller**

REDSTONE ARSENAL, Ala. — Military experts at the Boeing Co. will upgrade transportable flight simulators for the U.S. Army AH-64D and AH-64E Apache Longbow helicopter to make these flight trainers compatible with the latest versions of the Apache helicopter fleet.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., announced an $18.9 million contract in May to the Boeing Defense, Space & Security

Boeing is updating flight simulators for the U.S. Army AH-64D and AH-64E Apache Longbow helicopter to make these flight trainers compatible with the latest versions of the Apache helicopter fleet.

Scientists in Hong Kong improve memory efficiency of quantum computing

A team of scientists in Hong Kong has discovered a method to boost the efficiency of photonic quantum memory to over 85 percent with a fidelity of over 99 percent. Such quantum computers may push the boundaries of fundamental science and help create new drugs, explain cosmological mysteries or enhance accuracy of forecasts. Quantum computers are expected to be much faster and more powerful than their traditional counterparts as information is calculated in quantum bits — or qubits — which can represent both 0 and 1 at the same time. Researchers led by Professors Du Shengwang and William Mong at the Hong Kong University of Science and Technology created a quantum memory device by trapping billions of rubidium atoms into a hair-like tiny space.

segment in St. Louis to upgrade and field the Longbow Crew Trainer (LCT) Generation 4 and Generation 5.

Boeing will field AH-64D and AH-64E aircraft concurrency enhancements and a functional obsolescence upgrade for the generation (Gen) 4 and generation (Gen) 5 AH-64 LCT flight simulator.

The attack helicopter simulation and training systems can be used for in-theater training capability to the warfighter to enable Apache Longbow aircrews to keep their skills sharp, even while deployed in remote areas.

The Apache LCTs have high-resolution display systems optimized for attack helicopter operations; a dynamic motion cueing sea; distributed interactive simulation (DIS); high-fidelity crew stations; integrated helmet and display sight system (IHADSS); and full-fidelity aircraft operational flight programs.

These AH-64 Apache combat helicopter simulators use aircraft and improved data modem operational flight programs; simulate the Target Acquisition Display Sight (TADS) system; offer electronics display and control assembly (TEDAC); simulate high-resolution sensors; and offer data capture for after action review.

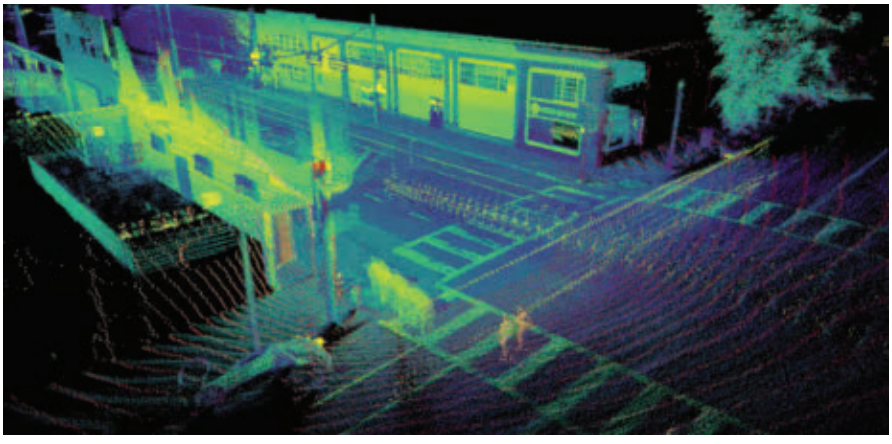
Boeing will handle Apache simulator concurrence enhancements, hardware and software improvements, information assurance controls, and mitigation of obsolete operating systems.

The company also will maintain concurrency of the primary training device to the fielded aircraft; upgrade the LCT virtual environment; enhance its Image Generator Pilot Night Vision System Intensification (PNVS12); and incorporate AGM-114R Hellfire missile, 70-millimeter rocket, and Gunnery Conduct of Fire Trainer (GCOFT) weapons enhancements.

The contract also calls for Boeing to develop modernized maintenance laptop computers; support training aids devices simulators and simulation (TADSS); and maintain concurrency of the primary training device to the fielded aircraft its latest enhancements. In addition, Boeing will field U.S. Army Aviation Center of Excellence (USAACE) LCT full motion system (FMS) and display kit enhancements. ←

On this contract Boeing will do the work in St. Louis, and should be finished by April 2022. For more information contact Boeing Defense, Space & Security online at www.boeing.com/defense, or the Army Contracting Command-Redstone at acc.army.mil/contractingcenters/acc-rsa.

PRODUCT applications



SENSORS

Air Force Research Lab chooses Princeton Infrared for ladar detector arrays

Princeton Infrared Technologies Inc. in Monmouth Junction, N.J., is developing detector arrays for military coherent laser detection and ranging (ladar) sensors.

The company is working under terms of a $750,000 phase-two Small Business Innovation Research (SBIR) contract from the U.S. Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio.

Princeton Infrared is focusing on developing detector arrays using multi-quantum well materials enabling detection from 0.9 to 2.4 microns with low-dark current and high-quantum efficiency, company officials say.

These ladar detector arrays will enable a new generation of high-resolution, high-speed cameras that can image near, room temperature at high sensitivity in the shortwave-infrared (SWIR) spectrum using arrays detectors, instead of single-element detectors.

The SBIR phase-two project concentrates on new materials development. Princeton Infrared will research new multi-quantum well materials and strained-superlattice materials manufactured on indium phosphide (InP) substrates for enabling technologies for military applications.

Using multi-quantum well materials "will enable high-sensitivity detectors to image beyond what lattice-matched indium gallium arsenide detectors can detect in the SWIR range," says Martin Ettenberg, president of Princeton Infrared.

"These next-generation detector arrays will benefit long-range ladar used by the Air Force to identify targets," Ettenberg says. "Current systems require cryogenic cooling while these materials will not, thus vastly lowering costs, size, weight, and power."

For more information contact **Princeton Infrared Technologies** online at *www.princetonirtech.com*.

TEST AND MEASUREMENT

Navy chooses vector network analyzers from Rohde & Schwarz for RF and power test

U.S. Navy test and measurement experts needed vector network analyzers to support the Naval Surface Warfare Center, Corona Division, Measurement Science and Engineering Department in Corona, Calif. They found their solution from Rohde & Schwarz USA Inc. in Columbia, Md.

Officials of the Measurement Science and Engineering Department of the Naval Surface Warfare Center Corona Division in Corona, Calif., announced a $7.3 million contract to Rohde & Schwarz for vector network analyzers.

Navy test and measurement experts will use these test instruments to calibrate devices like attenuators, power sensors, filters, terminations, and other RF and microwave passive devices.

Rohde & Schwarz offers several high-performance network analyzers to 500 GHz and multiport solutions to 48 ports to analyze passive and active components such as filters, amplifiers, mixers, and multiport modules.

The network analyzers feature analysis functions to help test engineers evaluate important parameters at a glance, company officials say.

Rohde & Schwarz offers the ZNA vector network analyzers that consists of the ZNA26, which operates from 10 MHz to 26.5 GHz; the ZNA43, which operates from 10 MHz to 43.5 GHz. The company's ZVA vector network analyzers consist of the ZVA 8, which operates from 300 kHz to 8 GHz; the ZVA 24, which operates from 10 MHz to 24 GHz; the ZVA 40, which operates from 10 MHz to 40 GHz; the ZVA 50, which operates from 10 MHz to 50 GHz; the ZVA 67, which operates from 10 MHz to 67 GHz; and the ZVA 110, which operates from 10 MHz to 110 GHz.

The Rohde & Schwarz ZVT8 operates from 300 kHz to 8 GHz; and the ZVT20 operates from 10 MHz to 20 GHz. The ZVA-Z75 operates from 50 GHz to 75 GHz; the ZVA-Z90 operates from

60 GHz to 90 GHz; the ZVA-Z110 operates from 75 GHz to 110 GHz; the ZVA-Z110E operates from 75 GHz to 110 GHz; the ZVA-Z140 operates from 90 GHz to 140 GHz; the ZVA-Z170 operates from 110 GHz to 170 GHz; the ZVA-Z220 operates from 140 GHz to 220 GHz; the ZVA-Z325 operates from 220 GHz to 325 GHz; and the ZVA-Z500 operates from 325 GHz to 500 GHz.

Rohde & Schwarz also offers other high-end vector network analyzers. The ZC170 operates from 110 GHz to 170 GHz; the ZC220 operates from 140 GHz to 220 GHz; the ZC330 operates from 220 GHz to 330 GHz; and the ZC500 operates from 330 GHz to 500 GHz.

On this contract Rohde & Schwarz will do the work in Columbia, Md., and should be finished by June 2024. For more information contact **Rhode & Schwarz** online at *www.rohde-schwarz.com*.

CLOUD COMPUTING

Navy chooses Metron to apply cloud computing and data analytics to warfighting

U.S. Navy researchers needed cloud computing that involves advanced analytic methods tailored to specific military warfighting domains. They found their solution from Metron Scientific Solutions in Reston, Va.

Officials of the Office of Naval Research (ONR) in Arlington, Va., announced a $6.9 million contract to Metron for the Navy Tactical Data Cloud project.

Metron experts will investigate, develop, and integrate data analytics for the warfighter by capitalizing on recent advances in battle management, search, risk management, and operations oversight.

Metron has developed specialized methods to mine massive data repositories quickly to identify suspicious and anomalous entities, subgraphs, and transaction patterns.

Company experts have demonstrated the ability to track, detect, and characterize networks of interest in a massive sea of transactional noise, company officials say.

Metron researchers have implemented these techniques on Hadoop-based architectures and performed analyses within distributed cloud computing environments.

On the low end, Metron conducted network analyses on repositories of 200 million Twitter messages. On the upper end, researchers applied MapReduce methods to the parallel-processing of billions of U.S. Transportation Security Administration records to learn complex passenger risk indicators and screening rules at rates 30 times faster than a previous non-Hadoop implementation, company officials say.

For more information contact **Metron Scientific Solutions** online at *www.metsci.com*, or the **Office of Naval Research** at *www.onr.navy.mil*.

COMMUNICATIONS

DISA asks DRS to provide U.S. Special Operations with SATCOM and C4I

Communications experts at U.S. Special Operations Command (USSOCOM) at MacDill Air Force Base, Fla., needed global satellite communications (SATCOM) for Special Operations warfighters in the field. They found their solution from the Leonardo DRS Global Enterprise Solutions segment in Dulles, Va.

Officials of the U.S. Defense Information Systems Agency (DISA) Defense Information Technology Contracting Organization at Scott Air Force Base, Ill., announced a potential $977 million contract to DRS for the USSOCOM Deployed Operations telecommunication program.

DRS will provide USSOCOM's Global Access Network (GAN) system — an end-to-end custom-engineered, global commercial SATCOM system engineered to meet USSOCOM's satellite communications needs.

USSOCOM requires an integrated satellite and terrestrial telecommunications system to send command, control, communications, computers and intelligence (C4I) information between USSOCOM, its components, and their major subordinate units as well as to selected U.S. government agencies that work with the Special Operations community, DRS officials say.

For more information contact **DRS Global Enterprise Solutions** online at www.leonardodrs.com, **DISA** at https://disa.mil, or **USSOCOM** at www.socom.mil. ←

new PRODUCTS

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

BLADE SERVERS

6U OpenVPX blade server for artificial intelligence (AI) and sensor fusion introduced by Mercury

Mercury Systems Inc. in Andover, Mass., is introducing the EnsembleSeries HDS6605 powerful general-purpose 6U OpenVPX embedded computing blade server with hardware-enabled support for artificial intelligence (AI) applications. Powered by second-generation Intel Xeon Scalable processors, the HDS6605 blade server is rugged defense applications and upgrades that require the utmost in processing capability. These rugged servers have the same cooling, packaging, and 100 gigabits per second in-system switch fabric interconnect technologies found in earlier generations of Mercury blades based on Intel Xeon processors. These open systems technologies have a technology readiness level of nine (TRL-9). The HDS6605 blade server is optimized for sensor fusion, complex C4I, and deep-learning applications. Second-generation Intel Xeon Scalable processors have Intel Deep Learning Boost, which extends Intel Advanced Vector Extensions-512 (Intel AVX-512) to accelerate inference applications like speech recognition, image recognition, language translation, and object detection. Its set of Vector Neural Network Instructions (VNNI) embedded accelerators speed up dense computations characteristic of convolutional neural networks and deep neural networks, delivering as much as a 14x improvement in inference performance compared to the first-generation Intel Xeon Scalable processor. For more information contact **Mercury Systems** online at *www.mrcy.com*.

DISPLAYS

Rugged flat-panel displays for defense applications introduced by EIZO

EIZO Rugged Solutions Inc. in Altamonte Springs, Fla., is introducing the Talon series rugged displays for mission-critical operation in harsh-environment aerospace and defense applications. These MIL-STD-810-, MIL-STD-461-, and IP65-compliant rugged displays also feature optical bonding, which protects the liquid crystal display (LCD) panel while improving visibility in bright environments. With a long-lasting LED backlight and less than 1 cd/m2 minimum brightness, users can view the displays comfortably in the dark. The displays also come standard with inputs like 3G-SDI, DVI, RGB, USB, and serial communication. The lineup includes the 24.1-inch RGD2401W, 21.5-inch RGD2101W, and 20.1-inch RGD2001. All three displays offer ruggedized features and can be customized to meet user needs. Talon displays are 19-inch rack mountable for flexible installation. EIZO designs, manufactures, and tests its harsh-environment displays in-house for total control over production for quality materials and extended life cycle support. Optional image enhancement technology is available to adjust dark or foggy images pixel by pixel for a clear and easy-to-see picture in real time. Touch screen options include projected capacitive (PCAP) touch with 10-point multitouch (RGD2001 and RGD2401W), or analog resistive touch (RGD2101W). For more information contact **EIZO Rugged Solutions** online at *www.eizorugged.com*.

Talon RGD2401W / RGD2101W / RGD2001

DATA STORAGE

Embedded digital video recorder (DVR) board introduced by Sensoray

Sensoray Co. Inc. in Tigard, Ore., is introducing the rugged model 4023 embedded digital video recorder (DVR) for aerospace, defense, and commercial imaging applications. The model 4023 supports simultaneous HD recording to two USB devices, captures JPEG snapshots without video interruption, offers selectable HD or composite output for playback/preview, has wireless operation with external WiFi adapter, can perform real-time video overlay of date and time, provides microphone and stereo line audio inputs, and has clock/calendar with battery backup. The embeddable DVR captures and records analog AHD, HD-TVI, or HD-CVI HD video and stereo audio to USB storage media and can capture JPEG imaging on-the-fly without interrupting stream recording. It measures 3.25 by 2.375 by 0.875 inches, and operates in temperatures from 0 to 5 degrees Celsius. It provides DVI and composite NTSC/PAL outputs to display live and recorded video and JPEG snapshots on an external HD or SD monitor. Date and time are maintained by a real-time clock with battery backup. It accepts a keypad or keyboard and a USB storage device. To create a wireless DVR, plug a USB WiFi adapter into one of the embedded board's USB ports. This enables phones, tablets, and laptops to view video and control recording and playback, and also can operate the DVR without a monitor or keypad. For more information contact **Sensoray** online at *www.sensoray.com*.

RF AND MICROWAVE

Coaxial packaged tunnel diode detectors for radar and SATCOM introduced by Pasternack

Pasternack Enterprises in Irvine, Calif., is introducing a product line of coaxial packaged tunnel diode detectors for prototype and proof-of-concept applications in military and commercial radar, test and measurement, and satellite communications (SATCOM) applications. Pasternack's offering includes 26 models of tunnel diode detectors that have rugged Germanium planar construction and operate over octave and broadband frequencies that range from 100 MHz to 26 GHz. These zero-biased designs for radar, SATCOM, and test and measurement are available in positive and negative video output polarities and offer dynamic range with efficient low-level signal detection. Another added benefit is an extremely fast pulse response rise time of 5 nanoseconds typical. These detectors have maximum input power handling of +17 dBm and exhibit a flat video output response across wide frequency bands over a maximum temperature range of -65 to 115 degrees Celsius. All models for radar, SATCOM, and test and measurement are RoHS and REACH compliant and available in compact cylindrical packages that have an SMA male RF input connector and an SMA female video output connector. For more information contact **Pasternack** online at *www.pasternack.com*.

POSITIONING, NAVIGATION, AND TIMING

Timing device to operate through GNSS jamming introduced by Microchip

Microchip Technology Inc. in Chandler, Ariz., is introducing the TimeProvider 4100 Release 2.0 system timing device to help keep services operating through Global Navigation Satellite System

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(GNSS) lapses due to vulnerabilities such as jamming, spoofing, or loss of signal. The TimeProvider release adds 10 Gigabit Ethernet support, a boundary clock operation mode that lowers operational costs, and other enhancements to improve how timing flows are distributed from several sources to a network's base stations and other end points. Extending the TimeProvider 4100's gateway clock operation mode with Microchip's high-performance boundary clock (HP-BC) operation mode enables it to support the latest high-accuracy ITU-T Class C & D boundary clock standards. These standards dictate accurate time transfer over optical networks so operators can use Dense Wavelength Division Multiplexing (DWDM) technology rather than dedicated fiber. Release 2.0 accommodates escalating bandwidth requirements of next-generation network devices through an optional expansion module that provides 10 Gigabit Ethernet interfaces that operate through electronic warfare (EW) jamming. For more information contact **Microchip Technology** online at *www.microchip.com*.

TEST AND MEASUREMENT

Programmable electronic DC loads for power supply testing introduced by SIGLENT

SIGLENT Technologies America Inc. in Solon, Ohio, is introducing the SDL1000X and SDL1000X-E series of programmable electronic DC loads for battery, solar cell, and power supply testing. The SDL1020X/X-E models offer an input range of 150 volts at 30 amps with 200 Watts total power dissipation, while the SDL1030X/X-E's have an input range of 150 volts at 30 amps to 300 Watts. The X type provide a measurement resolution of 0.1 millivolt at 0.1 milliamps, whereas the economical X-E type offers 1 millivolt at 1 milliamps. A four-wire sense compensation mode can remove any potential error due to a voltage drop in the connection wires. These DC loads for power testing support common modes of operation: CC, CV, CR, and CP. One of the most important features of this new e-load series is its high-speed response performance. In dynamic test mode, the highest frequency of periodical switching between two user-defined levels (Level A and Level B) can achieve 25 kHz. Users can set up the adjustable slew rate. All models come standard with a 3.5-inch TFT-LCD display and user interface. Operators can use the Program function (maximum 50 groups) and List function (maximum 100 steps) to create complex discharge profiles for battery charging circuitry design. For more information contact **SIGLENT Technologies** online at *www.siglentamerica.com*.

INTERCONNECT PRODUCTS

ITT Cannon rugged power connectors for spacecraft offered by TTI

Electronics parts distributor TTI Inc. in Maisach-Gernlinden, Germany, is offering the ITT Cannon MDM and MDV Micro series connectors for data, power, and signal transmission in demanding applications like space vehicles, defense systems, and oil exploration equipment. Suitable aerospace and defense applications for the ITT Micro series connectors include avionics, military ground vehicles, missile systems, satellites, and space vehicles. Optimized to save space and weight, Micro series Connectors are rugged and moisture-sealed. These data, power, and signal interconnects are designed to be comparable with MIL-DTL-83513-style connectors. The MDM and MDV Micro series are available in eight shell sizes, and accommodate nine to 100 contacts in copper alloy or gold plating in positions 9, 15, 21, 25, 31, 27, 51 and 100. Wire sizes are AWG 24 to AWG32. The interconnects use the Cannon micro twist pin contact system, which reverses the traditional pin and socket arrangement and ensures that the pins will mate even under misalignment conditions. Available configurations include Micro-D Metal (MDM); coaxial/power, circuit board, surface mount, micro strip, hermetic, filter, center jackscrew, and circular connectors. For more information contact **TTI** online at *www.ttieurope.com*.

DATA NETWORKING

Rugged data-router for harsh-environment applications introduced by Elma

Elma Electronic Inc. in Fremont, Calif., is introducing an EN 50155-compliant NetSys-5304 rugged fanless embedded data router for use in harsh-environment applications like railways and transportation. The rugged router facilitates seamless, secure communications in rolling-stock applications that involve vehicle positioning, monitoring, speed control, and collision avoidance. The NetSys-5304 is part of Elma's Cisco-enabled family of rugged systems designed for high performance communication and computing at the network edge. Designed to deliver secure IP-based data to mobile rail and transportation applications, the NetSys-5304 is based on Cisco's 5915 Embedded Services Router (ESR) with Advanced Enterprise IOS and Mobile Ready Net capabilities. An on-board hardware encryption engine ensures secure, uninterrupted handling of all data, video and voice. This Cisco 5915 embedded services router (ESR) system is designed to meet EN50155 and delivers secure IP based data to mobile applications in the rail transportation industry as well as other harsh-environment applications. The NetSys-5304 features a fanless design that provides passive conduction-cooling and reduces maintenance needs as well as possible component failures. For more information contact **Elma** online at *www.elma.com*.

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