JULY 2020

Military & Aerospace Electronics®

RELEVANT. TRUSTED.
ENABLING TECHNOLOGIES.

Helicopter synthetic vision

New enabling technologies seek to help chopper pilots fly safely in dust and snow. PAGE 3

Real-time software

New demands emerge for safety-critical operations for avionics and other life-critical applications. PAGE 20

militaryaerospace.com

LASER WEAPONS MAKE FOR THE BIG TIME

New electro-optical weapons increase in power, and aim at unmanned aircraft, rockets, mortar rounds, and artillery shells. PAGE 12

ENDEAVOR BUSINESS MEDIA

RUGGED SERVERS, ENGINEERED TO SERVE.

RUGGED, EXPANDABLE

1U/2U, FANLESS INTEL® SCALABLE XEON® SERVER

"TITAN" SMB

Dual/Quad Intel® Scalable
Xeon® CPUs
Up to 28 cores each

Removable Cartridges
16x SSDs
SATA/SAS/NVMe Gen 3

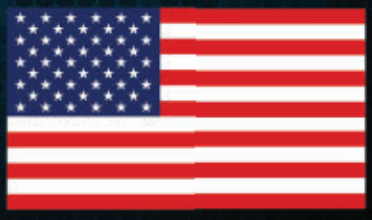
8 Copper/Fiber
1/10/40 Gb
Ethernet Ports

Air and Conduction Cooled
-20° to +55°C
Available Rugged Level 1-5

KEY FEATURES

- Dual or Quad Intel® Scalable Xeon® processors w/ up to 28 cores (2.50 GHz) and Turbo Boost (3.80 GHz) (server-class processors: Platinum and Gold)
- Air and conduction-cooled (sealed) versions with commercial (COTS) connectors or mil-circular 38999 connectors for ultimate reliability
- Available in 1U and 2U variants, with either dual (2S) or quad (4S) CPUs
- 3x UPI (10.4 GT/s) interconnects for HPEC, SMP, NUMA architecture
- Up to 1 TB DDR4 ECC memory (8 DIMMs) per CPU
- Up to 10 PCIe Gen 3 add-in cards (4x in 1U and 10x in 2U; factory-installed)
- Optional 20-port segregated Ethernet and 10GbE switch in TITAN-2U
- AI version > 400 TFLOPs supports up to 4x Nvidia V100 GPGPUs in 2U
- Encryption and security via Intel® AES-NI/Trusted Platform Module 2.0 (TPM)
- Dual-redundant MIL-STD-1275 500W power supplies
- Optional MIL-STD-704F power supplies with 50 ms hold-up
- Complete custom and COTS standard configurations available

100% AMERICAN MADE



"Server hardware exploits, banned Chinese electronics and a trade war are a wake-up call." *Ben Sharfi, GMS CEO*

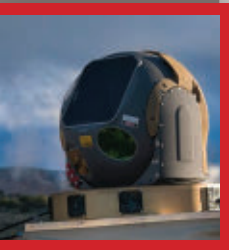
BUY AMERICAN SERVERS AGAIN!

GMS
GENERAL MICRO SYSTEMS, INC.
TRUSTED AND DEPLOYED SINCE 1979
(800) 307-4863 / GMS4SBC.COM

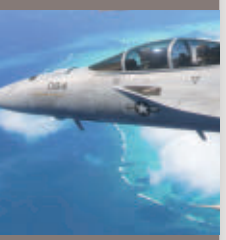
All General Micro Systems, Inc. products are proudly designed and manufactured in the U.S.A.

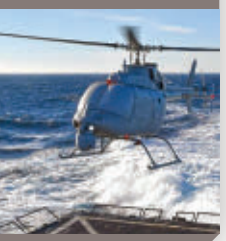
JULY 2020
VOL. 31, NO. 7

Military & Aerospace Electronics



COVER STORY





FOLLOW US

FACEBOOK.com /MilitaryAerospaceElectronics
TWITTER @MilAero
LINKEDIN.com /showcase/military-&-aerospace-electronics

Military & Aerospace Electronics® (ISSN 1046-9079, print; 2688-366X, digital / USPS 005-901) is published 12 times a year by Endeavor Business Media, LLC, 1233 Janesville Avenue, Fort Atkinson WI 53538. 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

Artificial intelligence: the best of computing without the drawbacks of human reasoning

Seems like everything that has to do with military computing today has some sort of artificial intelligence (AI) angle to it. AI is a catchy phrase that captures the imagination. Yet when we look beyond the shiny veneer, there's a lot of serious and difficult computer science going on to help humans make quick decisions, help unmanned vehicles navigate and carry out missions on their own, and many other computer tasks thought to be impossible only a few years ago.

Military electronics designers are asking a lot from AI today. We want it for rudimentary jobs like helping manned and unmanned aircraft navigate to and from their mission areas, and making sure the right equipment is on the battlefield to supply the troops. We also want artificial intelligence for new endeavors like ferreting-out fact from potential enemy propaganda in news reports, deploying new control surfaces on aircraft to make the most of aerodynamic efficiency, and evading enemy attempts to jam tactical communications.

Artificial intelligence can be a tough term to pin down. Is it real intelligence? Well, no, and probably won't be in my lifetime — maybe never. Essentially it describes a computer's ability to learn from its experience — particularly from its mistakes, like a human does. I don't think the goal of AI research is to create complex human-like thinking. The aim is to pull relevant data out of experience and then do what a computer does best, which is to process that data very quickly.

Does AI do some kinds of information processing better than a human? Well, it might. Computers are not bogged-down by emotions, a difficult upbringing, burning last night's dinner, partying too hard on the weekend, and doing things the way we've always done them.

Is AI a substitute for human intelligence? Probably not. The human brain is staggeringly complex, and is designed through evolution to make potentially life-saving decisions with a minimum of information. Human reasoning relies on intuition, a gut-feel, a hunch. What are those, by the way? I can't really explain it, much less program it. Any takers out there on programming a computer to have intuition?

Just how does the human brain do what it does? I don't think anyone's quite sure. People might claim they know, but a deep understanding of the human mind is in its infancy. People a hundred years from now might not be any closer to figuring out how the brain works than they are today.

What will change, however, is what we know about how computers work, and what we'll learn about them over time. Will we be able to emulate the complex firing of a countless number of neurons in an advanced computer architecture? Maybe, and maybe not.

The point is that doesn't much matter, because we have a pretty good understanding of how computers work. We know what their strengths and weaknesses are, and how to build computers to do what they do best. Computers can sift through mountains of data very quickly — much faster than humans can. Computers don't get tired, hungry, distracted, bored, or have to stop in mid-task and explain to a 3-year-old why grass is green.

Furthermore, we can design computers to run several different kinds of processing in parallel, with each doing what it's strongest at. Think of a team of home organizers descending on your house and accomplishing in a matter of hours what you hadn't even dreamed of over the past three years.

This takes us back to the question, what is artificial intelligence? Today it's a nice marketing phrase for some of today's most advanced computing. Today's artificial intelligence will be tomorrow's conventional processing ... and THEN what will artificial intelligence be? Probably what it is today — computing on the cutting-edge.

Suffice it to say that today's artificial intelligence researchers should stick to what computers do best, and improve each new generation of technology. The most advanced computing always will be described as intelligent. Let us just be thankful that machine intelligence doesn't have the worst weaknesses of human reasoning.

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

Sierra Nevada to build synthetic vision for helicopters flying in dusty or snowy 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., 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.

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.

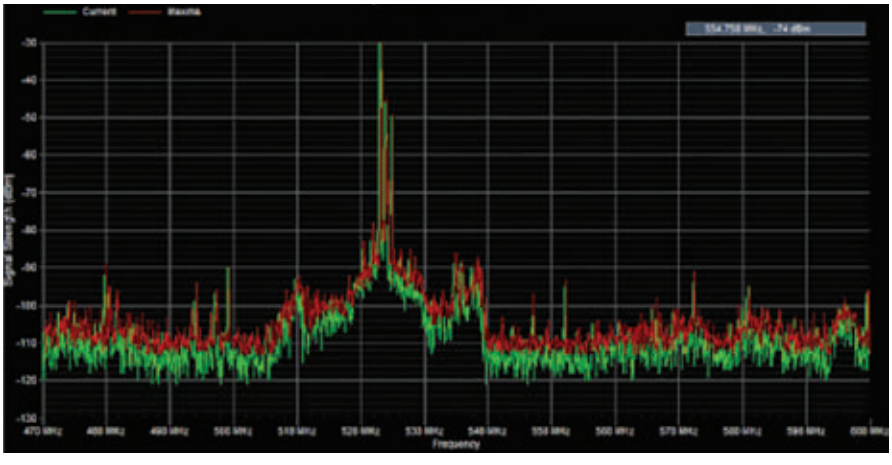
The system also included Brownout Symbology Software (BOSS), precise guidance to landing in zero visibility, and safe transition from visual to instrument flying conditions.

On last week's 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.

Wanted: signals intelligence (SIGINT) solutions for advanced RF and microwave threats

BY **John Keller**

CRANE, Ind. — U.S. Navy electronic warfare (EW) experts are reaching out to industry for new ways of detecting and countering enemy RF and microwave threats by automatically alerting warfighters to abnormal signals.



This two-to-three-year project aims at providing warfighters with an enhanced understanding of their battlefield environment by collecting and analyzing RF signals to compare against normal conditions.

Officials of the Naval Surface Warfare Center Crane Division in Crane, Ind., have issued a request for solutions (N0016420SNB55) for the Radio Frequency Spectrum Dominance (RFSD) Prototype Project.

This two-to-three-year project aims at providing warfighters with an enhanced understanding of their battlefield environment by collecting and analyzing RF signals to compare against a baseline environment.

Military signals intelligence (SIGINT) personnel supporting deployed missions today have little to no control of the frequency spectrum, which results in a lack of awareness into using radio, cell phones, wireless networks, the internet, 5G, and mesh communica-

tions, researchers explain.

This shortcoming is made worse by enemy wireless devices like unmanned aerial vehicles (UAV) and IP-based communications within about three miles from fixed bases and underway maritime vessels.

Enemy propaganda on the internet and cyber warfare attacks on military supply chains makes it more important than ever to recognize trusted devices and components and control of the acquisition supply chain.

Intercepting and interpreting RF and microwave signals today is an underdeveloped capability, Navy researchers point out. Improved RF spectrum analysis will enable warfighters greater ability to counter RF threats — especially the enemy's use of remote UAVs and improvised explosive devices (IEDs).

It is difficult — if not impossible — for humans to discern dangerous from innocuous frequencies with standard tools. Technologies exist today that parse through radio frequencies, yet there is a need to advance these systems.

The U.S. Department of Defense (DOD) seeks a capability to detect and counter emerging threats that use internet, telecommunications, and the electromagnetic spectrum.

From industry, Navy researchers want a prototype that will collect RF signals between 40 MHz and 6 GHz, analyze the signals, compare against a baseline, and automatically alert warfighters to anomalous signals.

Proposed prototypes For a prototype to be considered successful, the performer will conduct a Final Demonstration of the prototype on DOD range facilities.

Companies interested must be members of the Strategic & Spectrum Missions Advanced Resilient Trusted Systems (S2MARTS) consortium. More information on the S2MARTS consortium is online at https://s2marts.org. Information about joining is at https://nstxl.org/register-now.

Companies interested were asked to respond by 15 June 2020 online at https://nstxl.org/opportunity/rf-spectrum-dominance/. Click the submit a solution tab to send proposals. For questions or concerns contact the Navy's Jason Clark by email at jason.j.clark@navy.mil, or by phone at 812-854-3320. Also contact Don Davis by email at donal.davis@navy.mil, or by phone at 812-854-3709. More information is online at https://beta.sam.gov/opp/e86ee4715097403eb877fbe6d2cf5695/view.

Lockheed Martin to build 24 sensor-packed MH-60R ASW helicopters

U.S. Navy anti-submarine warfare (ASW) experts are asking Lockheed Martin Corp. to build 24 MH-60R ASW helicopters — three for the Navy and 21 for India — under terms of a $904.8 million order. Officials of the Naval Air Systems Command at Patuxent River Naval Air Station are asking the Lockheed Martin Rotary and Mission Systems segment in Owego, N.Y., to build the new MH-60R helicopters, one of the latest version of the Sikorsky Seahawk, which is based on the U.S. Army Sikorsky UH-60 Black Hawk utility helicopter. The multimission MH-60R helicopter has sophisticated sensors, and is designed for anti-submarine and anti-surface warfare. The MH-60R is designed to operate from frigates, destroyers, cruisers, and aircraft carriers. It is an airborne multi-mission naval platform. The MH-60R cockpit also has secure VHF/UHF communication; inertial navigation system; satellite communications; data link; and accommodation for forward-looking infrared sensors and night-vision goggles. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com, or Naval Air Systems Command at www.navair.navy.mil.

LCS maker Fincantieri Marinette to build new U.S. Navy frigate

The U.S. Navy has awarded Fincantieri Marinette Marine Corp. in Marinette, Wis., a $795 million contract to design and build a

Army asks industry for wearable IFF sensors to help infantry fight at night

BY **John Keller**

NATICK, Mass. — U.S. Army researchers are surveying industry for companies able to design and build small, lightweight wearable identification-friend-or-foe (IFF) sensors to help infantry soldiers fight safely at night.

Officials of the Army Combat Capabilities Development Command Soldier Center (CCDC SC) in Natick, Mass., issued a sources-sought notice last week (W911QY-20-IFFDEVSOLUTIONS) for the Identification Friend or Foe (IFF) Integrated Verifiable Technology for Combat Clothing and Individual Equipment project.

Army researchers are looking for technologies that provide covert, secure, and verifiable IFF capabilities that infantry soldiers can wear. These technologies not only should minimize size, weight, and power (SWaP) usage, but also should be covert, authenticated, integrated, or detachable, and be compatible with the electromagnetic spectral range of military clothing.

The IFF system should be integrated into, or be removable from, the clothing and individual equipment of the foot soldier. It should have a military-relevant color for camouflage, and be no larger than nine square inches.

IFF sensor technologies should be located on the soldier's head or upper torso, and provide at least 270 degrees of detectable coverage. It must min-

Army researchers are asking industry to develop wearable identification-friend-or-foe sensors to help infantry fight effectively at night.

imize detection by common night vision goggles, and minimize light transmission.

IFF sensors help U.S. and allied fighting forces quickly discern friend from enemy in the often-chaotic environment of nighttime combat, and help avoid friendly fire incidents.

The system's use should not give away the location of friendly forces during scanning or detection, and have peak performance from sunset to sunrise. The minimum detection distance should be 328 yards.

Companies interested were asked to email five-page concept papers to the Army's Mary Prebensen by 7 June 2020 at mary.k.prebensen.civ@mail.mil and to Denise Tolliver at denise.m.tolliver.civ@mail.mil. More information is online at https://beta.sam.gov/opp/bf8a391d17b54689a46e621414683e3a/view.

new class of guided-missile frigate known as FFG(X). The company will build as many as 10 new frigate surface warships, with a cumulative contract value of $5.6 billion if all options are exercised. Electronic systems aboard the new ship will include an Enterprise Air Surveillance Radar, Baseline Ten AEGIS Combat System, a MK 41 Vertical Launch System, communications systems, MK 57 Gun Weapon System countermeasures, and added capability for EW and information warfare area, with design flexibility for future growth. The vessel is expected to operate in the open ocean, as well as in shallow coastal waters and harbors, and handle anti-aircraft, anti-surface, and anti-submarine warfare (ASW). Frigates typically are relatively small surface warships for convoy escort, and to participate in the outer air defense of Navy carrier battle groups and surface action groups. The FFG(X) will be longer, wider, heavier, and have a longer range than the Perry-class frigate.

Boeing to build hardware for high-speed fiber-optic shipboard networking

Military communications experts at the Boeing Co. will build new hardware for high-speed fiber-op-

Navy eyes computing and sensor technologies for shipboard and submarine sonar

BY **John Keller**

WASHINGTON — U.S. Navy shipboard electronics experts are extending a project to develop new computing and sensor technologies for active and passive sonar systems involved in surveillance, situational awareness, and anti-submarine warfare (ASW).

Officials of the Naval Sea Systems Command in Washington have amended a broad agency announcement (N00024-17-IWS5A-01) for the Submarine and Surface Combat System Sensor and Signal Processing Technologies program.

Navy officials say technologies that industry develops in this initiative likely will be tested as prototypes before being moved quickly to the fleet. Of prime interest are computers and sensors. This amendment extends the deadline for industry responses to 1 April 2021.

Computing technologies involve applying sophisticated computing technologies such as artificial intelligence, deep learning, machine learning, and predictive analytics to help detect man-made signals.

Other computing technologies of interest include cyber security, decision support, and detection and classification of ships from visual images.

Sensor technologies of interest include high-power active sonar projectors in conformal acoustic velocity sonar (CAVES) matrix. Also of interest are new kinds of towed-array sonar telemetry components that use Open Architecture Telemetry (OAT) government-standard interfaces.

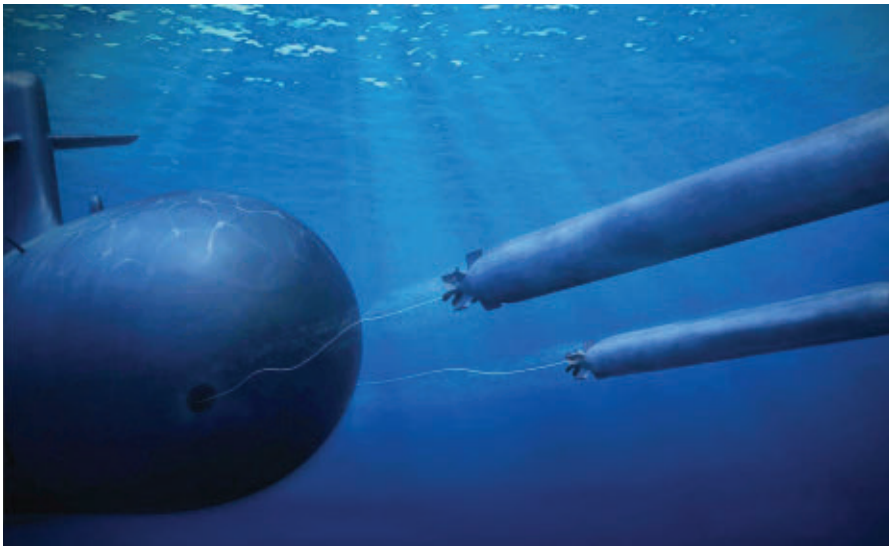
Depending on technological progress, Navy officials also may pursue new technologies in automation; torpedo defense; electronic warfare; situational awareness; active sonar signal processing; imaging; computing technologies; sensor technology; and training.

Sponsoring this project is the Naval Sea Systems Command's Advanced Development Office for Undersea Systems, which is part of the Program Executive Office for Integrated Warfare Systems (PEO IWS).

Companies interested may request technical information by contacting the Navy's Joshua Tuxhorn by post at Commander Naval Sea Systems Command ATTN: Code PEO IWS5A (Joshua Tuxhorn), 1333 Isaac Hull Ave., SE, Stop 2040, Washington Navy Yard, DC 20376-2040.

Companies who wish to participate should submit white papers by post to Commander Naval Sea Systems Command ATTN: Code PEO IWS5A (Joshua Tuxhorn), 1333 Isaac Hull Ave., SE, Stop 2040, Washington Navy Yard, DC 20376-2040.

Navy officials will invite those submitting the most promising white papers to submit full cost and technical proposals for contracts lasting as long as five years. This phase will involve maturing technologies in the laboratory, as well as at-sea testing.



Navy wants computing technologies that involve artificial intelligence, deep learning, machine learning, and predictive analytics to help detect man-made sonar signals.

For questions or concerns contact the Navy's Joshua Tuxhorn by email at Joshua.tuxhorn@navy.mil, or by phone at 805-228-7839. Also contact the Navy's Lt. John Haney by email at John.f.haney1@navy.mil, or by phone at 202-781-1493. More information is online at https://beta.sam.gov/opp/8c8c142e89684557a5d9e626d078c724/view.

Researchers want technologies for next-gen secure military radio

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are asking industry to develop secure radio frequency (RF) transmitter and receiver technologies to enable the next generation of secure military tactical radio systems.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a solicitation (HR001120S0030) for the Wideband Secure and Protected Emitter and Receiver (WiSPER) project.

Today's military secure tactical radios achieve security by spreading transmitted content over time and operating frequency in attempts to reduce transmitted power density and operate below the adversary's receiver detection limit.

Still, spread-spectrum techniques lack sufficient complexity to evade detection by modern signals intelligence (SIGINT) receivers or interception by compromised devices.

Today's military tactical radio systems are vulnerable to hypersensitive and collaborative receivers.

Hypersensitive receivers use cryogenic-cooled energy detectors and cyclostationary processing over prolonged observation time to increase detection sensitivity by reducing uncorrelated noise. This technique reveals chip rate and modulation format to establish spread-spectrum transmissions. Collaborative receivers, meanwhile, involve multi-receiver networks that coherently recombine power to detect the transmitter.

Today's spread-spectrum approaches have several limitations. Narrowband signals are only spread in the time and frequency domains and contain cyclic features, for example. Narrowband RF waveform typically use fixed and limited dynamic range of less than 30 decibels, leading to the inability to remain undetectable while providing persistent communications.

New chaotic waveforms that reduce cyclic features only provide marginal reduction of detectability, require higher signal-to-noise ratios to synchronize and operate, and are not sufficiently featureless to evade detection. Directional beams and reconstruction of coherent scattered signals, in addition, are impractical for today's tactical radios.

While spread-spectrum techniques minimize the signal strength to avoid detection, today's tactical radios face additional operational challenges from channel impairments

Traditional spread-spectrum radio techniques lack sufficient complexity to evade detection by modern SIGINT receivers or from interception by compromised devices.

that reduce the link margin of the radio.

With fixed operational frequency and bandwidth, existing tactical radios provide limited options and margins to sustain persistent transceiver operations under varying and unpredictable natural and man-made channel impairments.

Instead, the WiSPER program seeks to develop fundamentally disruptive wireless air interface transceiver technology to enable and sustain secure high-bandwidth RF communication links. The WiSPER wideband adaptive air interface also will mitigate impairment from dynamic harsh and contested environments to maintain a stable communication link.

DARPA researchers anticipate that WiSPER capabilities also will provide future U.S. warfighters with a dominant technology advantage over their adversaries. Researchers want radios small enough for portable or ground installations.

WiSPER will be a four-year, three-phase program with an 18-month first phase, an 18-month second phase, and yearlong third phase. Several phase-one contracts are expected, with a reduced number of participants in the second and third phases.

Phase 1 performers will carry the WiSPER system architecture through a conceptual design supported by modeling and simulation, culminating in a benchtop implementation and lab test.

Phase 2 performers will improve the design, culminating in a transportable implementation and field test. Phase 3 performers will further optimize the air interface to demonstrate adaptation to weather and other impairments in a portable prototype implementation.

Proposals to WiSPER will be classified at the collateral SECRET level, so performers will need collateral SECRET clearances and access to an accredited facility and secure communications.

DARPA must receive proposals by post or by courier no later than 15 July 2020 to Defense Advanced Research Projects Agency, ATTN: Program Security Officer, MTO, Reference: HR001120S0030, 675 North Randolph St., Arlington, VA 22203-2114.

Email questions or concerns to Young-Kai Chen, the DARPA technical point of contact, at HR001120S0030@darpa.mil.

tic shipboard networking aboard U.S. Navy Arleigh Burke-class guided missile destroyers under terms of an $13.3 million order. Officials of the Naval Sea Systems Command in Washington are asking the Boeing Defense, Space & Security segment in Huntington Beach, Calif., to provide AN/USQ-82(V) hardware new-construction and upgrades for Burke-class destroyers, as well as for related support to Japan and Australia. The AN/USQ-82(V) fiber-optic control systems network transfers mission-critical data to and from users of combat, navigation, aviation, power, propulsion, steering, alarms and indicating, and damage-control systems. The AN/USQ-82(V) family consists of the Data Multiplex System (DMS), the Fiber Optic Data Multiplex System (FODMS), and Gigabit Ethernet Data Multiplex System (GEDMS). The AN/USQ-82(V) family of shipboard networking equipment transfers inputs and outputs for the Burke-class destroyer's machinery control systems, damage-control system, steering control system, Aegis combat system, navigation displays, and interior communications alarms and indicators. Boeing will do the work in Smithfield, Pa., and should be finished by August 2021. For more information contact Boeing Defense, Space & Security online at www.boeing.com, Argon ST at www.argonst.com, or Naval Sea Systems Command at www.navsea.navy.mil.

DARPA asks Stealth Software to help advance trusted computing and cryptography

Trusted-computing experts at Stealth Software Technologies Inc. in Los Angeles are helping U.S. military researchers enhance information security and trusted computing by advancing zero-knowledge proof technology to enable cryptography in complex military applications. Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced an $8.5 million contract to Stealth Software for the first phase of a research project under the Securing Information for Encrypted Verification and Evaluation (SIEVE) program. SIEVE seeks advance the state of the art in zero-knowledge proofs to enable complex military applications. A zero-knowledge proof in cryptography enables one party to prove that he knows a particular without conveying any secret information; the challenge is proving possession of sensitive information without revealing the information itself. Stealth Software joins Galois Inc. in Portland, Ore., on the SIEVE program. SIEVE will use zero knowledge proofs to verify military capabilities without revealing the sensitive details. The project also will focus on increasing the efficiency of zero knowledge proof technology to enable large, complex proof statements — such as billions of gates or more — where the statement consists of probabilistic and indeterminate-branching conditions. For more information contact Stealth Software Technologies online at www.stealthsoftwareinc.com, or DARPA at www.darpa.mil.

Army orders tactical network manpack radios from L3Harris and Collins Aerospace

The U.S. Army is ordering second-generation manpack radios from L3Harris Technologies Inc. and the Raytheon Technologies worth $203.2 million, ahead of a forthcoming operational test that will inform a full-rate production decision next fiscal year. The Army awarded a negotiated bilateral firm-fixed-price delivery orders to the Raytheon Technologies Collins Aerospace segment in Cedar Rapids, Iowa, and to the L3Harris Technologies Communications Systems segment in Rochester, N.Y., for a total of 3,440 (1,720 each) radios and ancillaries. The radios are a key element to what the Army calls the integrated tactical network, the concept behind the Army's modernized battlefield network that will incrementally add capabilities units every two years beginning in 2021. The orders will support the ITN and tactical satellite modernization efforts, as well as security force assistance brigades and future deployments, according to the Program Executive Office Command, Control, Communications-Tactical (PEO C3T).

Global defense spending in 2019 sees largest annual increase since 2010

Global defense spending hit $1.917 trillion in 2019, a 3.6 percent increase over previous year figures and the largest increase in one year since 2010, according to the annual report by the Stockholm International Peace Research Institute (SIPRI) in Stockholm. The United States remains the world's largest defense spender in 2019, with its $732 billion representing 38 percent of global military spending, SIPRI has reported. This increase was followed by China ($261 billion, at 14 percent of global total); India ($71.1 billion, at 3.7 percent); Russia ($65.1 billion, at 3.4 percent); and Saudi Arabia ($61.9 billion, at 3.2 percent). All told, the top five nations accounted for 62 percent of overall global military spending. Large year-over-year increases were seen in China (5.1 percent), India (6.8 percent), Russia (4.5 percent), Germany (10 percent) and South Korea (7.5 percent).

In this Raytheon illustration, a small unmanned aircraft is shot down with a high-energy laser weapon.

Laser weapons get ready for the big time

New electro-optical weapons are increasing in power and lethality, and are ready for air, land, and sea deployment to defend against enemy threats like unmanned aircraft, rockets, mortar rounds, and artillery shells.

BY **J.R. Wilson**

Since the first laser was demonstrated in 1960, there has been speculation about and growing interest in using the technology as a weapon, starting in 1963 with a classified U.S. Department of Defense (DOD) conference to assess the military potential of lasers. For the following four decades, however, size, weight, and power (SWaP) were critical issues that prevented lasers from assuming a practical role in defense planning.

With sufficient resources, the chemical lasers of the time could generate enough power to damage a target, but only could be carried by the largest available platforms and, needing replenishment of the chemicals used, could only be fired for a limited time before returning to base.

In recent years, however, solid-state (SSL) and fiber lasers that include high energy lithium-ion batteries have made high-energy lasers (HEL) practical and potentially as ubiquitous in combat as unmanned vehicles. While Russia claims to have deployed operational lasers, there is no proof that any laser weapon system actually has been deployed as more than a prototype.

Largest RF Selection

Available for Same-Day Shipping

The Engineer's Immediate RF Source

Pasternack meets the immediate needs of engineers who are building the future of RF communications.

- Over 40,000 RF, microwave, and mmWave components in 100+ categories of interconnect, passives, actives, and antennas
- 99.4% in-stock availability
- Shipped same day
- No minimum order required

In-Stock and Shipped Same Day

USA & Canada +1 (866) 727-8376
International +1 (949) 261-1920
pasternack.com

PASTERNACK®
an INFINITE brand

A high-energy laser system is shown above mounted on a U.S. Army Boeing AH-64 Apache attack helicopter during flight tests at White Sands Missile Range, N.M.

That, however, is about to change.

"The idea that this is 5 or 10 years away is no longer the case," says Chris Frei, director of short range air defense at Northrop Grumman Corp. "In the fight, there tends not to be a 'silver bullet,' so the services are looking at a mix of different solutions, each with its strengths and weaknesses. So it is critical to have a system that can pull all that together so you can defend against 30 threats in the sky or a half dozen on the ground. Doing that gets the maximum effect out of any of these technologies."

Evan Hunt, director of business development for high-energy lasers and counter-unmanned systems at the Raytheon Technology Corp. Intelligence & Space segment says he agrees.

The Raytheon High Energy Laser Weapon System (HELWS) is shown mounted on a Polaris MRZR all-terrain vehicle. The laser uses pure energy to detect, identify, and take down enemy drones.

"Laser weapons will be a core part of layered air defense employed by DOD and its coalition allies. That means laser weapons in any integrated system we have protecting serious assets in our territories. In five years, any large base that needs to defend its assets will have laser weapons, regardless of service."

As for Russia's claims, he adds: "Not all laser weapons are created equal. It's easy to throw together a laser weapon and claim it is high power. You can buy lasers from industry, combine them on a truck. But for those who actually deal with targets as needed, it's an entirely different scenario."

Prototype lasers

Raytheon, Northrop Grumman, Lockheed Martin Corp. and others have been testing prototype lasers on Army Stryker combat vehicles, Navy ships, Air Force planes, and fixed facilities for all services for most of this century. Now, they say, many of those prototype demonstrators are ready to become programs of record, getting into the hands of warfighters in the next two or three years – perhaps sooner.

"Last October, we integrated the ATHENA — advanced tactical high energy asset — into an existing Army infrastructure and the Air Force Strategic Development and Training Office spent a day training two airmen, who then went against a number of different Class 1 and 2 UAV systems and we achieved greater than 88 percent effectiveness," says Paul Shattuck, director of directed energy systems at Lockheed Martin Space Systems in Sunnyvale, Calif.

"We also networked an external radar into the command and control system," Shattuck continues. "That was truly a full-up battlefield demonstration of the system, putting a prototype into a realistic operation and showing its effectiveness. We continue to mature our Spectral Beam Combined Fiber Laser technology to combine higher power lasers in a package that is smaller in size and weight with a higher conversion of electrical power in the light going out the laser. A lot of work also is ongoing in developing the control systems for laser weapons and in battle damage assessment."

Industry experts won't predict which service will deploy laser weapons as a standard part of their systems first, but the Army and Navy are moving forward quickly to place high-energy lasers into service as a major part of their air defense capabilities.

Navy efforts to develop solid state lasers include:

- Solid State Laser Technology Maturation (SSL-TM) effort;
- Optical Dazzling Interdictor, Navy (ODIN);
- Surface Navy Laser Weapon System (SNLWS) Increment 1, also known as the high-energy laser with integrated optical dazzler and surveillance (HELIOS); and
- High Energy Laser Counter-ASCM Program (HELCAP).

SSL-TM, ODIN, and HELIOS are part of the Navy Laser Family of Systems (NFLoS) effort, which, along with HELCAP and technologies developed by other parts of DOD, will support the development of future, more capable shipboard lasers.

HELIOS is undergoing system integration at Moorestown, N.J., home of the Aegis combat system, before going to Wallops Island, Va., for additional testing prior to its integration into an Arleigh Burke destroyer in 2021, where it will be built into the ship structure as well as being integrated into its Aegis system.

"HELIOS will provide an additional layer of protection for the fleet — deep magazine, low cost per kill, speed of light delivery and precision response. Additional HELIOS systems will accelerate the warfighter learning curve, provide risk reduction for future laser weapon system increments and provide a stronger demand signal to the supply base," Brendan Scanlon, HELIOS program director at Lockheed Martin Rotary and Mission Systems, noted in a March news announcement.

The Lockheed Martin Advanced Tactical High Energy Asset (ATHENA) is a prototype laser weapon system to defeat close-in, low-value threats such as improvised rockets, unmanned aerial systems, vehicles, and small boats.

Protecting ships

According to an April 2020 Congressional Research Service report to Congress — "Navy Lasers, Railgun and Gun-Launched Guided Projectiles" — lasers offer a significant improvement in the Navy's ability to protect it ships against an enemy with a virtually unlimited number of missiles and swarming UAVs.

This artist's rendering of the Lockheed Martin High Energy Laser with Integrated Optical-dazzler and Surveillance (HELIOS) depicts the defensive weapon designed to burn boats and shoot down unmanned drones.

"The Navy in recent years has leveraged significant advancements in industrial SSLs and decades of research and development work on military lasers done by other parts of DOD to make substantial progress toward deploying high-energy SSLs on Navy surface ships. Navy surface ships would use high-energy SSLs initially for jamming or confusing (i.e., "dazzling") intelligence, surveillance and reconnaissance (ISR) sensors, for countering small boats and UAVs and potentially in the future for countering enemy missiles, as well," the report said.

"High-energy SSLs on Navy ships would generally be short-range defensive weapons — they would generally counter targets at ranges of about one mile to perhaps eventually a few miles. In addition to a low marginal cost per shot and deep magazine, potential advantages of shipboard lasers include fast engagement times, an ability to counter radically maneuvering missiles, an ability to conduct precision engagements and an ability to use lasers for graduated responses ranging from detecting and monitoring targets to causing disabling damage."

U.S. Special Operations Command is integrating a 60-kilowatt laser weapon aboard the AC-130J Ghostrider gunship for air-to-ground interdiction.

However, the report continued, lasers are not a "silver bullet" protection against all threats or under all circumstances:

"Potential limitations of shipboard lasers relate to line-of-sight; atmospheric absorption, scattering and turbulence (which prevent shipboard lasers from being all-weather weapons); an effect known as thermal blooming that can reduce laser effectiveness; countering saturation attacks; possible adversary use of hardened targets and countermeasures and risk of collateral damage, including damage to aircraft and satellites and permanent damage to human eyesight, including blinding."

Nonetheless, all of the services see lasers as future integral — and invaluable — components of an integrated, layered defense system for platforms, fixed sites and warfighters.

Battlefield lasers

In April, the Air Force Research Laboratory (AFRL) delivered the service's first high-energy laser — Raytheon's HEL Weapon System — for battlefield use against UAVs. Along with the Tactical High Power Operational Responder (THOR), it will undergo a one-year overseas assessment.

"The fact that it's a laser weapon allows you to put energy on target at the speed of light. It can be an instantaneous heating event," Michael Jirjis, head of the Air Force's directed energy experimentation projects, said at the time.

"THOR is a directed energy game-changer," AFRL directed energy Director Kelly Hammett added in the same AFRL news release. "Drones are becoming more and more pervasive and can be used as weapons intended to cause harm to our military bases at long standoff ranges. We built the THOR weapon system as a deterrent against these type threats. THOR, with its counter electronic technology, can take down swarms of drones in rapid fire. This capability will be an amazing asset to our warfighters and the nation's defense."

The Army is fielding a Stryker-mounted 50-kilowatt laser, with deployment planned for 2022, to defend warfighters against UAVs, rockets, artillery and mortars. Rather than following that with a 100-kilowatt high-energy laser, however, the Army now is looking at a 250-to-300-kilowatt component to its Indirect Fire Protection Capability (IFPC), intended to

counter cruise missiles. Officials say that HEL-IFPC system should be available to warfighters by 2024.

"The advantage of the laser is that we have the ability to have an unlimited magazine when it comes to unmanned aerial systems, as well as rockets, artillery, mortars," Lt. Gen. Paul Ostrowski, principal military deputy to the Assistant Secretary of the Army for Acquisition, Logistics and Technology, said last year. "Where before we were shooting $100,000 missiles at $7,000 UAVs, this puts us in a position where we're not spending that kind of money to do that. We're taking those targets down in a much more rapid fashion and a much cheaper fashion."

Special Operations also has a strong interest in laser weapons, as demonstrated by the Air Force Special Operations Command's (AFSOC) efforts to integrate a 60-kilowatt laser aboard the AC-130J Ghostrider gunship.

"The goal is to provide an armed overwatch capability using directed energy," AFSOC commander Lt. Gen. James Slife said at the Air Force Association's Air, Space and Cyber Conference last year. "The testing of that and the integration work that is ongoing is all proceeding at pace. We haven't seen anything up to this point that would lead us to believe that is not all achievable in the near-term time horizon that we're working against."

Enabling technologies

From championship car racing to medicine to computer gaming to increasingly computerized household products, laser weapons have benefitted from wide and diverse sources of new technology.

"One of the enabling technologies is electric lasers and the fiber lasers. That has been a real revelation and one of the keys to our packages of laser weapon systems," says Lockheed Martin's Shattuck. "At the dawn of laser weapons, you were talking about chemical lasers, which were huge systems with quite a logistics footprint. The next generation was probably half as efficient. Fiber lasers are two to three times more efficient than that, so the power and thermal requirements are half to one-third what they were. The advent of being able to scale fiber lasers up to hundreds of kilowatts has been a major advance.

"Also impacting those systems are improvements in computing, a lot of it coming from the gaming arena, where the commercial market is driving improvements in size and processing power and allowing for very advanced algorithms for tracking targets, such as UAVs that maneuver and fly in cluttered backgrounds."

The future, he adds, will see a continuation of those synergies:

"You'll see a continued development of the laser diode, with more compact packages and higher power, improvements in putting more power through fiber. There also will be continued development in the processing power we need for optics, coding, algorithms. With optical coding, some of the preeminent coding providers today were coding smaller optics, primarily for medical use. There will continue to be synergy between military and commercial. The whole advent of AI and machine learning also will continue to evolve and find its way to better determine what targets to go after, what's the optimum beam point, etc."

In the near-term, Raytheon's Hunt says laser weapons technology is making rapid progress.

"We are in a mature prototype phase, a technology transition phase, where

we have finally developed laser weapons with operational, proven capability against asymmetric threats, such as Class 1 and 2 drones. Those are being tested in operational environments and will inform programs of record. That's also true for 50-kilowatt weapons, such as the one we're building for the Army on a mobile platform for other targets than just drones," he says. "Laser weapons are really on the verge of moving to production programs for operational use in the air defense category, from 10-to-50-kilowatt for short range air defense, typically within 10 kilometers.

"The laser weapon is part of a layered defense approach. For larger, long-range threats, you'll still rely on kinetic weapons," Hunt continues. "Close-in, laser weapons are very precise and capable, reducing collateral damage. They don't create large explosions or shrapnel. They're also silent and invisible, so they are not disruptive. The second you start affecting the target, you get real-time damage assessment, so you have almost no chance of missing the target and hitting something you don't intend to."

Leveraging commercial lasers

Hunt notes the synergistic nature of military and commercial lasers and support systems has added to the speed of development and system capability.

"All of the laser weapons technologies have matured to the point where we are ready to integrate them into the field. One is the E/O sensor. At Raytheon, we use a multi-spectral system we have used on the ground and in the air that enables us to get the laser beam on the precision point we need to be effective," he says.

"Another is advanced lithium batteries," Hunt says. "There is no way to store a direct run from ground power, so now we have batteries that make power available on demand. There have been advances in the fiber laser arena, which are compact, clean and efficient. We use those modules, modified for defense use, and combine them to create our laser power. And finally, frankly, video game technology for integrated training. We use a single laptop as the interface and games that can help us train users in just a couple of hours."

Several laser technologies are being tested for the next generation of systems.

"There are competing technologies — fiber, DPALs [diode-pumped alkali lasers], distributed lasers, etc. That is part of the current effort for the 300-kilowatt development, to see which of these technologies will come to the front," says Dennis Hammons, Director of Strategy and Capture-Directed Energy at Northrop Grumman.

"A key part of the enabling technology has been electric driven lasers, currently fiber. High brightness and low cost are other aspects. In combining these lasers to make higher power systems is multilayer dielectric grating, which was initiated by Lawrence Livermore. Other key aspects are more in the realm of how we identify, track and maintain aim point on the target and how we reduce jitter in the system for line-of-sight stabilization."

America's allies also are moving forward rapidly with laser technology for defense. In January, for example, Israel's Ministry of Defense (MOD) announced a major achievement in a high-energy laser effort by the Directorate of Defense Research and Development (DDR&D). According to an MOD release, the effort will produce a system able to precisely focus laser beams on long-range targets, overcoming atmospheric disturbances, adding new capability to Israel's four-layer air defense system.

"The new technology will prompt a strategic change in Israel's defense capabilities. Throughout the year 2020, we will conduct a demo of our capabilities," an MOD release said, then quoted DDR&D chief Brig. Gen. Yaniv Rotem as saying, "We are entering a new age of energy warfare in the air, land and sea."

Efforts in Europe

Europe also is working to field laser weapons sometime in the 2020s. The Tactical Advanced Laser Optical System (TALOS), backed by the European Defense Agency, could lead to fielding laser weapons with European forces by 2027, says Antoine Bouvier, former CEO of defense manufacturer MBDA in Le Plessis-Robinson, France.

In the United Kingdom, meanwhile, the Defence Science & Technology Laboratory (DSTL) is working with British industry and the U.S. Navy, under the Advanced Electric Power and Propulsion Project Arrangement, to develop future energy storage options for British warships to power the next generation of naval laser weapons. Related to that, DSTL and GKN Aerospace in Redditch, England, developed the Flywheel Energy Storage System (FESS), using high-speed, lightweight flywheels to provide high-power electric pulses.

In testing FESS, the U.S. and United Kingdom teams used power hardware-in-the-loop (PHIL) to integrate FESS into a virtual ship power architecture emulating real-time Royal Navy operations.

For the United Kingdom-U.S. testing of FESS, the teams have used an approach known as power hardware in-the-loop (PHIL), which sees the integration of a real FESS system into a virtual ship power architecture that emulates a Royal Navy ship operating

in real time. This was initially carried out at Florida State University in Tallahassee, Fla., then was taken to the Power Networks Demonstration Centre (PNDC) in Scotland to advance the United Kingdom's PHIL capabilities.

"This project gave us a great opportunity to showcase the PHIL test-bed that we've developed at PNDC," program technical lead Kyle Jennett said in a United Kingdom MOD statement. "This test bed lets us connect real-world hardware, like the FESS, to simulated naval platforms to evaluate the impact on the ship during different operational scenarios."

Government officials say they hope this technology will smooth the way for integration of next-generation weaponry onto naval vessels, including the United Kingdom Dragonfire, being developed by DSTL and United Kingdom industry as part of the laser directed energy weapon capability demonstrator program.

Fielding a fully operational laser weapon would require advances across a complex range of technologies, many of which are ready — or nearly so — for deployment. But the first generation of such weapons will go to the warfighter with demands for greater and greater capability.

Need for power

"Everybody wants more laser power. If you build the weapon correctly, then more power equates to longer range and kill capability for larger targets. But it's not that simple. You also have to be able to direct that more powerful beam on a precise point at a long range and package it in a configuration that is viable to the warfighter; 50-kilowatt gets you on a vehicle such as Stryker, but more power means larger platforms as costs and lead times go up," Hunt says.

WHO'S WHO IN LASER WEAPONS

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/

Lockheed Martin Space Systems
Sunnyvale, Calif.
https://www.lockheedmartin.com/en-us/capabilities/space.html

Northrop Grumman Aeronautics Systems
Redondo Beach, Calif.
https://www.northropgrumman.com/who-we-are/business-sectors/aeronautics-systems/

Raytheon Intelligence & Space
McKinney, Texas
https://www.raytheonintelligenceandspace.com

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

"Certainly we will continue to advance laser power, but it makes sense to get 10 and 50-kilowatt systems into the field quickly, then we can start stepping up accordingly and begin providing air-to-ground capability, using the same core components we have on the MRZR for next-generation rotor platforms for the Army and U.S. Special Operations Command," Hunt continues.

"Adjacent applications for high-energy laser are power beaming to recharge something at very long range. That also applies to laser communications. The hope is that in the long run, the laser is not just a replacement for kinetic effectors. In some cases, it won't do things as well as missiles, but it will fill a gap in short-range defense and, eventually, to longer range targets."

The U.S. military will move from deployed prototype demonstrators to programs of record on a variety of defensive lasers across all services far more quickly than the general public may expect.

"In the next five years, we'll see operational systems being deployed on ships, land vehicles, in fixed emplacements and potentially airborne. The current generation of demonstrators and prototypes are consistent with the acquisition strategies of OSD and, I believe, will be the first generation of laser weapons to be operationally deployed," predicts Lockheed Martin's Shattuck.

"Over decades I've watched the development of these technologies and it's been good to see the maturity of the overall laser weapons systems and have utility for specific warfighter gaps. One of the enablers is the maturity of these systems compared to the warfighter gaps. It's not a technology in search of a use, but a technology that clearly offers precision, deep magazines, lower costs per shot and a lot of advantages as you look at potential future concepts. It is not a do-all, but is designed to basically provide a layer in an overall defensive system."

New frontiers in real-time software

Efficient execution is key to real-time mission-critical operating systems software, yet new demands are emerging such as safety critical operations for avionics and other life-critical applications.

BY **Jamie Whitney**

Real-time software in embedded computing, like real-time operating systems (RTOS) in military and aviation applications, must work quickly and with no errors. On top of reliability, experts in real-time technology say it must have robust information security for critical and classified data.

"The intrinsic value of an RTOS is to provide guaranteed processing performance," explains Richard Jaenicke, director of marketing for Green Hills Software in Santa Barbara, Calif. "For sensor signal processing, that can be used to make sure the data is processed in real time so that none are dropped. To achieve that level of determinism, an RTOS generally is smaller and faster than a basic OS, consuming fewer resources. Consuming fewer resources is a particular advantage when running on processor cores embedded in an FPGA [Field Programmable Gate Array]. Finally, many RTOS are safety-certifiable. The safest RTOS are based on a separation kernel, which isolates applications from each other and from the kernel so that a fault in one cannot affect the others. When a particular function requires the absolute lowest latency, it can be included in the kernel and still retain the benefits of isolation from the other applications."

Abaco Systems in Huntsville, Ala., which produces rugged embedded computing solutions for defense, aerospace, and industry, use real-time software to carry out signal processing.

"In terms of the underlying hardware, FPGA-based systems deliver a perfect solution for rapid signal processing," says Abaco software product manager Francesco Fiaschi. "No less important than speed in sophisticated signal processing applications is determinism — and the challenge is often how to deliver information in a deterministic manner from the point of acquisition in the FPGA to the destination application. This is normally a function of the operating system. Choosing the appropriate real time operating system — such as VxWorks, Integrity, LynxOS or any Linux real time extension — will provide predictability in the way data from the source can be delivered to the user in the most expeditious and reliable manner. When an application is mission critical, an RTOS can deliver both predictability and reliability."

Ray Petty, vice president of global aerospace and defense at Wind River Systems in Alameda, Calif., says that embedded systems control technologies are used in our daily lives from phones to airplanes.

"Embedded systems typically comprise both hardware and software," Petty says. "The hardware consists of tiny components, like microcontrol-

The Abaco 3U VPX SBC3511 provides SR-IOV capabilities in the data plane because it leverages the XL710 chipset.

RUGGEDIZED CONNECTIVITY SOLUTIONS KEEP NETWORKS OPERATING – ANYTIME. . .ANYWHERE.

Available for Same-Day Shipping!

OPERATING IN A HARSH ENVIRONMENT?

Are you operating in a harsh environment where cabling and interconnectivity components must withstand temperature extremes, moisture, corrosive materials, shock and vibration? To address these challenges L-com delivers connectivity solutions to keep your networks operating – ***anytime…anywhere.***

- **Weatherproof and Waterproof**
- **Resilient to Temperature Extremes**
- **EMI and RFI Resistant**
- **Shock, Vibration, Corrosive Materials Protection**

Our ruggedized connectivity solutions are in stock and available for same-day shipping.

Learn more at:
www.L-com.com/ruggedized-solutions
+1 (800) 341-5266

L-com™
an INFINITE brand

Curtiss-Wright Defense Solutions supports Green Hills Software's field-proven INTEGRITY-178 tuMP safety- and security-critical multicore RTOS on its VPX3-133 single board computer.

lers or microprocessors. The software is usually a real-time operating system, such as VxWorks, that performs dedicated tasks and is designed to control time-dependent applications and components in a consistent and predictable manner. RTOS form the foundation of an embedded system."

Petty says that "an RTOS must respond in a fully predictable manner to unpredictable external occurrences. If it does not, in many cases it can impart severe and irreversible repercussions. Timing errors, for example, in a car's anti-lock braking system, or in an airplane's autopilot system, can threaten or even result in the loss of life."

Petty continues, "RTOS are created to be tough and rigid but, at the same time, very flexible. A highly complex genre of software, an RTOS is based on highly intricate inter-task communications and multitasking technologies. An RTOS's effectiveness is decided not only by the correctness of a job's results, but also by the time in which the results are produced. Real-time computing occurs when the system acts in a predictable manner, but also within an exact delivery time. RTOS are designed to handle the execution of applications within extremely rigid response times—sometimes involving microseconds and nanoseconds. This timing factor, of course, separates RTOS from general-purpose operating systems. RTOS absolutely cannot perform sluggishly. They must meet system-timing constraints to ensure predictability and accuracy. They must react in a timely, fully predictable way to unpredictable external conditions as they arrive. They must eliminate risk from extreme load conditions."

Earlier this year, Collins Aerospace selected real-time software from Green Hills for trusted computing in Navy combat jet training systems.

Open standards

For years, the U.S. Department of Defense (DOD) and its military branches have been driving adoption of open standards to make systems compatible and upgradable.

"It's also worth noting that rapid signal processing on CPU-based systems is facilitated by optimized signal processing and math libraries that take advantage of specific features of the target CPU architecture," Abaco's Fiaschi says. "Well-optimized, open-source offerings that support embedded real-time operating systems are not commonplace, neither are they tailored to the needs of mil-aero applications. It is important to ensure that suitable libraries meeting the needs of the signal processing application are available for the RTOS of choice."

Green Hills's Jaenicke concurs and says the move to open standards "has been happening for a while but has accelerated due to the tri-service mandate to use a modular open systems approach (MOSA). For RTOS in military applications, the most important open standard is the Future Airborne Compute Environment (FACE) technical standard. One of the many unique qualities of the FACE approach is that it has a domain-specific data modeling mechanism that expedites the integration of multiple open standards for the same system. That is important because, as the saying goes, the wonderful thing about standards is that there are so many to choose from."

Virtualization

Real-time experts note that hypervisors — a system made of software or hardware that runs virtual machines — are making a mark in this sector. Ian Ferguson, vice president of marketing and strategic alliances at Lynx Software Technologies in San Jose, Calif., says that hypervisors are seeing increased usage in mixed-criticality systems.

"Separating out resources that are doing video processes from other resources that are doing time sensitive stuff around GPS networks," Ferguson says. "Increased use of hypervisors into those elements — that helps partition parts of the software that you have to take through certification and prove that you can isolate that from the other pieces of the system that is running on Linux typically."

Abaco's Fiaschi says that major RTOS vendors are now offering virtualized hypervisors in a single platform.

"This very much reflects the need in the mil-aero market to deploy encapsulated applications that might, at some point, also be part of a certifiable software solution. Products like the open source KVM, Helix from Wind

River, INTEGRITY-178 from Green Hills Software and MOSA.ic from Lynx are well suited for this purpose, because they embed a bare metal hypervisor to abstract the hardware horizontally, while also offering guest operating systems as a vertical solution in separate containers. This architecture serves multiple goals. First, it uses most of the hardware capabilities in the single board computer to use and efficiently share hardware resources. The multicore capabilities that today's SBCs are able to offer adapt well to this hypervisor abstraction," says Fiaschi. "Beyond this, dedicated hardware functionality at the CPU and at the device level, such as SR-IOV, allow hardware design to function efficiently in a virtualized context."

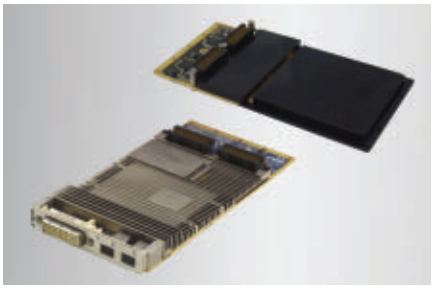
Fiaschi notes that hypervisors allow the simple migration of existing software applications.

"A hypervisor — sitting on top of the hardware — provides the possibility of encapsulating the application and operating system in a single container," Fiaschi says. "This means that porting the application from one operating system environment to another can be achieved much more easily."

Finally, Fiaschi says that the architecture allows those applications to coexist with other previously-certified software components without compromising system integrity and responsiveness.

As mentioned by Fiaschi, Green Hills Software's INTEGRITY-178 RTOS is suitable for use as a hypervisor.

"The INTEGRITY-178 tuMP RTOS from Green Hills Software supports ARM processors on FPGAs, such as the Zynq UltraScale+ MPSoC, and heterogeneous ARM processor combinations, such as the Cortex-A72 and Cortex-A53 core in the NXP i.MX 8QuadMax," says



RTOS drivers are available for the Wind River VxWorks and Green Hills INTEGRITY-178 tuMP operating environments on Curtiss-Wright's XMC-4740 rugged video-processing mezzanine module.

Green Hills's Jaenicke. "The combined solutions are suitable for high-assurance sensor and image processing applications, such as synthetic vision for degraded visual environments. All INTEGRITY-178 tuMP deployments are capable of simultaneously meeting the safety requirements of DO-178C to DAL A and the security requirements in support of NSA 'high robustness' and Common Criteria EAL6+."

Jaenicke explains that in the avionics market, customers are deploying synthetic vision systems that fuse data from radar and infrared imagers to enable landing in a degraded visual environment (DVE).

"Future systems will use an array of multi-spectral, multi-function sensors to enable DVE terrain flight as well as landing," Jaenicke says. "Both of those systems can require flight safety certification up to the highest design assurance level (DAL A). The INTEGRITY-178 tuMP RTOS provides the architecture and tools to run multitasking fusion algorithms across multiple cores while achieving DAL A."

'Soft' real-time

"Another trend we are seeing in embedded signal processing applications is a transition from the traditional real time operating systems widely used on the PowerPC architecture to Linux running on the Intel architecture," Abaco's Fiaschi says. "Linux on Intel, if well-tuned, can provide 'soft real-time' performance that is sufficient for many signal processing applications. For applications where hard real-time performance is required, more specialized commercial versions of Linux are being utilized on Intel platforms. These have modified micro-kernels with specific features to provide the real-time determinism needed for the application.

Lynx's Ferguson says that increases in Linux usage stems from an abundance of code and the need to certify systems.

"One of the things that we are seeing is, rather than having everything on a real-time operating system, we're seeing the use of mixed-criticality systems," Ferguson says. "Increased use of Linux because there's networking stacks that exist. So rather than migrating everything onto an RTOS and having a single point of failure there, the first bit is partitioning the system so that you got only the real certification stuff that you absolutely need on the RTOS — offload other bits onto other operating systems and run them there."

Optimizing processing

"Our customers request middleware to help them optimize signal processing applications running on real-time systems," Abaco's Fiaschi says. "They also need middleware to move data efficiently between processing entities within multicore systems, as well as tools to help characterize and tune performance. Abaco is meeting these requests via our AXIS software environment as well as additional toolkits that provide optimized middleware for signal and image processing, system health monitoring, data movement and graphics. This is complemented by graphical tools to enhance productivity to minimize time to deployment."

An Air Force loadmaster, performs preflight checks in the cockpit of an HC-130J aircraft. Multi-core processors in cockpit avionics are difficult to certify because they were not designed with that task in mind.

Fiaschi continues, "To meet the significant demands of system responsiveness and application partitioning, customers need to look even deeper than the software ecosystem and into how data streaming is controlled by the underlying hardware components. For example, the SR-IOV feature in an Intel architecture single board computer opens up the benefits of a fully virtualized platform — but it's not a feature of all Intel-based platforms. The 3U VPX SBC3511 single board computer from Abaco not only guarantees SR-IOV capabilities in the data plane because it leverages the XL710 chipset, but also provides support for hypervisors such as those featured by KVM, Helix and MOSA.ic."

Vector instructions

High-intensity data processing can be aided by using vectors to store a large number of variables. Lynx's Ferguson explains that mil-aero experts are now taking full advantage of vector processing with custom instructions.

"If you look at these newer Intel Xeons AVX512 their accelerator extensions," says Ferguson. "There are custom instructions on ARM; there's custom instructions on PowerPC. We certainly see people taking more advantage over those instructions to get the performance up without scaling up frequency, staying within power budgets and correlated to that really is increases to FPGAs. We see people doing more encryption and crypto and bit manipulation inside the FPGAs, also video encoding subsystems."

Ferguson continues, "Silicon partners have actually created Operating Systems and software specs that take full advantage of that. Typically, open source running on Linux coming into the aerospace and defense area and

those people really segment and isolate as minimal amount of code onto the RTOS as possible."

Green Hills's Jaenicke says that the industry is seeing an "explosion" of demand for RTOS on ARM-based processors, which he says is driven in part by the ARM cores embedded in FPGAs.

"Whereas many military signal processing systems, such as radar signal processing, traditionally divide the processing between FPGAs in the front end and Intel or Power Architecture processors in the back end, the dividing line is shifting to do more in the FPGAs," Jaenicke says. "Even if all of the signal processing is done in the FPGA fabric, the processor cores are still used for the control functions.

Security and certification

Wind River's Petty notes that customers are asking for support in new development, security, and operations (DevSecOps) requirements.

"Legacy software acquisition and development practices in A&D do not provide the agility to deploy new software 'at the speed of operations,'" Petty says. "In addition, security is often an afterthought, not built in from the beginning of the life cycle of the application and underlying infrastructure. DevSecOps is the industry best practice for rapid, secure software development ... The main characteristic of DevSecOps is to automate, monitor, and apply security at all phases of the software life cycle: plan, develop, build, test, release, deliver, deploy, operate, and monitor. In DevSecOps, testing and security are shifted to the left through automated unit, functional, integration, and security testing — this is a key DevSecOps differentiator since security and functional capabilities are tested and built simultaneously."

WHO'S WHO IN REAL-TIME SYSTEMS

Abaco Systems
Huntsville, Ala.
www.abaco.com/

BlackBerry Ltd.
Waterloo, Ontario
www.qnx.com

CMX Systems
Sunnyvale, Calif.
www.cmx.com

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

DDC-I Inc.
Phoenix, Ariz.
www.ddci.com

ENEA
Stockholm, Sweden
www.enea.com

Extreme Engineering Solutions (X-ES)
Verona, Wis.
www.xes-inc.com/

Green Hills Software
Santa Barbara, Calif.
www.ghs.com

Lynx Software Technologies
San Jose, Calif.
www.lynx.com

Mercury Systems
Andover, Mass.
www.mrcy.com/

Micrium
Weston, Fla.
www.micrium.com

OAR Corp.
Huntsville, Ala.
www.rtems.com

Quadros Systems Inc.
Houston, Texas
www.quadros.com

TimeSys
Pittsburgh, Pa.
www.timesys.com

Wind River Systems
Alameda, Calif.
www.windriver.com

Petty says that benefits from adopting DevSecOps include reduced mean-time to production; increased development frequency; fully automated risk characterization; and software patching at "the speed of operations."

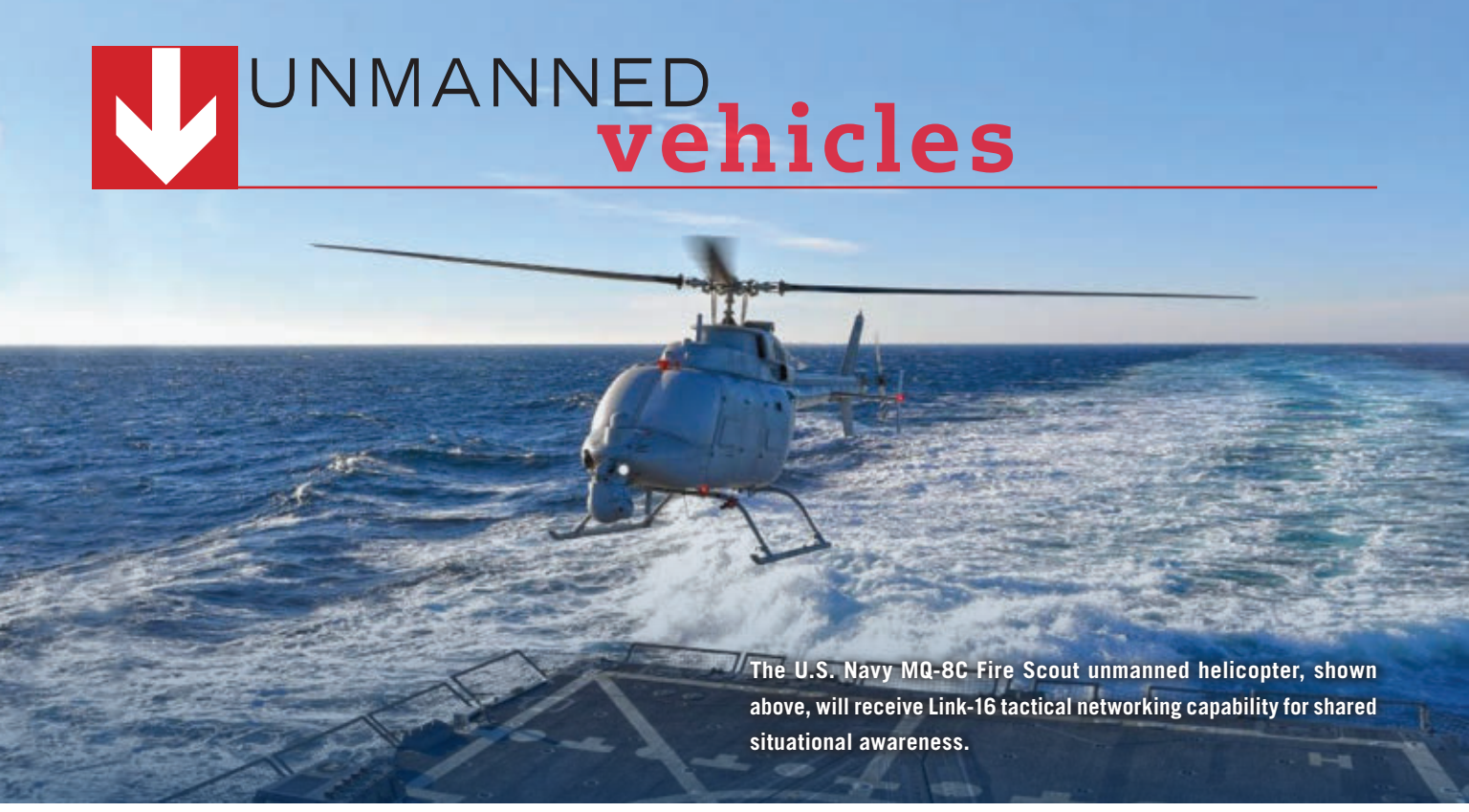
Green Hills's Jaenicke also says that industry is seeing an increase in the need for security in RTOS in the mil-aero sector.

"With our Wind River Simics offering, teams can simulate anything, chip to system, giving them a path to DevSecOps and Continuous Integration and Deployment," Petty says. "Also, a number of Wind River offerings are FACE conformant, such as VxWorks 653, Wind River Helix Virtualization Platform, and Wind River Linux. In fact, Wind River is the first and only to achieve FACE Conformance for Linux."

"(This is) driven by the rise in identified vulnerabilities over the last few years," Jaenicke explains. "Security has finally become a serious enough concern that programs are requiring security instead of giving waivers when the system integrator tells them how much it will cost."

Lynx Software Technologies' Ferguson says that certifying multi-core processors for cockpit avionics is difficult because the systems weren't designed with that task in mind.

"They're designed for servers, they're designed for base stations, they're designed for whatever other workloads in video technology isn't designed with Lockheed as their primary customer focus," Ferguson says of multi-core processors. "Certification and how it works around the current flavor around multi-core products are still a big challenge. How do you guarantee determinism on certain things? What happens when you have memory systems that have unpredictable access times and those pieces? There are people that have claimed to have solved multi-core processors for avionics, we are in the camp that thinks it isn't solved yet. There are things you can do to mitigate it but I think there's going to need to be more work done into the underlying hardware to get to a place where software can help partner up with hardware to deliver...where the FAA can truly feel comfortable that a multicore system can be certified for all eventualities."



The U.S. Navy MQ-8C Fire Scout unmanned helicopter, shown above, will receive Link-16 tactical networking capability for shared situational awareness.

Navy, Northrop Grumman to add Link 16 tactical networking to MQ-8C unmanned helicopter

BY **John Keller**

PATUXENT RIVER NAS, Md. — U.S. Navy unmanned helicopter experts plan to add tactical networking capability to enable the radar-equipped MQ-8C unmanned aerial vehicle (UAV) to share its radar picture with nearby ships, aircraft, and ground forces.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., have announced plans to continue developing a Link 16 tactical datalink capability for radar-equipped MQ-8C Fire Scout unmanned helicopters.

The Navy will negotiate a contract with MQ-8C manufacturer the Northrop Grumman Aeronautics Systems segment in San Diego to integrate and field a Link 16 tactical datalink capability into radar equipped MQ-8Cs.

This effort also will include procurement of as many as 38 retrofit kits and installs. The contract action requires expertise in MQ-8C aircraft engineering, integration and testing. The value of the upcoming contract has yet to be negotiated.

Link 16 is a military tactical data link network used by the U.S. military and its NATO allies that enables military aircraft, ships, and ground forces to exchange their tactical picture in near-real time. Link 16 also supports the exchange of text, imagery, and digital voice messages.

The MQ-8C unmanned helicopter is aboard Navy destroyers and other surface warships. These aircraft are based on the manned Bell 407 helicopter from Bell Helicopter Textron Inc. in Fort Worth, Texas.

The MQ-8C provides the Navy with an increased range of more than 30 percent, twice the endurance, and an increased payload capacity over the existing MQ-8B variant, which is based on the Schweizer 333 helicopter from Schweizer Aircraft Corp., now owned by Rotorcraft Services Group in Fort Worth, Texas. The unmanned systems architecture developed for the MQ-8B is re-used in the MQ-8C.

The primary advantage of the MQ-8C Fire Scout over its MQ-8B and MQ-8A versions is the newest shipboard UAV has double the useful payload of its predecessors.

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

Air Force asks industry to design air-launched hypersonic cruise missile in 17 months

BY **John Keller**

EGLIN AIR FORCE BASE, Fla. — U.S. Air Force hypersonic weapons experts are surveying industry for companies able to design an aircraft-launched hypersonic cruise missile within the next 17 months.

Officials of the Air Force Armament Directorate at Eglin Air Force Base, Fla., issued a source-sought notice (FA8682-20-R-0008) for the Future Hypersonics Program. Hypersonic missiles travel through the air at speeds of at least Mach 5, or 3,836 miles per hour.

The Air Force wants companies to identify themselves if they can integrate a Weapon Open System Architecture (WOSA)-based, solid-rocket boosted, air-breathing, hypersonic conventional cruise missile that can be launched from existing fighter or bomber aircraft.

This future hypersonic cruise missile should be ready for preliminary design review (PDR) no later than late September 2021. PDR establishes a design baseline to ensure a system is operationally effective.

This design phase happens before the start of detailed design work gives the Air Force an opportunity to closely observe the designer's hardware and software design closely to ensure that the system has a reasonable expectation of satisfying Air Force requirements on budget and on schedule.

Hypersonic munitions are among the highest priorities of the U.S. Department of Defense (DOD) because of their ability to attack high-value mobile targets like surface warships, relocatable missile launchers, and strategic command posts.

The U.S. Air Force is challenging industry to design a next-generation aircraft-launched hypersonic cruise missile within the next 17 months.

The Future Hypersonics Program for an air-launched munition involves digital- and model-based engineering for planning, qualification, component and subsystem testing, manufacturing, and sustainment.

Companies responding should have experience in ramjet, scramjet, or dual-mode sustained air-breathing hypersonic propulsion; stable hypersonic aerodynamics; aero-thermal protection systems; solid-rocket motors; warhead and missile integration; advanced hypersonic guidance, navigation, control, and communications; and jet fighter and bomber weapon integration.

Air Force officials will use responses from this sources-sought notice to determine if they should issue a future solicitation as a full and open competition, as a set-aside for small business, or any small business program.

The Lockheed Martin Missiles and Fire Control segment in Orlando, Fla., and the Raytheon Technologies Corp. Missiles & Defense segment in Tucson, Ariz., are some of the few U.S. prime systems integrators able to design a hypersonic cruise missile. Lockheed Martin, for example, is in charge of the Air Force's hypersonic Air-Launched Rapid Response Weapon (ARRW) project.

Companies interested in participating in the Future Hypersonics Program were asked to email capabilities statements by 11 May 2020 to the Air Force's Lanie Bolin at lanie.bolin@us.af.mil. More information is online at https://beta.sam.gov/opp/7201c51b033b46699d8d88bfebad8bf4/view.

RAD-HARD ELECTRONICS

Honeywell to design radiation-hardened gyroscope for satellite navigation

U.S. Air Force space warfare experts needed a small, lightweight navigational gyroscope for spacecraft applications able to withstand the effects of enemy nuclear explosions. They found their solution from Honeywell Aerospace in Phoenix.

Officials of the Air Force Research Laboratory's Space Vehicles Directorate at Kirtland Air Force Base, N.M., announced a $41.6 million contract to Honeywell to design the Compact Strategic-Grade Gyroscope (CSG).

This project seeks to design gyroscope technology capable of performing in space and strategic environments, with an eventual path to operating through radiation and electromagnetic pulse of nuclear explosions.

The gyro will have high accuracy and minimal degradation over a typical strategic systems service lifetime, and show a technology path to hostile radiation tolerance.

The five-year CSG project has five objectives: build and test four prototypes; make iterative improvements to design six strategic-grade units; continue with improvements that will include developing a radiation-hardened application-specific integrated circuit (ASIC) and VHDL software code; integration into experimental space vehicles for a one-year mission at low-Earth orbit; and develop a radiation-hardened gyroscope as an attitude reference system aboard a space vehicle.

The initial four prototypes will be 30 cubic inches in size, with an eventual goal of 15 cubic inches. The final prototypes that will perform as spacecraft attitude reference systems will be about 65 cubic inches in size.

On this contract Honeywell will do the work in Phoenix, and should be finished by August 2025. For more information contact Honeywell Aerospace online at https://aerospace.honeywell.com, or the Air Force Research Lab Space Vehicles Directorate at https://www.kirtland.af.mil/Units/AFRL-Space-Vehicles-Directorate.

SENSORS

Northrop Grumman to provide threat warning sensors for large aircraft

U.S. military aerial warfare experts needed advanced threat warning (ATW) sensors for the AN/AAQ-24 large aircraft infrared countermeasures system (LAIRCM). They found their solution from The Northrop Grumman Corp. Mission Systems segment in Rolling Meadows, Ill.

Officials of the U.S. Defense Logistics Agency's aviation activity in Philadelphia announced a $12.5 million order to Northrop Grumman for AN/AAQ-24 threat warning sensors.

The Northrop Grumman AN/AAQ-24(V) LAIRCM electro-optical missile warning sensor is designed to provide missile-warning capability to protect large military aircraft from infrared-guided, heat-seeking missiles — particularly those from shoulder-fired launchers like the U.S.-made Stinger Block 2 and Russian-made SA-14 missiles.

The LAIRCM is a derivative of the AN/AAQ-24 Nemesis Directional IR Countermeasure (DIRCM) system. It jams the incoming missile's seeker with a IR laser energy beam, and operates autonomously without intervention from the aircraft crew.

LAIRCM automatically detects a missile launch, determines if it is a threat, and activates a high-intensity laser-based countermeasure system to track and defeat the missile, Northrop Grumman officials say.

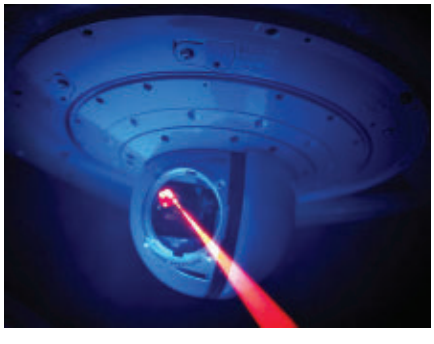
The system is for large aircraft like the Air Force C-5, C-17, C-37, and C-40 cargo and utility jets; Air Force C-130H and MC-130W four-engine utility turboprop aircraft, the CV-22 tiltrotor aircraft, the KC-46 aerial refueling jet, as well as the U.S. Navy P-3 maritime patrol jet. LAIRCM also can fit on some large military helicopters.

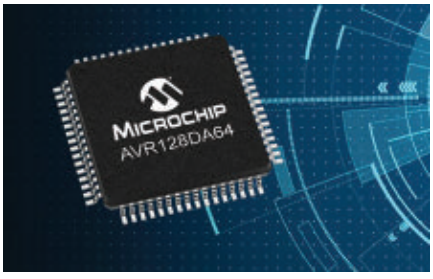
LAIRCM focuses high-intensity laser energy at the infrared seeker head of incoming missiles to blind the missile and force it off its target. The system is designed to protect large aircraft from shoulder-fired, vehicle-launched, and other infrared-guided missiles when the planes are operating close to the ground, such as on takeoff and landing, as well as during low-level operations and aerial refueling.

Initial LAIRCM systems equipped C-17 and C-130 aircraft as a stop-gap measure, using an ultraviolet sensor, a countermeasure processor, and a small laser turret assembly.

Later-model LAIRCM systems use a smaller laser turret, and operate in the infrared region.

On this order Northrop Grumman will do the work in Rolling Meadows, Ill., and should be finished by May 2022. For more information contact Northrop Grumman Mission Systems online at www.northropgrumman.com, or the Defense Logistics Agency Aviation activity at www.dla.mil/Aviation.





INTEGRATED CIRCUITS

Microcontrollers for industrial and vehicle applications introduced by Microchip

Microchip Technology Inc. in Chandler, Ariz., is introducing the next-generation AVR DA family of microcontrollers for industrial and home applications, as well as connected vehicles. The microcontrollers have Microchip's Functional Safety Ready designation for devices that incorporate the latest safety features and are supported by safety manuals, Failure Modes, Effects, and Diagnostic Analysis (FMEDA) reports, and in some cases, diagnostic software – reducing the time and cost of certifying safety end applications. The AVR DA MCU family includes several integrated safety functions to ensure a sufficient supply voltage such as power-on reset, brown-out detector, and voltage-level monitor. Microchip's AVR DA family of microcontrollers enables CPU speeds of 24 MHz over the full supply voltage range, memory density to 128 KB flash, 16 KB SRAM and 512 bytes of EEPROM, 12-bit differential A/D conversion, 10-bit D/A conversion, analog comparators, and zero cross detectors. The peripheral touch controller enables capacitive touch interface designs supporting buttons, sliders, wheels, touchpads, small touch screens, and gesture controls in consumer and industrial products and vehicles. The AVR DA family of microcontrollers supports as many as 46 self-capacitance and 529 mutual capacitive touch channels and features the latest generation peripheral touch controller with Driven Shield+ and boost mode technologies providing enhanced noise immunity, water tolerance, touch sensitivity, and response time. For more information contact Microchip Technology online at www.microchip.com.

SENSORS

Inertial navigation for flight control applications introduced by Gladiator

Gladiator Technologies in Snoqualmie, Wash., is introducing the high-performance LandMark 60 INS/GPS and compact LandMark 005 inertial navigation systems (INS/GPS) for accurate position, velocity and attitude. These GNSS receivers are integrated with a 72 channel low-noise micro electro-mechanical systems (MEMS) inertial sensor with VELOX high-speed processing to suit several positioning, navigation, and timing (PNT) applications like flight control, navigation, and stabilization for imaging, platforms, and antennas. These navigation and guidance devices offer sensor fusion technology that combines GPS position data, low-noise high output inertial sensors, barometric pressure, and magnetometers. Both products feature Gladiator Technologies's proprietary VELOX processing technology and Extended Kalman Filter (EKF) to enable precision position information during short-term GPS outages. The LandMark 60 INS/GPS offers plus-or-minus 0.3 degrees of heading accuracy and pitch/roll angle measurements of 0.1 degrees. It also is available with a real-time kinematics (RTK) GPS receiver. The small LandMark 005 INS/GPS measures smaller than 35 cubic centimeters, and is for space-constrained applications that require precise INS/GPS performance. For more information contact Gladiator Technologies online at https://gladiatortechnologies.com.

RUGGED COMPUTERS

Mil-spec Intel Core i7-based tablet computer introduced by Getac

Rugged computer specialist Getac Technology Corp. in Irvine, Calif., is introducing the A140 G2 rugged tablet computer for use in rugged outdoor work environments. The A140 G2 delivers Intel Core i7 processing power and responsiveness with no performance drop-off, even when running many applications simultaneously. Integrated UHD graphics and an 14-inch Lumibond 2.0 display enables users of the rugged tablet computer to see all of their information in detail on one screen, without unnecessary scrolling. The A140 G2 is certified to MIL-STD 810H and IP65, meaning it can withstand drops from nearly four feet, as well as shocks, spills, vibration, dust, and liquid. The rugged tablet operates in temperatures from -20 to 145 degrees Fahrenheit. The A140 G2 has built-in 4G LTE/Wi-Fi/Bluetooth connectivity and processing power that suits it for use as a mobile data terminal (MDT) for emergency services professionals. For instance, fire fighters can send or receive critical site specific risk information, verify response plans, and perform chemical data checking from the scene of an incident. The large touchscreen display also works in the rain and while wearing gloves. For more information contact Getac online at www.getac.com.

CHASSIS AND ENCLOSURES

8U VPX embedded computing chassis with 1600 Watts introduced by VadaTech

VadaTech Inc. in Henderson, Nev., is introducing the VTX661 8U VPX chassis with 12 3U VPX slots for commercial embedded computing applications. The VTX661 8U VPX chassis can accept 0.8-inch, 0.85-inch, and 1.0-inch pitch modules. The chassis has three AC universal-input power supplies to provide 1600 Watts with redundancy (2+1), supplying 95 Watts per slot. The VTX661 is designed to meet the ANSI/VITA 65 standard, providing front to back push/pull cooling (18 cubic feet per minute of air per slot to the VPX payload and Rear Transition Module (RTM) slots. The standard VTX661 embedded computing backplane provides 10 3U VPX payload slots in a star configuration, and complies with to VITA 46.0 baseline specification with additional support to the RTMs, compliant to VITA 46.10 and OpenVPX VITA 65. There is an optional JTAG Switch Module to provide JTAG access to the front, and custom backplane design is available on request. For more information contact VadaTech online at www.vadatech.com.

RF AND MICROWAVE

High-power signal limiter for EW and radar introduced by Teledyne e2v

The Teledyne Defense Electronics Teledyne e2v HiRel segment in Milpitas, Calif., is introduced the TDLM202402 high-power signal limiter for demanding electronic warfare (EW) and radar applications. A quasi-active S-band SMT PIN

PRODUCT & LITERATURE SHOWCASE

ADVERTISERS INDEX

Military & Aerospace Electronics

SUBSCRIPTION INQUIRIES
Phone: 1-877-382-9187 / International Callers: +1-847-559-7598
E-mail: MAEM@omeda.com
Web: www.mae-subscribe.com

VICE PRESIDENT/GROUP PUBLISHER Paul Andrews
203 423-3963 / pandrews@endeavorb2b.com

EDITOR-IN-CHIEF John Keller
603 891-9117 / jkeller@endeavorb2b.com

ASSOCIATE EDITOR Jamie Whitney
603 891-9135 / jwhitney@endeavorb2b.com

CONTRIBUTING EDITOR WESTERN BUREAU J. R. Wilson
702 434-3903 / jrwilson@endeavorb2b.com

EDITORIAL ART DIRECTOR Kermit Mulkins

PRODUCTION MANAGER Sheila Ward

AUDIENCE DEVELOPMENT MANAGER Debbie Bouley
603 891-9372 / dbouley@endeavorb2b.com

MARKETING MANAGER Adrienne Adler
603 891-9420 / aadler@endeavorb2b.com

ENDEAVOR BUSINESS MEDIA
www.endeavorbusinessmedia.com

EDITORIAL OFFICES
Endeavor Business Media, LLC
Military & Aerospace Electronics
61 Spit Brook Road, Suite 501, Nashua, NH 03060
603 891-0123 / www.milaero.com

SALES OFFICES

EASTERN US & EASTERN CANADA & UK
Keith Gregory, Sales Manager
508 1/2 Ocean Park Ave., Bradley Beach, NJ 07720
732 897-9550 / Cell 917 993-3741
kgregory@endeavorb2b.com

WESTERN CANADA & WEST OF MISSISSIPPI
Maureen Elmaleh, Sales Manager
7475 Miller Street, Arvada, CO 80005
303 975-6381 / Cell 212 920-5051
melmaleh@endeavorb2b.com

REPRINTS Jessica Stremmel
717 505-9701 x2205 / Jessica.stremmel@theygsgroup.com

DIRECTOR LIST RENTAL Kelli Berry
918 831-9782 / kberry@endeavorb2b.com

For assistance with marketing strategy or ad creation, please contact Marketing Solutions
Kaci Wheeler
918 832-9377 / kwheeler@endeavorb2b.com

diode limiter that offers always-on high power continuous wave (CW) and peak protection, the TDLM202402 comes in an 8-by-5-millimeter packages, and uses hybrid assembly technology. It has 50 dBm 100-Watt CW power handling capability and 60 dBm 1,000-Watt peak power from 2 to 4 GHz at a 25-microsecond pulse width at 5 percent duty cycle. These RF and microwave parts are screened and qualified for high-reliability applications, and operate in temperatures from -65 to 125 degrees Celsius. Thermal management features involve a proprietary design methodology that minimizes thermal resistance from the PIN Diode junction-to-base plate (RTHJ-A). The signal limiter design employs a two-stage detector circuit which enables ultra-fast turn-on of the high-power PIN Diodes. The TDLM202402 is designed for small signal insertion loss, permitting a low receiver noise figure while simultaneously offering a large input signal. Other key features and specifications include 0.5 dB insertion loss; 17 dB return loss; 14 dBm flat leakage power; 0.5 ergs spike energy leakage; I/O DC blocking capacitors; and compliance to RoHS guidelines. For more information contact Teledyne Defense Electronics Teledyne e2v HiRel online at www.teledynedefenseelectronics.com.

EMBEDDED COMPUTING

Software development tool to help add custom IP to FPGAs introduced by Pentek

Pentek Inc. in Upper Saddle River, N.J., is introducing the ArchiTek FPGA Development Suite software tool for adding custom IP to Pentek Talon recording systems. The ArchiTek development environment enables engineers to add field-programmable gate array (FPGA) intellectual property (IP) to recording systems like threshold detection, spectral filtering, digital down-conversion, signal classification, demodulation, and other digital signal processing (DSP techniques. Developing custom IP for FPGA embedded computing requires an architecture that protects the user from custom IP development pitfalls such as breaking the existing IP and corresponding recording software. ArchiTek harnesses Pentek's Navigator FPGA Development Kit (FDK) and Board Support Package (BSP) to provide a development environment that steps engineers through the process of integrating custom IP into the recorder. Along with the Navigator FDK, ArchiTek development tool provides the foundation and example projects for adding IP to user blocks and creating additional datapath branches from existing data streams. The structured design protects the recorder's standard functionality, reducing development time and risk. The tool enables users to add FPGA IP to a recorder for real-time on-the-fly DSP during data acquisition to reduce the time necessary for post-processing recorded data. Recording of only critical data also greatly reduces transfer rates, recording capacity requirements, and data offload time. For more information contact Pentek online at www.pentek.com.

SENSORS

Measurement sensors for motion control introduced by Kaman

The Measuring Division of Kaman Precision Products Inc. in Middletown, Conn., is introducing the KD-5600 family of eddy current measurement systems for use in COTS applications for fast steering mirrors, magnetic bearing active control, shaft vibration, image stabilization, and adaptive optics. Designed for non-contact linear position displacement sensing applications, Kaman released three configurations for tailored use. The KD-5656 (digital system), KD-5640 (analog system) and KD-5690 (FE system) have custom sensors, signal processing, analog to digital converter, and a custom calibration system for precision and accuracy. For optimum operation for each channel, the KD-5600 system has two matched sensors. Input signals are filtered and SWaP-C scaled to provide optimum operation, remove common mode noise, and deliver a drive signal. They also provide digital filtering as part of the signal conditioning to reduce signal noise. Oversampling at high volume provides relatively high resolution at the defined data rate. For more information contact the Measuring Division of Kaman Precision Products online at www.kamansensors.com.

RUGGED COMPUTERS

Small-form-factor rugged computer introduced by Trenton Systems

Trenton Systems Inc. in Lawrenceville, Ga., is introducing the ION Mini PC rugged computer for military, industrial, and commercial applications that need a rugged, affordable, high-performance computer in a small form factor. The ION Mini PC weighs 3.2 pounds, and supports some of the latest, fastest Intel Coffee Lake processors and up to 32 gigabytes of unbuffered DDR4-2666 RAM across two SODIMM slots. The small-form-factor rugged computer has as many as eight cores and 16 threads. ECC-registered and non-registered options can help reduce cost and increase performance. The computer also has 35 Watts of thermal design power (TDP) to help with cooling and thermal management. For more information contact Trenton Systems online at www.trentonsystems.com.

Military & Aerospace Electronics

SUBSCRIBE TODAY!

ENABLING TECHNOLOGIES FOR NATIONAL DEFENSE

Military & Aerospace Electronics magazine delivers time-sensitive news, in-depth analyses, case studies, real-world applications of new products, industry opinion, and the latest trends in the use of mil-spec rugged and commercial off-the-shelf (COTS) components, subsystems and systems. Don't miss the next issue – subscribe today!

www.MAE-subscribe.com

ENDEAVOR BUSINESS MEDIA

The Big Thing in RFSoC is Here.

(And it's only 2.5 inches wide!)

Small | Powerful | Deployable

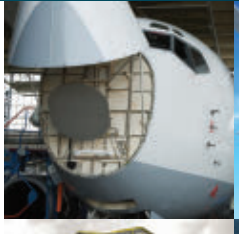
Pentek's Model 6001 FPGA board lets you quickly develop and deploy RFSoC technology, while optimizing your system for SWaP.

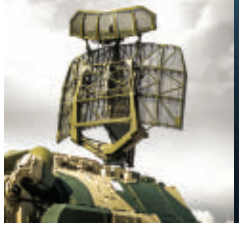
Mounted on your custom carrier or Pentek's proven 3U VPX carrier, the new QuartzXM® comes pre-loaded with a full suite of IP modules, robust software, and fully integrated hardware — all geared to shorten time to market and reduce design risk.

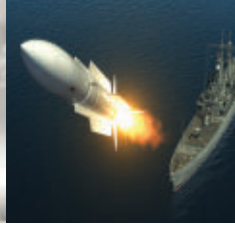
And at only 4"x2.5", it can be deployed in extremely compact environments, including aircraft pods, unmanned vehicles, mast-mounted radars and more.

- **QuartzXM eXpress Module** speeds migration to custom form factors
- **Powerful Zynq® Ultrascale+™ RFSoC** with built-in wideband A/Ds, D/As & ARM processors
- **Dual 100 GigE** interfaces for extreme system connectivity
- **Robust Factory-Installed IP** for waveform generation, real-time data acquisition and more
- **Board Resources** include PCIe Gen.3 x8 and 16 GB DDR4 SDRAM
- **Navigator® Design Suite** BSP and FPGA design kit for seamless integration with Xilinx Vivado®

All this plus FREE lifetime applications support!







QUARTZ NAVIGATOR Design Suite

Unleash the Power of the RFSoC. Download the FREE White Paper!
www.pentek.com/go/marfsoc

PENTEK
Setting the Standard for Digital Signal Processing

Pentek, Inc., One Park Way, Upper Saddle River, NJ 07458
Phone: 201-818-5900 • Fax: 201-818-5904 • email: info@pentek.com • www.pentek.com