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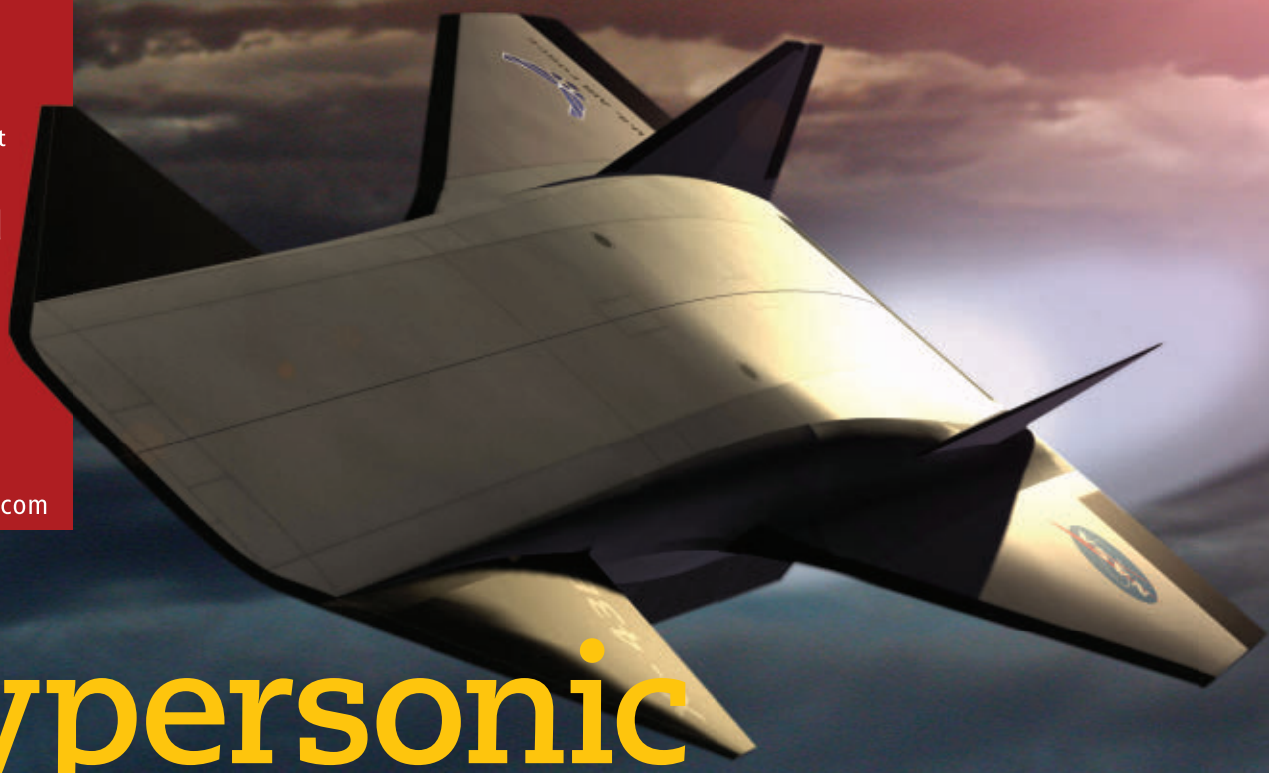

Hypersonic weapons

Mach-5 missile electronics confronts challenges of extreme heat, shock, and vibration. PAGE 14

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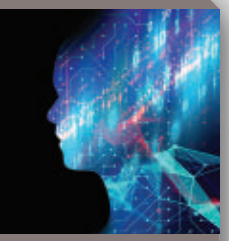

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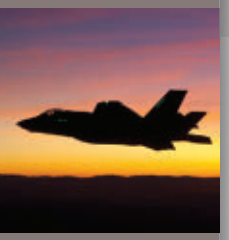

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BY **JOHN KELLER**, EDITOR IN CHIEF

The technological challenges of developing reliable, deployable hypersonic weapons

Of all the forward-looking defense technologies under development to counter perceived threats of the next several decades, hypersonic weapons represent the one with the highest sense of urgency. The reason these future Mach-5 weapons are getting so much attention is the nation's military leaders believe the U.S. is behind — perhaps far behind — its chief military rivals, Russia and China.

Hypersonic weapons are particularly scary because today there's no way to defend against them; they're just too fast. These kinds of weapons are considered so formidable and beyond any of today's missile defenses that they will be in the 2020s what some of the first reliable intercontinental ballistic missiles were in the 1960s — the focal point of billions of dollars in research and development to build ever-faster hypersonic weapons, and new ways to counter them. Military & Aerospace Electronics tracks some of the trends in our special report feature on page 14.

Remember President Ronald Reagan's Strategic Defense Initiative (SDI) "Star Wars" program back in the mid-1980s to defend against Soviet nuclear ballistic missiles? We'll probably see much the same thing with regard to hypersonic weapons by the 2030s — perhaps much earlier. It all comes down to how soon Russia and China (and perhaps others) can build the first reliable and deployable hypersonic missiles.

Hypersonic weapons stand out because of their speed. Today a weapon is considered hypersonic if it could achieve Mach 5. That's about 3,800 miles per hour, or one mile per second, which is twice the speed of a bullet. Future generations of hypersonic weapons could be expected to exceed Mach 5 by a wide margin.

The U.S. Air Force is working with the Lockheed Martin Corp. Space Systems segment in Huntsville, Ala., on the Hypersonic Conventional Air-Launched Strike Weapon program to develop a Mach 5 hypersonic weapon. This would be for jet fighter and bomber aircraft to provide a prompt precision-strike capability against high-value, time-critical fixed and relocatable surface targets, like enemy warships.

Ships at sea typically would have less than a minute to react after detecting the launch of hypersonic missiles fired their way. Effective defenses are likely to involve detection at extremely long ranges, and technologies able to destroy or disable incoming weapons at much longer distances than today's technology allows.

Despite their potential as offensive weapons, however, here's something to think about: there's a lot of hype behind hypersonic weapons. Today their value in political propaganda is much higher than it is in real firepower. Are the U.S., Russia, and China near to developing deployable hypersonic weapons? It's hard to say, but there are substantial technological challenges involved.

First, it's no easy feat to control a weapon moving twice as fast as a bullet, and the ability to control a hypersonic vehicle is critical; just because you can propel a weapon through the air at Mach 5, doesn't mean you can hit what you shoot at.

There are environmental conditions to consider. Something going that fast generates a lot of heat, shock, vibration, and other environmental extremes because moving through the atmosphere at speeds like that is like a spacecraft during re-entry. The Mercury, Gemini, and Apollo spacecraft needed sophisticated heat shields to prevent them from burning up on re-entering the Earth's atmosphere. Even the Space Shuttle needed heat shielding; it was this shielding's failure that caused the Space Shuttle Columbia to disintegrate on re-entry in February 2003.

Heat is an issue not just for the weapon itself. Its guidance systems, sensors, sensor processing, communications, and other electronics also must be able to survive the heat, as well as the anticipated shock and vibration of hypersonic flight. Do we have enabling technologies yet to protect the hypersonic weapon, its electronics, and weapons payload during torturous high-Mach flight? That's not clear, but believe me, military leaders and defense contractors are working on it.

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news

Lockheed Martin to build THAAD interceptors in $2.54 billion order

Missile defense experts at Lockheed Martin Corp. will build missile defense rocket interceptors for the U.S. and Saudi Arabia to protect against incoming ballistic missiles under terms of a $2.54 billion order. Officials of the U.S. Missile Defense Agency (MDA) in Huntsville, Ala., are asking the Lockheed Martin Missiles and Fire Control segment in Dallas to build Terminal High Altitude Area Defense (THAAD) interceptors and associated one-shot devices. THAAD is designed to shoot down short-, medium-, and intermediate-range ballistic missiles in their terminal phase using a hit-to-kill kinetic warhead. The THAAD interceptor missile relies on the kinetic energy of the impact to destroy the incoming missile. The system is a key element of the U.S. ballistic missile defense system to defend the continental United States, its deployed forces, friends, and allies against ballistic missiles of all ranges and in all phases of flight. THAAD consists of five major components: launchers, interceptors, a radar, THAAD fire control and communications (TFCC) units, and THAAD-specific support equipment.

Raytheon to build air-to-air missiles with lock-on after launch capability

U.S. Navy aerial warfare experts are asking the Raytheon Co. to build additional AIM-9X precision short-range infrared-guided air-to-air missiles for jet fighters and other combat aircraft under terms of a $12.1 million order. Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking the Raytheon Missile Systems segment in Tucson, Ariz., to build lot-18 AIM-9X block II air-to-air

Making English understandable to intelligence and battle-management computers

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers want to make English text and speech readily understandable to computers by creating an artificial intelligence (AI) prototype that can learn language in much the same way as a young child does — from visual and auditory cues.

The idea is to help computers make quick and efficient use of written and spoken language to help military commanders and intelligence analysts make quick decisions based on the resources they have at hand.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a solicitation last week (DARPA-PA-18-02-06) for the Grounded Artificial Intelligence Language Acquisition (GAILA) project.

The goal is to develop a model for grounded language acquisition and an automated language-acquisition prototype that learns to understand English text and speech for making the information more useable by automated analytics.

Children acquire language based on their perceptions of sounds and images, researchers explain; they link moving images with corresponding sounds, using only a tiny fraction of the examples that AI and machine learning systems require.

Sequencing information, variations of word forms, and other information helps children make ever-finer classifications of what they learn. If AI computers could learn language like children do, they could see vast improvement in their abilities in machine translation, information retrieval, name entity detection, event detection, and knowledge base creation.

Military researchers are trying to make it easier for human warfighters to interact with computers by making the English language understandable to machines.

The accuracy of AI and machine learning computers today suffers from their need for large amounts of annotated data for training. Machine learning technology, moreover, is incapable of dealing with new data sources, topics, media, and vocabularies.

Instead, DARPA researchers want industry to develop a computer prototype

that starts with no language skills, and learns associate text and speech with live scenes, images, or video. It will use logic, heuristics, and inference to describe previously unseen objects, relations, and events.

For example, after seeing a black table, a white table, and a black chair, the prototype should be able to learn enough about the meanings of the words "black," "white," "table," and "chair" to recognize and describe a white chair. As the computer evolves, it should be able to describe increasingly complex events and relations.

GAILA is fundamentally different from previous semantics and language-learning efforts because it will use visual cues to describe what it experiences before, during, and after an event.

The prototype, in the learning stage, must be able to accept text and speech and build internal language representations. GAILA software must be able to accept images, video, or virtual visual scenes depicting previously unseen things, and produce English descriptions that capture salient elements. ←

Companies interested were asked to upload eight-page proposals no later than 26 April 2019 to the DARPA BAA Website at https://baa.darpa.mil. More information is online at http://www.fbodaily.com/archive/2019/03-March/30-Mar-2019/FBO-05263271.htm.

missiles. The order includes AIM-9X block II all-up round missiles, as well as captive air training missile guidance units, tail caps and containers, and spares for the U.S. Navy and Air Force, as well as for the governments of South Korea, Australia, Qatar, Norway, Indonesia, Kuwait, Saudi Arabia, Israel, Poland, Japan, Taiwan, Turkey, Belgium, Malaysia, United Arab Emirates, the Netherlands, Finland, Switzerland, Slovakia, Singapore, and Denmark. The AIM-9X is an infrared heat-seeking missile that equips most jet fighters, fighter-bombers, and other offensive combat aircraft in the U.S. arsenal, and is for shooting down enemy aircraft close-by. The AIM-9X works by homing in on an enemy aircraft's hot

engine exhaust. The block II version of the AIM-9X adds lock-on after launch capability with a datalink, so F-35 and F-22 pilots can launch the missile first and then direct the weapon to its target afterwards.

EFW to build 132 avionics mission computers for V-22 tiltrotor aircraft

Military avionics experts at EFW Inc. in Fort Worth, Texas, will provide 132 integrated avionics processors (IAP) for the U.S. Navy and Air Force V-22 Osprey tiltrotor aircraft under terms of a $17.8 million order. This order consists of 106 processors for the Navy and 26 for the Air Force. EFW engineers use an open-system architecture that relies on commercial off-the-shelf (COTS) components to produce a high-performance, scalable, and maintainable avionics computer for the V-22. The company's mission computers have an open architecture that is suited for several different aircraft to provide general-purpose processing and display processing not only for the V-22, but also for the Boeing AH-64E Apache Guardian attack helicopter, and the Eurocopter UH-72 Lakota utility helicopter. On this order EFW will do the work in Haifa, Israel, and Fort Worth, Texas, and should be finished by February 2021. For more information contact EFW online at www.elbitsystems-us.com.

Navy asks L-3 Chesapeake to build TB-34X submarine towed array sonar

Submarine sonar experts at L-3 Chesapeake Sciences Corp. in Millersville, Md., will build additional TB-34X towed array sonar systems for U.S. Navy submarines under terms of a $13.8 million order. Officials of the Naval Sea Systems Command in Washington are asking L-3 to provide TB-34X towed array assemblies,

DARPA asks industry for SWaP-optimized machine learning ASICs

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are asking industry to develop real-time machine learning hardware able to interpret and learn from data, solve unfamiliar problems using what it has learned, and operate at power levels on par with or better than the human brain.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have released a broad agency announcement (HR001119S0037) for the Real Time Machine Learning (RTML) project, which will develop machine-learning hardware generators and circuit architectures.

Driven by rapidly evolving challenges from U.S. adversaries, future defense systems will need access to low size, weight, and power (SWaP) artificial intelligence (AI) solutions that can switch rapidly idea to practice.

Still, today's machine learning systems generally are trained prior to deployment and cannot adapt to new datasets in the field, limiting real-time function. The RTML seeks to develop algorithms and circuits from the ground up for real time machine learning.

The project seeks to develop energy-efficient hardware and machine learning architectures that can learn from a continuous stream of new data in real time. It will create no-human-in-the-loop hardware generators and compilers to enable automated creation of machine learning application-specific integrated circuits (ASICs) from high level source code.

DARPA researchers especially are interested in architectures like conventional feed forward (convolutional) neural networks; recurrent networks and their specialized versions; neuroscience-inspired architectures, such as spike time-dependent neural nets including their stochastic counterparts; non-neural machine learning architectures inspired by psychophysics as well as statistical techniques; classical supervised learning (e.g., regression and decision trees); unsupervised learning (e.g., clustering) approaches; semi-supervised learning methods; generative adversarial learning techniques, and other approaches such as transfer learning, reinforcement learning, manifold learning, and/or life-long learning.

It is likely that ultra-specialized ASICs will be necessary to meet the physical SWaP requirements of autonomous systems with real-time response and low learning latency requirements. Unfortunately, the high cost of design and implementation today has made development of machine learning ASICs impractical for all but

Military researchers are asking industry to develop real-time ASICs able to learn perhaps better than the human brain.

the highest-volume applications.

Complex machine learning processor chips take months or years to design, and require a large team of experts with knowledge in machine learning, low-level micro-architectures, and physical chip design. The complexity challenge of modern ASIC design is under investigation in DARPA's Intelligent Design of Electronic Assets (IDEA), Posh Open Source Hardware (POSH), and Circuit Realization at Faster Timescales (CRAFT) programs.

The DARPA RTML program will capitalize these approaches by creating no-human-in-the-loop hardware generators optimized for machine learning, and enable automated generation of machine-learning ASICs directly from high-level source code. The RTML program is split into two 18-month research phases: machine learning hardware compiler; and real-time machine learning systems.

The first segment will create automated hardware compilers for state-of-the-art machine learning algorithms and networks using existing machine learning programming frameworks as inputs. The goal is to demonstrate a compiler capable of auto-generating a large catalog of scalable machine learning hardware instances ranked by performance, size, weight, area, power, throughput, and latency.

The second segment will incorporate state-of-the-art machine learning advances while adding compiler support for hardware optimization driven by system requirements.

The RTML seeks to answer these questions: can we build an application-specific silicon compiler for machine learning; what hardware architectures are best suited to RTML; what are the lower latency limits for various RTML tasks; and what is the lowest SWaP feasible for various RTML tasks?

Unwanted are research that does not result in deliverable hardware; circuits that cannot be produced in standards CMOS foundries; new domain-specific languages; new approaches to physical layout; and incremental efforts. ←

Companies interested were asked to upload responses to the DARPA BAA Website at https://baa.darpa.mil no later than 1 May 2019. Email questions or concerns to DARPA's Andreas Olofsson at HR001119S0037@darpa.mil. More information is online at https://www.fbo.gov/spg/ODA/DARPA/CMO/HR001119S0037/listing.html.

cable assemblies, test sets, and engineering services. The TB-34X is a submarine fat line towed array passive sonar receiver It is in the same form factor as the TB-34 array, yet it provides increased capability, reliability, and ability to resist the effects of obsolescence. The Navy's TB-34 towed array is replacing the TB-16 legacy array, and provides enhancements to towing and self-noise characteristics compared to the TB-16. It provides more hydrophones than the TB-16 for future capability in passive sonar processing. The TB-34 towed array is one of several acoustic sensors that provide data to the Acoustics-Rapid Commercial Off-the-Shelf Insertion (A-RCI) sonar system installed on U.S. fast-attack, ballistic missile, and cruise missile submarines.

Northrop Grumman to build 24 E-2D radar aircraft in $3.2 billion deal

U.S. Navy airborne reconnaissance experts ordered 24 new E-2D Advanced Hawkeye carrier-based airborne early warning aircraft under terms of a $3.2 billion deal. Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking the Northrop Grumman Aerospace Systems segment in Melbourne, Fla., to build 24 full-rate production lots 7 to 11 E-2D aircraft. The Navy Northrop Grumman E-2D is a tactical airborne early warning (AEW) aircraft designed to operate from aircraft carriers. The twin-engine turboprop aircraft has a distinctive antenna, and provides the carrier battle group with wide-area radar surveillance for enemy monitoring and combat air traffic control. Its large saucer-like radar antenna mounted to the top of the aircraft, as well as other advanced avionics, enables it to detect hostile aircraft and missiles at extremely long ranges and vector Navy aircraft to intercept. ←

SAIC to build Marine Corps Armed Reconnaissance Vehicle (ARV) and vetronics

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are asking Science Applications International Corp. (SAIC) in Reston, Va., to build a prototype reconnaissance armored combat vehicle to enable U.S. Marine Corps battlefield reconnaissance units to fight through the enemy to gather and disseminate crucial intelligence information from the battle front.

Officials of the U.S. Office of Naval Research in Arlington, Va., announced a $19 million contract to SAIC for a portion of the Armed Reconnaissance Vehicle (ARV) program that involves advanced high-risk technology development called "at the edge."

The future ARV will be able to fight for information on a complex and contested battlefield using an automatic rapid-fire medium-caliber cannon, remotely operated medium-caliber machine gun, and open-architecture advanced vetronics to include sensors, communications, and battlefield networking.

The project seeks to build two ARV variants — a base model and an at-the-edge model — to evaluate technologies, performance, and battlefield concepts. Contractors will build two demonstrators of each variant. SAIC has been selected for the at-the-edge model. Other contractors will handle the base variant.

SAIC engineers will develop an at-the-edge ARV demonstrator with relatively high-risk technologies — some of which could have limited operability with development paths that would lead to full capability. This demonstrator is to push the upper limits of capability and performance.

The at-the-edge variant that SAIC will build will be operational, but isn't supposed to have the durability necessary to withstand sustained operations on the battlefield. It is to demonstrate enabling technologies at technology readiness level 5, which seeks to validate components in a simulated or real environment.

SAIC's at-the-edge demonstrator will push the limits of combat vehicle enabling electronic technologies such as a self-healing cyber-safe electrical and data distribution architecture; and power generation for all on-board systems with a 25 percent power buffer, with support for 100 percent power growth within 10 years for power and distribution, data distribution and processing, and memory storage.

Other electronics that SAIC engineers will address in this project are communications with technology refresh updates every four years that supports secure voice, video, and data exchanges in GPS-denied environments; interfaces to launch, control, retrieve, and recharge unmanned aerial vehicles (UAVs) and unmanned ground vehicles (UGVs); modular electronic architectures to support insertion of emerging technologies and multi-mission payloads; and manned and unmanned teaming operations with robotics and autonomy.

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The SAIC ARV demonstrator also will have protection from direct fire, underbody, and top attacks; energy-attenuation seats to protect the crew from IED attacks; water mobility sufficient for shore-to-shore operations; transportability aboard a landing craft air cushion (LCAC); and crew vision systems for reconnaissance.

The ARV demonstrators will be designed to collect mobility data, determine reconnaissance and sensing capabilities, determine unmanned systems integration and operation, evaluate platform lethality, determine platform survivability, and evaluate overall performance.

Technology demonstrators will have modular open systems architectures, with an eye to future integration of third-party hardware and software and will enable third-party repair.

The base variant and its vetronics will have an average manufacturing unit cost of $6 million per platform for 500 units, with initial operating capability (IOC) in 2027. The SAIC at-the-edge version, with its advanced high-risk technologies, has no IOC date.

The ARV is to a possible replacement for the U.S. Marine Corps legacy Light Armored Vehicle (LAV). It would support light armored reconnaissance battalions within the Marine divisions.

The vehicle will have new ways to sense and communicate, will be able to destroy heavily armored threats close-in and at range, and will be transportable with the naval expeditionary force

SAIC is helping the U.S. Marine Corps design a next-generation Armed Reconnaissance Vehicle (ARV) able to fight through the enemy to gather and disseminate crucial intelligence information from the battle front.

by military and commercial trailers, railway, C-17 fixed-wing aircraft, naval amphibious warfare ships and surface connectors, and military sealift command and commercial ships.

The ARV will have persistent surveillance capability using manned and unmanned vehicles; modern command, control, communications, and computers (C4I) vetronics; cross-country and on-road land mobility with shore-to-shore water mobility; passive and active force protection; direct and indirect weapons; be similar size and weight to the legacy LAV; drive-by-wire capability; and a modular interoperable open-systems architecture.

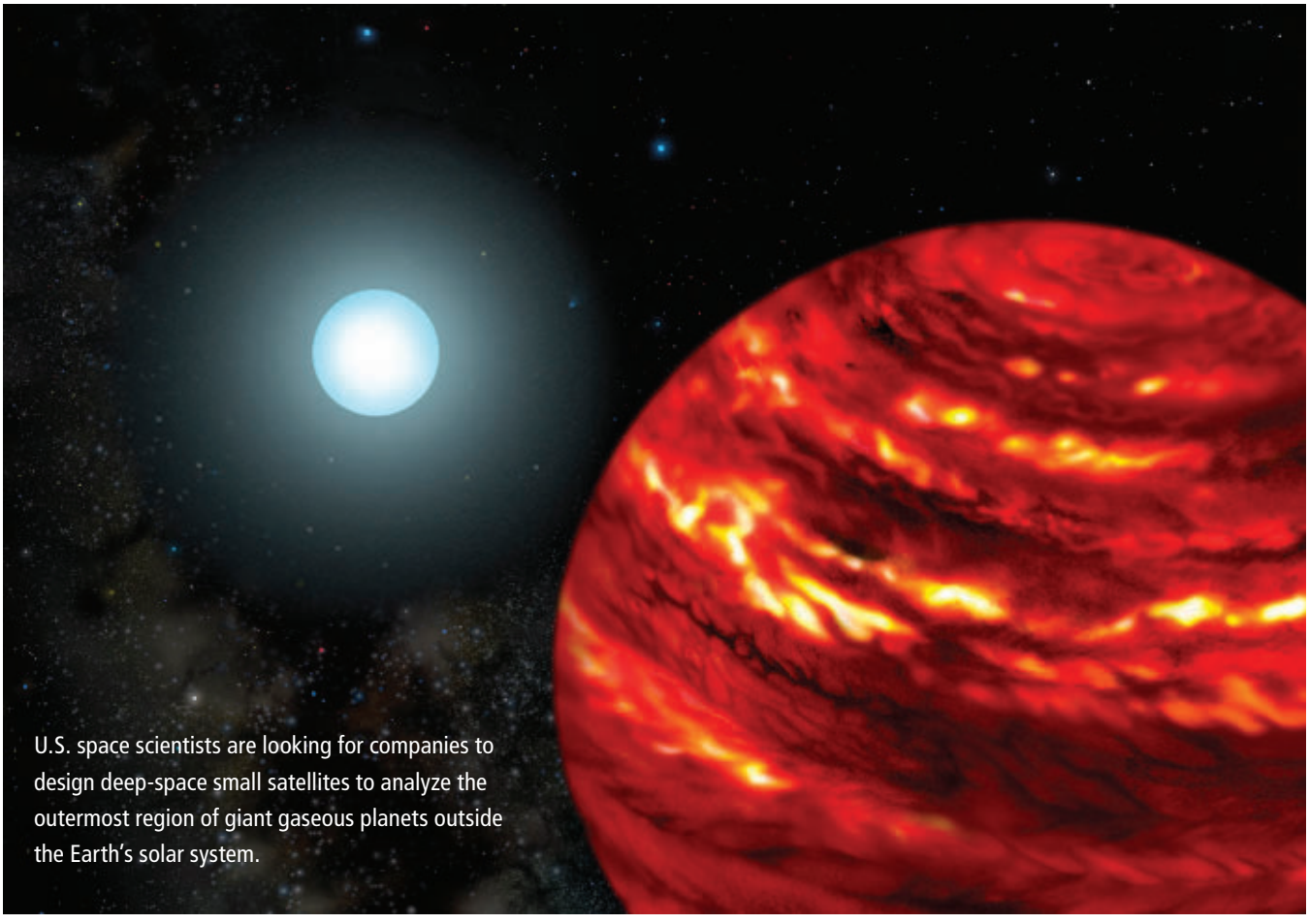
The new reconnaissance vehicle will identify weapons and targets through obscurants, beyond threat range, and beyond line of sight. It also will be able to transmit sensing and targeting information among the crew, the dismounted scout team, other ARV crews, and other Marine Corps sensors, as well as collect, process, and exploit sensor information and disseminate it to other Marine Corps units.

It also will be able to communicate voice, video, and data where sensors and communications are degraded. Its command and control system will handle weapons fire control; secure voice, video, and data exchanges; battlefield situational awareness in GPS-denied environments; and control unmanned systems beyond line of sight. Its communications network suite also will be able to operate through cyber attacks, and the vehicle will minimize its visual, infrared, RF emissions, radar cross section, and acoustic signatures.

The ARV will be survivable against weapons as large as heavy machine guns, artillery fragmentation rounds, land mines, and improvised explosive devices (IEDs). The Marine Corps is interested in modular and upgradable armor.

The ARV will achieve standoff with active and passive protective systems to sense, orient, classify, track, and defeat incoming rocket-propelled grenades, anti-tank guided missiles, and precision-guided munitions. ←

The contract to SAIC has options that could increase its value to $20.5 million. SAIC will do the work in Reston, Va., and with options should be finished by April 2023. For more information contact SAIC online at www.saic.com, or the Office of Naval Research at www.onr.navy.mil.



U.S. space scientists are looking for companies to design deep-space small satellites to analyze the outermost region of giant gaseous planets outside the Earth's solar system.

NASA eyes smallsat and instruments to explore atmospheres of gas giant planets

BY **John Keller**

MARSHALL SPACE FLIGHT CENTER, Ala. — U.S. space exploration experts are reaching out to industry to find companies able to design small satellites (smallsats) to analyze the outermost region of giant gaseous planets outside the Earth's solar system.

Officials of the National Aeronautics and Space Administration (NASA) Marshall Space Flight Center near Huntsville, Ala., have issued a request for information (80MSFC19ST329) for the Smallsat Exploration of the Exospheres of Nearby Hot Jupiters Orbiting X-ray Bright Stars (SEEJ) Mission Support Capability project.

NASA Marshall researchers are trying to find companies able to build and operate a smallsat bus, on-board scientific instruments, and ground support equipment to explore the exospheres of nearby Hot Jupiters that are orbiting X-ray bright stars.

An exosphere is the outermost regions of a planet's atmosphere. Hot Jupiters are gas giant planets that are so close to their host stars that their orbital periods are shorter than 10 days. Gas giants are planets composed mainly of hydrogen and helium, and contain the same basic elements as a star; Jupiter and Saturn are the gas giants of Earth's solar system. Exoplanets are located outside of Earth's solar system.

To develop a spacecraft and onboard instruments to observe Hot Jupiters outside the solar system, NASA officials say they envision an industry team where the partner will assess options with the mission proposal team.

NASA is trying to evaluate company capabilities that could be used on a small spacecraft like an evolved expendable launch vehicle secondary payload adapter suitable for a future SEEJ mission.

Companies interested were asked to email 10-page .pdf responses by 19 April 2019 to NASA's Robyn Crabtree at robyn.v.crabtree@nasa.gov. More information is online at https://www.fbo.gov/notices/ecd3a0132511e4db7f1a1e497aeb1b2c.

DARPA to outline military microelectronics opportunities next July in Detroit

DETROIT — U.S. military researchers will brief industry on market opportunities for leading-edge microelectronics research for aerospace and defense applications from 15 to 17 July 2019 at the Fillmore Detroit and the Cobo Conference Center in Detroit.

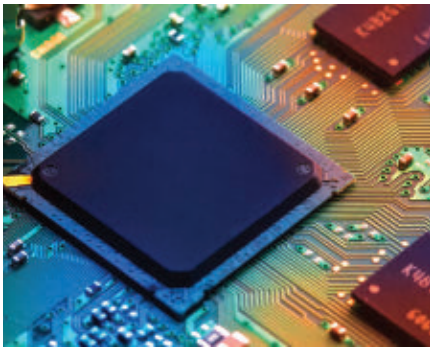
Officials of the Microelectronics Technology Office of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., will sponsor briefings at the Electronics Resurgence Initiative (ERI) Summit.

The 2019 ERI Summit will highlight the technical achievements of ERI programs, support continued research collaborations, and offer opportunities to solicit community input on new efforts. The Summit will emphasize the influence of advanced microelectronics for semiconductor designers, manufacturers, and users in the defense, automotive, telecommunications industries.

DARPA launched the ERI in June 2017 to develop technologies to improve microelectronics performance beyond the limits of traditional transistor scaling. ERI is a five-year project with expected investments of more than $1.5 billion.

The ERI summit will have workshops, technical presentations, and keynotes from industry leaders. Confirmed speakers include AMD CEO Lisa Su, Qualcomm CEO Steve Mollenkopf, GlobalFoundries CEO Thomas Caulfield, IBM executive vice president John Kelly III, and Amazon Web Services vice president of technology Bill Vass. ←

Those interested in attending should register online no later than 24 June 2019 online at http://eri-summit.com. Email questions or concerns to DARPA's Richard Chambers at ERI-Summit@darpa.mil. More information is online at http://eri-summit.com.



DARPA microelectronics experts will outline upcoming agency contracting opportunities at the Electronics Resurgence Initiative (ERI) Summit July 15 to 17 in Detroit.

THE EMERGING WORLD OF

HYPERSONIC WEAPONS TECHNOLOGY

U.S. military leaders find themselves in a global technology race to develop hypersonic weapons able to travel at speeds faster than Mach 5, which requires research breakthroughs in electronics, thermal management, electronics, and command and control.

BY **J.R. Wilson**

For most people, hypersonic weapons and aircraft represent yet another 21st century technology breakthrough in which science fiction becomes science fact. As with the vast majority of such "overnight" miracles, however, hypersonics have a long history, stretching back more than half a century. Just as with unmanned aerial vehicles (UAVs) at the same time, hypersonics languished in the lab largely due to military indifference.

To begin with, hypersonic refers to aircraft, missiles, rockets, and spacecraft that can reach speeds through the atmosphere faster than Mach 5, which

Photo (above): The now-cancelled NASA X-43 experimental unmanned hypersonic aircraft was meant to test various aspects of hypersonic flight, as part of the X-plane series and NASA's Hyper-X program.

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"I believe we were well poised to attack this problem in the 1960s, with the X-15, which was a successful hypersonic vehicle," says William Carter, program manager for the Materials Architectures and Characterization for Hypersonics (MACH) at the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va.

The North American X-15, was a rocket-powered hypersonic aircraft of the 1960s. Three of these research aircraft were built, and one of them set a world speed record 52 years ago that still stands — Mach 6.7, or 4,520 miles per hour, at an altitude of 102,100 feet.

"Aside from the NASP [National Aerospace Plane], there hasn't been a strong national need to sustain research in this area," Carter continues. "There was a lot more trial and error 50 years ago because we didn't have the computing capabilities we have today."

The U.S. Air Force played a major role in the NASP program, says James Miller, principal advisor to the High-Speed Systems Division of the Air Force Research Laboratory (AFRL) Aerospace Systems Directorate at Wright-Patterson Air Force Base, Ohio. Although it never was completed, the NASP program advanced many hypersonic technologies, including computational fluid dynamics, air-breathing propulsion, and high-temperature structures and materials.

"Following NASP, the Air Force focused on developing technologies to enable hypersonics for a range of applications, with weapon concepts representing the near-term application," Miller says. "The Air Force developed a scramjet engine that burned liquid hydrocarbon fuel [JP-7]. This was flight tested on the X-51 Scramjet Engine Demonstrator — Waverider — which flew four times between 2010 and 2013. This proved the viability of a scramjet-powered vehicle for weapon applications. The Air Force has been leading in developing technologies for a High-Speed Strike Weapon (HSSW) to enable a responsive, long-range strike capability via a partnership with DARPA."

The X-51 Scramjet Engine Demonstrator, called Waverider, flew four times between 2010 and 2013 to prove the viability of a scramjet-powered vehicle for hypersonic weapons applications.

Withstanding high temperatures

Today active research and development is in progress on all aspects of hypersonic flight, from materials to withstand high temperatures generated in the atmosphere, to more efficient propulsion systems, to size, weight and power (SWaP)-constrained enhanced electronics for sensors, guidance, communications, and other harsh-environment applications. Space programs have used many of those for decades to protect spacecraft re-entering the atmosphere at hypersonic speeds.

"The community is responding tremendously and the number of young, early-career engineers who have expressed interest in hypersonics is very encouraging," DARPA's Carter says. "I hope we will see the emergence of a community very much like what we had back then [the 1960s], but informed by the new computing capabilities and materials science capabilities we have today, fueled by the American entrepreneurial spirit."

Advances in technology, especially since the turn of the century, have improved greatly on what was possible half a century ago. The need for such capabilities also has grown substantially.

"There have been significant advances in computational fluid dynamics, air-breathing propulsion, and high-temperature structures and materials. Current efforts are using advanced design and manufacturing techniques. Cost is an important factor that has received significant emphasis in the current generation of programs. And, finally, the need for hypersonic

systems is emerging and maturing," AFRL's Miller says.

"Hypersonics is one of the game-changer technology areas that provide high-speed options for engaging time-sensitive targets and improving the survivability of our systems," Miller continues. "Hypersonics amplifies many of the enduring attributes of air power — speed, range, flexibility, and precision. Systems that operate at hypersonic speeds offer the potential for military operations from longer ranges with shorter response times and enhanced effectiveness compared to current military systems. Such systems could provide significant capabilities for future U.S. operations, particularly as adversaries' capabilities advance."

The new foothold hypersonic research has gained in military, academic, and industrial labs in recent years has not been limited to the United States, but also has grown significantly in Europe and the Asia/Pacific region — especially China and Russia. Both of those old adversaries, who are challenging America's technological lead, have boasted of great advances in hypersonics and their intentions to field operational aircraft and weapons in the near future.

Hypersonics technology race

While there is considerable debate over the validity of Russian and Chinese claims, some of America's top military officers say there is enough evidence to make dismissing them a serious mistake. That is especially true regarding China, which Air Force Gen. Paul J. Selva, vice chairman of the Joint Chiefs of Staff, says has made hypersonics a Manhattan Project-level operation on which they are willing to spend "up to hundreds of billions to solve the problems of hypersonic flight, hypersonic target designation, and then, ultimately, engagement."

For example, in March 2018, China's state media announced construction on an 870-foot wind tunnel capable of simulating conditions from Mach 10 to Mach 25. Scheduled for completion in 2020, it will join existing wind tunnels able to simulate environments from Mach 5 to Mach 9. The U.S., by comparison, has Mach 5 to Mach 9 wind

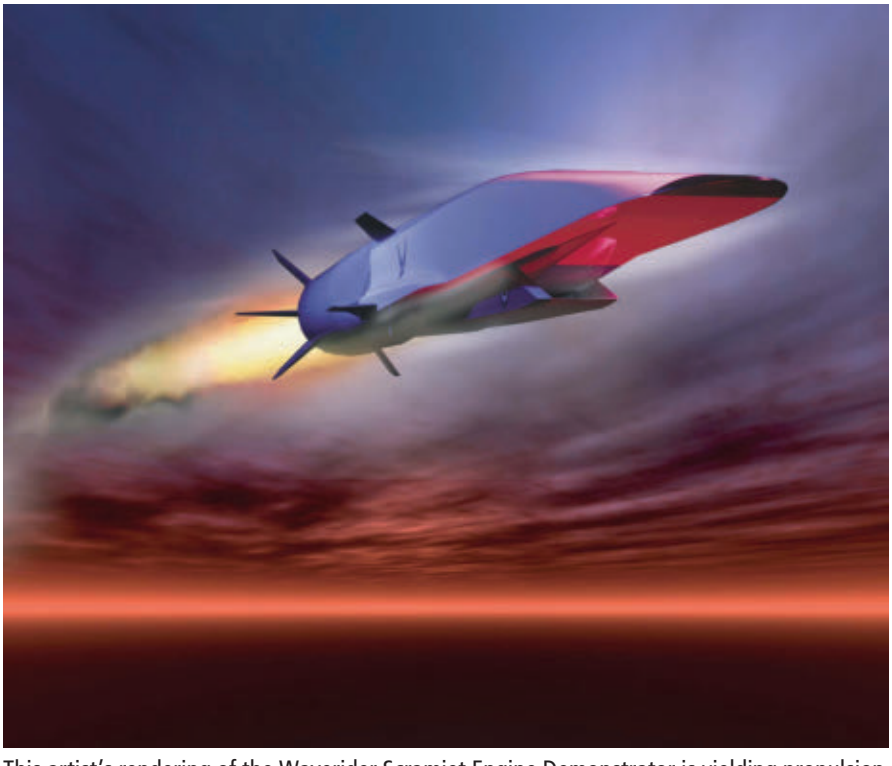
Generation Orbit Launch Services Inc. in Atlanta is developing technologies expected to lead to military and commercial hypersonic flight.

tunnels, but they are smaller than the Chinese tunnels, and capable of tests lasting only a few seconds.

That same month, Russian President Vladimir Putin announced testing on the Kinzhal missile, which he claims can reach Mach 10 speeds, carrying conventional or nuclear warheads, while impervious to existing or prospective air and missile defenses.

At a Colorado space conference in April 2018, Air Force Gen. John E. Hyten, currently head of the U.S. Strategic Command and recently nominated to succeed Selva on the Joint Chiefs of Staff, told reporters "you should believe Vladimir Putin about everything he said he's working on ... We listen to what they say very closely and none of what he said surprised me."

Michael D. Griffin, former NASA Administrator who became the nation's first undersecretary of defense for research and engineering last year, has said developing and deploying hypersonic technology is his number-one priority — and he is extremely concerned about the progress China has made while the United States, which once had a commanding lead, essentially shuttered its efforts in the mid-2010s. As a result, he said, China has made 20 times as many hypersonic tests as the U.S. in the past five years.



This artist's rendering of the Waverider Scramjet Engine Demonstrator is yielding propulsion technologies that could be used aboard first-generation hypersonic weapons.

Disruptive technology

Shortly after taking his new post, Griffin told a McAleese/Credit Suisse defense conference that a U.S. hiatus in hypersonic research must change because leaving the Chinese unchallenged in hypersonics could enable them to "hold at risk our carrier battle groups ... [and] our entire surface fleet. They hold at risk our forward-deployed forces and land-based forces."

Without a way to respond in kind or defend against a hypersonic attack, he warned, means "our only response is either to let them have their way — or go nuclear", which, he added, is "an unacceptable situation for the United States."

The Pentagon's budget allocations and requests for hypersonic research demonstrate just how seriously military leaders now take pursuing this technology. Funding for hypersonics seesawed between $50 million and $100 million a year during the two decades following cancellation of NASP,

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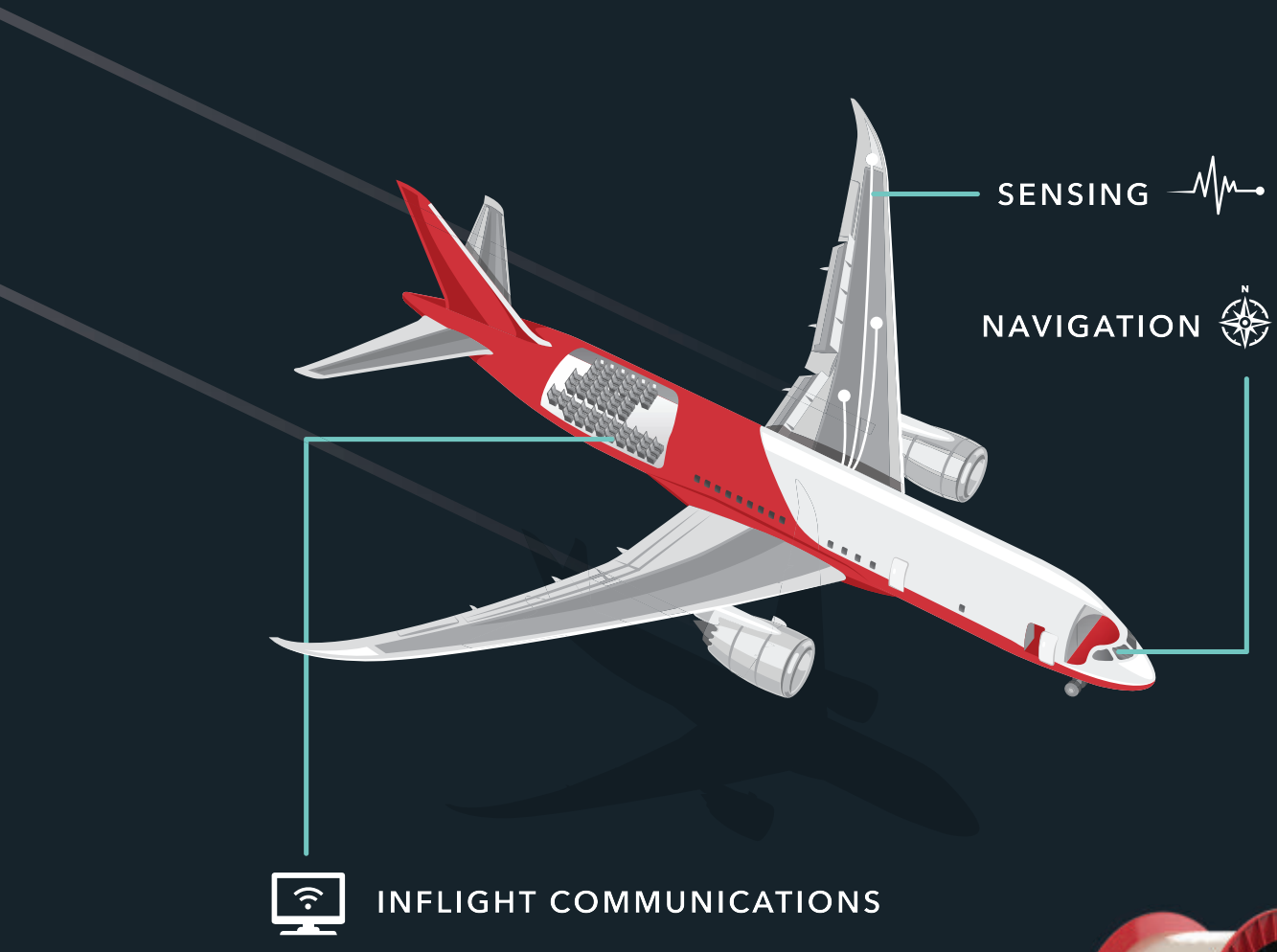

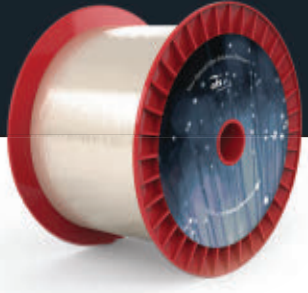

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The Generation Orbit X-60A project seeks to develop an affordable launch and propulsion system that could be applied to future hypersonic munitions and vehicles.

then ballooned to more than $250 million in the 2019 budget. That was dwarfed in the 2020 budget request, however, with $2.6 billion requested for hypersonics.

"As technology matures, it gets easier to fund," says Richard L. Aboulafia, vice president for analysis at market researcher The Teal Group in Fairfax, Va. "In the '60s, it would have been on the scale of the Manhattan Project in terms of cost. The thing to look for is areas where technology gets less costly to develop and mature and relevance remains high. That may be the case with hypersonics. It's not a technology issue; it's a money issue, although there may be show stoppers we don't know about with the horizontal air-breather," Aboulafia continues. "When it comes to something like this, it's all about the building blocks. A lot of that comes down to the materials."

This is where DARPA's MACH project comes in.

Advanced electronics cooling

"The purpose is to develop new leading-edge technologies for the front of the vehicle, which meets the atmosphere first, enabling it to go faster or go deeper into the atmosphere," DARPA's Carter explains. "Looking at it from a thermal management perspective, the design of the vehicle is dominated by heating at hypersonic speeds. These are topics that recently the electronics and program management world has started to address. A common holy grail in electronics is one kilowatt per square centimeter of heating, which is very similar to what is required for the leading edge of hypersonics.

"We're trying to advance the technology very quickly and develop a leading edge component that future designers can use in the vehicle," Carter continues. "The approaches you see there are things like heat pipes, which are used extensively in high-performance electronics."

Moving heat from hot components like microprocessors and leading-edge aeronautic structures also is a big issue. This is how trees keep cool through leaves and was applied to some of the earliest hypersonic platforms back in the 1950s. In addition, film cooling, which is used in turbine engine blades today, enables materials to survive in environments where they ordinarily would melt.

Carter says he hopes MACH will lead to development of a disruptive technology "that will get us on a new design curve that will transcend materials we use today, such as carbon/carbon composites. In a way, it's history coming back to us. Carbon/carbon was one reason we stopped working on thermal issues."

All the U.S. military services, academia, and corporate research organizations, are working on hypersonics and sharing information. Still, Pentagon leaders have expressed a strong aversion to creating a joint program such as the F-35 jet fighter. Instead of trying to create one system that can be all things to all users, U.S. Department of Defense (DOD) experts say they want several programs to solve technological challenges common to many service requirements, without adversely affecting individual programs. Dealing with a submarine-launched hypersonic missile, for example, could slow development of a missile designed for launch from a tracked vehicle.

Dispersing efforts across all military and non-military labs, could encourage a wide range of out-of-the-box thinking, experts say. This approach also allows

more inquiry into different approaches, such as a boost/glide system that launches a weapon or sensor payload like a ballistic missile to hypersonic speed, then glides down to its target.

Launch challenges

Another candidate is horizontally launched payload from an aircraft or missile, but with its own engines to maintain hypersonic flight and target changes. Military experts also are interested in a manned or unmanned system that takes off like an airplane, flies at hypersonic speed to a standoff position, launches hypersonic missiles, then returns to base for reload and another flight.

Recent and future advances several technologies are necessary to field true hypersonic systems. Those include high-temperature structures and materials; power and thermal management; solid rocket motors with high-energy propellants; advanced electronic guidance, navigation, and control systems; and advanced design and manufacturing techniques to build systems quickly and affordably.

"There are some efforts in space launch that may have applicability to hypersonics that could be useful for the military," AFRL's Miller notes. "The Hadley liquid rocket engine was developed by Ursa Major and will be used on the X-60A. The X-60A will provide flight research allowing affordable, routine and flexible access to hypersonic flight conditions. Like the X-15, the X-60A will provide a 'flying facility' to test and advance hypersonic technologies quickly, affordably and at relevant hypersonic flight conditions."

The Teal Group's Aboulafia says he expects China and the U.S. — and possibly Russia — to deploy boost/glide hypersonic systems in the next five to ten years, although that approach still will have all the problems of launching a ballistic missile, such as targeting and stabilization. This technology also is easier to defend against. The U.S., he says, is ahead in horizontal air-breathing technology, but deployment of that capability is further out, possibly the late 2020s or early 2030s.

"The Russians are talking a good game about doing something air-breathing, but they don't have the same resources as the U.S.," he says. "Air-breathing is all about the propulsion system. Some people think we're close to a

"SWaP is important because these are very constrained platforms," says DARPA's William Carter.

supersonic combustion ramjet [scramjet], but others think that's still far away."

"Hypersonics are fundamentally offensive and strategic," Aboulafia continues. "You won't use them for anything less than the highest-value targets. One school of thought says it is destabilizing because you don't have any reaction time. It's perfect for a unipolar world, which we don't have anymore and, technologically, the genie has a way of getting out of the bottle. The boost/glide approach involves a ballistic missile launch, which, alone, is a little disconcerting. But the full-up air-breathing, horizontal launch capability is the most destabilizing of all because it can appear just offshore of a capital city and you have less than a minute to decide what to do."

Defining research

The next five to ten years will be critical to the development of new and advanced technologies required for hypersonics, such as MACH.

"If we are successful, we can see dramatic improvements in the capability of these platforms in velocity, range, the atmospheric conditions we can fly in," Carter says. "We're also thinking about manufacturability, so I expect to see an industrial base to produce these structures. And we'll see American ingenuity come to the fore in other areas of hypersonics. One is how we model those, which is a cornerstone of how we develop systems. I expect to see dramatic advances not only in modeling materials but in modeling vehicles; model-driven design is being done today, but it's not as connected and powerful as we would like."

"You cannot recreate the conditions a hypersonic vehicle will experience in flight in the lab; there's always some kind of gap, but I believe we will close that gap. We have new tools in the toolbox, not only advances on the computational side, but in meeting the longstanding challenge of scaling. Nobody in the world can do this today, but I believe we will crack it. That will enable us to do small frames much more quickly and develop flight vehicles scaled up using the computational capabilities we're developing. For the first couple of iterations, we'll follow the discipline we have used for more than a century — crawl, walk, run — but we will be shortening that walking step very quickly."

At the same time, hypersonics requires greater care than other programs when it comes to making changes, both external and internal.

"Hypersonics is a very interconnected design process. Every change you make has to be connected to every other component, unlike building an airplane. With MACH, we're talking about a leading-edge technology that will improve the capability of the vehicle with very little redesign required," he says. "It's one thing to have an aeroshell on the leading edge, but you also have to have all the communications and other stuff on the inside protected from the heat of hypersonic flight. Just swapping out one component could leave you vulnerable to a thermal shift."

"Cooling is interesting because you are trying to get heat off a very hot vehicle. SWaP is important because these are very constrained platforms. Based on the aerodynamic principles involved and launch capabilities, you have a highly SWaP-constrained platform. So, advances in electronics, fuel and materials in general will be very important."

The U.S. Air Force and NASA X-15 achieved hypersonic flight more than 50 years ago in attempts to set new aircraft speed and altitude records through the atmosphere.

Thermal-management materials

A greater understanding of material composition and applications in just

the past five or so years has set the stage for a new century of development that could take hypersonic technology into areas never before considered.

"Our ability to model materials at the atomic scale is really emerging as a way to not only understand materials but to be predictive tools. When you marry that up with AI [artificial intelligence], we have a truly new way to approach materials development," DARPA's Carter says. "These new capabilities are very inspiring and I'm anticipating the next century will be just as exciting as the last in materials science as we integrate all that into multidisciplinary design, looking at how the mission may drive fundamental development. We've tried to model MACH on that new future, not only making new materials, but what is driving that development so sensible engineers will want to use them.

One area is new materials that involve compositionally complex alloys (CCAs). "For the past two centuries, we have looked at the periodic table and added small amounts of other materials," Carter says. "CCAs bring together at least five or more elements in an attempt to confuse nature that actually works. They have some interesting properties — high temp, anti-corrosion, fatigue, and toughness you don't see in traditional alloys. The story of composites really has yet to be written. Some of those have properties that could be very useful in building other aspects of the vehicle."

Other thermal-management design approaches, such as insulating and highly conductive materials to manage heat pathways inside of hypersonic vehicles also are of considerable concern. "In the world of thermal management, we are still making substantial inroads in ultra-high heat," Carter says. "The headroom to go to even higher heat flux and temperatures still has a long way to go."

Hypersonics Manhattan project?

The development of hypersonics has been likened to developing the atomic bomb, yet some say there are significant differences that may limit the number of nations attaining hypersonic capability even further.

> "The market would probably be close to nuclear level, but without the cultural taboo," said Aboulafa.

"The market probably would be close to the nuclear level, but without the cultural taboo. So, a country like Japan could have hypersonics where they wouldn't have nukes," says Teal's Aboulafia. "But the cost factor and technology base will keep the number of nations using hypersonics limited, maybe just to the U.S., China and Russia. It's hard to do something efficiently with a hypersonic, where nukes can be delivered by oxcart, as the saying goes. So, while Iran is working on nukes, it's hard to see what they would do with hypersonics."

There is another reason countries may opt not to develop hypersonic weapons — to avoid becoming preemptive targets. A nation with nuclear weapons, even if it does not have intercontinental ballistic missiles, forces potential adversaries to think twice about an attack. But hypersonic weapons without the added threat of nukes could encourage its enemies to attack first.

"It's basically an invitation for retaliation, sort of a less intimidating form of nukes," Teal's Aboulafia says.

The DARPA Falcon Project seeks to develop a reusable, rapid-strike hypersonic cruise missile, as well as a launch system to accelerate the weapon to hypersonic cruise speeds.

Connectors and cabling are crucial for eliminating single points of failure

Among the most common field failures in aerospace and defense electronics are connectors and cabling, which, if compromised, can spell the difference between mission success or mission failure.

BY **Jamie Whitney**

One point of failure can be all that stands between the best, most technologically advanced system on the battlefield and a very expensive paperweight. Industry experts and engineers are hard at work to ensure every portion of their systems — from under the ocean to space, from individual warfighters to multi-million-dollar systems — can withstand everything thrown at them, including components like cables and connectors.

"Modern warfare sees a plethora of electronic equipment being carried by soldiers, all with a variety of electrical requirements," says Mark Owen, director of product management/connectors at TT Electronics in Perry, Ohio. "These include radios, personal digital assistants (PDAs), GPS units, laser and optical rangefinders, video cameras and much more. This is sometimes referred to as the Christmas tree effect, whereby more and more items just keep being added and hung onto a soldier's battle vest. But in the heat of battle the last thing soldiers want to do is struggle with circular barrel connectors, which are often the most common point of failure."

Amphenol SMP high-frequency subminiature board-to-board connector system for blind-mate applications.

With wearable technology, TT Electronics offers its mag-Net electrical connector. The Woking, England-based company says mag-Net is an auto-aligning, self-coupling connector "designed for the 21st century soldier." "Intended for equipment connection to soldier-worn garments and load-carrying systems, these types of designs must provide mechanical latching with no moving parts for reliable, jam-free operation," company officials say. "Together with an ultra-lightweight, no-bulk design that maximizes mobility and eliminates cable snag hazards, these systems feature abrasion-resistant, flush-flat receptacles are virtually self-cleaning and require no protective caps, ensuring maximum durability and full environmental-sealing, both in mated and unmated conditions."

The mag-Net plug connector can be fitted to equipment such as personal role radios (PRRs) or batteries, providing a direct connection to the vest. Plugs feature 'pogo' spring contacts, machined from copper alloy, for high-mating-cycle resilience and easy cleaning, with an optional first-mate, last-break contact configuration. At the rear, PCB tail contacts provide for flex-print or regular PCB termination. An 'O'-ring gasket and blind holes ensure environmental sealing when the plug is fitted into an equipment box or enclosure.

For cable connections, there is an over-molded flying lead assembly, which is EMC shielded to MILSTD461 and Def Stan 59411. Cable plugs can be over-molded to match any color requirement including Multicam, MTP, and Coyote. Equipment and cable plugs are available in either latching

Annapolis Micro Systems Inc VPX backplane with integrated SMPM VITA 67.3 connectors from SV Microwave.

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or non-latching versions and the standard garment receptacle can accept either type. An 8-way contact configuration supports power up to 8A and USB 2.0 high-speed data transmission. Cable plugs can be oriented to allow for cable entry in any direction.

Under pressure

ITT Cannon in Irvine, Calif., provides harsh-environment interconnects and cable assemblies for industries like commercial aerospace and military, as well as industrial, medical and transportation end markets. The company specializes in cable assemblies including RF, LF Power, HV, and mixed-signal packages, fiber optic cable harnesses, micro- and nano-interconnect assemblies and data bus harnesses. In addition, Cannon manufactures custom and standard coaxial, optical fiber, ribbon, flex and power cable assemblies.

ITT Cannon takes wearable connectors to new heights — scratch that — new depths as its Nemisis II CBA 20M+ generation miniature circular interconnects is designed and tested to be submerged as deep as 66 feet.

The Nemesis II CBA 20M+ blends high speed, high mating, and quick termination to perform in extreme conditions and harsh environments, making it suitable for battlefield communication devices and applications such as manpack- and hand-held radios. The Nemesis II CBA 20M+ enables power, signal and data in a smaller, more robust and integrated design package, helping warfighters reduce physical load, maintain communication and receive mission-critical information.

The connector is made with a stainless-steel shell with high-temperature plastic, and a copper alloy contact. The contact is plated with gold and can operate from -55 to 125 degrees Celsius.

Sub-mini

Amphenol RF in Wallingford, Conn., has introduced its SMP high-frequency subminiature board-to-board connector system for blind-mate applications in instrumentation and broadband applications. The SMP includes several bullet adapters and a straight cable plug. The SMP series operates at DC to 26.5 GHz making it suitable for applications that require high data rate transmission, such as broadband, instrumentation, and telecommunications applications.

L-Com high temperature Ethernet cables

The SMP bullet adapters feature a straight plug to plug (with female, socket contacts) in-series configuration and are available in lengths of 6.45, 6.96, 9.90, 13.16, 14.5, and 22.4 millimeters. These 50-Ohm bullets are constructed with gold plated beryllium copper and are designed to compensate for radial and axial misalignment.

The straight cable plug on the connectors is optimized for RG-178 and RG-196 cable and joins the previously released right-angle version. This connector features push-on coupling.

Ready when you are

Pasternack in Irvine, Calif. provides RF, microwave, and millimeter wave products. The company has introduced a line of military-grade MIL-DTL-17 RF cable assemblies for avionics, military electronics, satellite ground stations, and autonomous vehicles. In addition, Pasternack is offering same-day shipping on numerous products.

Pasternack's series of military-grade cable assemblies consists of 124 basic configurations from six different cable types for a total of more than 700 part numbers that are all available for same-day shipment. These cables provide operating frequencies to 12.4 GHz and voltage standing wave ratio (VSWR) as low as 1.3:1 per connector. They are made from MIL-DTL-17-qualified cable, MIL-PRF-39012-qualified connectors, AS23053 heat shrink, and J-STD soldering. The final commercial off-the-shelf (COTS) cable assemblies are 100 percent tested and include test report, as well as material lot traceability. They are suitable for defense, aerospace, and transportation applications, or any other place where the cost of failure is high.

"We are excited to offer this new line of cable assemblies with such a high service level. In the past, customers would wait weeks or months for cables built to these specifications and with traceability. Now, they can select from hundreds of different COTS solutions and have the cables shipped same-day with test reports," says Dan Birch, product manager at Pasternack.

The company also has unveiled a series of low-PIM coaxial cable assemblies that has 18 standard configurations with PIM levels of less than -160 dBc. This product line is made with lightweight, flexible UL910 plenum-rated SPP-250-LLPL RF coaxial cable which can operate in temperatures from -55 to 125 C. They are offered with the following connector types: 4.3-10, 7/16 DIN, 4.1/9.5 mini-DIN and Type-N, which also include right-angle connector options.

These high-quality cables deliver low insertion loss and excellent VSWR,

MilesTek 1-Stub Compact Box Coupler

are 100 percent RF and PIM tested, and come with the PIM test results marked on the cables. In addition to DAS systems, these cables are for indoor wireless systems, wireless infrastructure, multi-carrier communication systems, WISP networks, small cell installations and PIM testing applications.

"The launch of this product line not only gives us the opportunity to provide our customers with high-quality, low-PIM cable assemblies, but now we're also able to deliver them in standard and custom lengths with same-day delivery," says Steve Ellis, Pasternack product manager.

Take a break

ODU-USA in Camarillo, Calif., offers a break-away connector in its ODU AMC circular connector, which also has a locking option, an aluminum shell, and operating temperature from -51 to 125 C.

ODU connectors are suitable for soldier communication systems, unmanned systems, and military vehicles. In solder wearables, ODU officials say their connectors are suitable for helmet-mounted cameras and displays, headset, battery packs, GPS, mission computer, body diagnostic sensors, radio, rifle-mounted systems, as well as wrist-worn displays. In addition, ODU officials note that their connectors offer high vibration resistance and are shock resistant.

MilesTek inline bus coupler

ODU also offers its Advanced Threaded Connector Technologies, which provide a reliable connectivity solution for all military applications that require an additional degree of security or where environmental conditions including temperature, pressure or vibration would be problematic.

The ODU Threaded Connector Solutions are available in different individual contact configurations: signal, low/high voltage, coax/triax. Additional product features include: wide temperature range, high vibration resistance, up to 2,000 mating cycles, IP68, mechanical coding with matched color coding, various standard inserts available, reliable high-speed data transmission, lightweight and easy to handle, cable assembly integrated solutions.

Viva VITA

Annapolis Micro Systems Inc. in Annapolis, Md., is integrating SMPM VITA 67.3 connectors from SV in several high-performance embedded computing boards, for maximum RF signal density and speed to the VPX backplane.

The Annapolis Microsystems board products and connectors SV Microwave in West Palm Beach, Fla., for phased array radar, cyber security, network processing, DRFM, beamforming, sensor processing, wireless communication, and radar signal processing.

The SV Microwave RF connectors are a dense and rugged high-speed coax solution that is aligned with the Sensor Open Systems Architecture (SOSA) standard. The connectors are available in 11- and 14-port modules that accept coaxial cable as large as 0.086 inches, with SMPM minimum pitch of 0.228 inches.

The blind-mate VPX backplane connectors are available on versions of the Annapolis Microsystems WILDSTAR 6U OpenVPX baseboards; WILDSTAR 3U OpenVPX baseboards; and WILDSTAR clock cards, which are shipping now.

The VITA 67.3 connectors mount side-by-side with other

standard VITA connectivity, including VITA 66 optical connectors and MULTIGIG RT3 connectors, which support embedded computing throughput of 25 gigabits per second.

"The SV Microwave connectors give us a combination of performance, high reliability, and VITA and SOSA standardization," says Noah Donaldson, chief technology officer of Annapolis Micro Systems.

TE Connectivity's MULTIGIG RT 3 connectors also conform to VITA 46 industry standards with its ruggedized design these connectors suited to withstand many extreme military, aerospace, and space environments.

MULTIGIG RT 3 connectors employ quad-redundant contacts to meet VITA standards for performance under intense vibrations. Each MULTIGIG RT 3 connector is made of durable, lightweight thermoplastic and copper alloys.

MULTIGIG RT 3 connectors integrate with other VPX products. They conform to VITA 46 industry standards, making them backwards compatible with legacy OpenVPX systems. Furthermore, their modular design enables numerous configurations by interchanging higher-speed RT 3 connectors with the legacy MULTIGIG RT 2 and RT 2-R connectors.

TE's MULTIGIG RT 3 connectors are designed for military electronics, C4ISR (Command, Control, Communications, Computers and Intelligence [C4]; Information, Surveillance, Recon [ISR]) electronic warfare systems, avionics, ground defense, missile defense and systems designed for outer space.

Pasternack MIL-DTL-17 RF cable assemblies.

Making the connection

Last fall, L-com Global Connectivity in North Andover, Mass., a manufacturer of wired and wireless connectivity products, announced a line of high-temperature-rated Ethernet cables for aerospace and demanding high-temperature applications.

These cable assemblies feature special FEP jackets that are rated to operate n temperatures from -55 to 150 C, as well as double cable shielding with both 100 percent foil and 85 percent braid shields that provide EMI and RFI protection.

The cables are offered off-the-shelf in Cat6a, Cat5e and Cat5e slim construction variants and comply with all RoHS directives

"These robust cables are for use in cabin management, in-flight systems, backbone avionics, ground vehicle trunks, high-temp testing and for general military, avionics, or aerospace use," says L-com Product manager Dustin Guttadauro. "We now offer these hard to find cables off-the-shelf to address our customer's urgent delivery requirements."

Fairview Microwave Inc. in Lewisville, Texas, a supplier of on-demand microwave and RF components, has launched a product line made-up of 45 BMA connectors with VSWR as low as 1.2:1, and seven BMA adapters with VSWR as low as 1.15:1. Typical

ODU Break-away connectors.

applications include blind mating, RF backplanes, rack and panel connectivity, high-speed switching and use in phased array systems.

Fairview's line of 54 BMA connectors and BMA adapters provide a maximum operating frequency of 22 GHz. They feature 50 Ohm impedance, gold-plated BeCu contacts, and an operating temperature range of -65 to 125 C. Radial and axial float is offered in many of the models to help with alignment. Commercial versions are constructed of brass and military versions are made of stainless steel. Hermetic versions also are available.

"Our new BMA connectors and adapters make a great addition to our already extensive interconnect product line. As BMA interfaces are deployed globally, and have been for years, there is great need for these products across a wide variety of applications," says Fairview Product Manager Dan Birch.

Standard bearers

MilesTek in Lewisville, Texas, has been a trusted source of for the design and production of MIL-STD-1553B devices and supporting equipment for more than three decades, including custom designs and special requests.

ODU threaded connectors.

The MilesTek box-style coupler can be single-, double- or non-terminated and offer a robust and rugged solution for military, aerospace and commercial applications. The company also offers an inline stub coupler mainly for use in airborne applications. According to MilesTek, its inline bus couplers offer the performance and utility of a box-style coupler in a smaller form-factor. ←

COMPANY LIST

Advanced Interconnections Corp.
West Warwick, R.I.
www.advanced.com

AE Petsche Co.
Arlington, Texas
www.aepetsche.com

Aerospace Aviation 360
Pittsburgh, Pa.
www.aerospace-aviation360.com

AirBorn Inc.
Georgetown, Texas
www.airborn.com

Amphenol
Wallingford, Conn.
www.amphenol.com

Carlisle Interconnect Technologies
St. Augustine, Fla.
www.carlisleit.com

Coaxial Components Corp (Coaxicom)
Stuart, Fla.
www.coaxicom.com

Data Bus Products
Manhasset, N.Y.
www.databusproducts.com

Delphi
Washington
www.delphi.com

Diamond USA
North Billerica, Mass.
www.diausa.com

Digi-Key Electronics
Thief River Falls, Minn.
www.digikey.com

Eaton
Camarillo, Calif.
www.eaton.com/interconnect

Esterline
Bellevue, Wash.
www.esterline.com

Fischer Connectors
Alpharetta, Ga.
www.fischerconnectors.com

Harwin Inc.
New Albany, Ind.
www.harwin.com

HIROSE Electric
Downers Grove, Ill.
www.hirose.com

Huber+Suhner Inc.
Charlotte, N.C.
www.hubersuhner.com

IEH Corp.
Brooklyn, N.Y.
www.iehcorp.com

Interstate Connecting Components
Lumberton, N.J.
www.connecticc.com

Ironwood Electronics
Eagan, Minn.
www.ironwoodelectronics.com

ITT Cannon
Irvine, Calif.
www.ittcannon.com

Kensington Electronics
Austin, Texas
www.keiconn.com

LEMO USA
Rohnert Park, Calif.
www.lemo.com

March Electronics Inc.
Bohemia, N.Y.
www.marchelectronics.com

MilesTek
Denton, Texas
www.milestek.com

Mill-Max
Oyster Bay, N.Y.
www.mill-max.com

Molex
Lisle, Ill.
www.molex.com

ODU-USA
Camarillo, Calif.
www.odu-usa.com

OFS
Norcross, Ga.
www.ofsoptics.com

Omnetics Connector
Minneapolis
www.omnetics.com

Pasternack Enterprises
Irvine, Calif.
www.pasternack.com

PAVE Technology
Dayton, Ohio
www.pavetechnologyco.com

PIC Wire & Cable
Sussex, Wis.
www.picwire.com

Positronic
Springfield, Mo.
www.connectpositronic.com

Powell Electronics
Swedesboro, N.J.
www.powell.com

Reflex Photonics
Kirkland, Q.C.
www.reflexphotonics.com

Schurter Inc.
Santa Rosa, Calif.
www.schurterinc.com

Smiths Interconnect
Stuart, Fla.
www.smiths.com

Southwest Microwave
Tempe, Ariz.
www.southwestmicrowave.com/interconnect

SV Microwave
West Palm Beach, Fla.
www.svmicrowave.com

TE Connectivity
Berwyn, Pa.
www.te.com
www.designsmarterfaster.com

Timbercon Inc.
Tualatin, Ore.
www.timbercon.com

TT Electronics
Perry, Ohio
www.ttelectronics.com

Winchester Interconnect
Norwalk, Conn.
www.winconn.com

WL Gore & Associates
Landenberg, Pa.
www.gore.com

Russia's radar surveillance aircraft can track 300 targets at once

Russia's new ultra-modern spy-in-the-sky plane has been dubbed the flying mushroom thanks to its distinctive appearance. Despite the less-than-fearsome moniker, the aircraft is seen as far superior to Western models - and it has completed its first flight trials, say reports. The aircraft is nicknamed The All-Seeing Eye and carries some 20 tons of unique surveillance equipment. The new Beriev A-100 plane has been dubbed the flying mushroom thanks to its distinctive look. It has a distinctive rotating radar dome above the fuselage and has also been dubbed the flying mushroom. Until now, the sophisticated aircraft has been kept largely under wraps. Its capabilities far exceed Russian and foreign counterparts, including the [Boeing] E-3 AWACS aircraft of the U.S. Air Force, Russian officials say.

GaN-SiC high-power amplifier for SATCOM downlinks introduced by Arralis

Arralis Ltd. in Castletroy, Ireland, is introducing the Leonis series gallium nitride-silicon carbide (GaN-SiC) high-power amplifier optimized for satellite communications (SATCOM) downlink systems. Applications include 5G communications, airborne high-speed Wi-Fi, low-Earth orbit mega constellation communications, drone constellations and SAT-Drone-Ground data networks, satellite-to-automotive connectivity, connected vehicles, last mile and remote internet solutions, IoT, and M2M communications. The GaN-SiC part is matched to 50 Ohms with integrated DC-blocking capacitors on RF ports and incorporates an output power detector to assist with system integration. For more information contact Arralis online at https://arralis.com.

Low-band radar may be able to detect stealth aircraft like the F-35. Today's jammers may be able to take this kind of radar out.

L-3 and Northrop Grumman to upgrade low-band jammers to foil anti-stealth radar

BY **John Keller**

PATUXENT RIVER NAS, Md. – U.S. Navy aerial electronic warfare (EW) experts are asking two prime defense contractors to improve components of experimental low-band tactical RF jammers intended to enable Navy EA-18G Growler carrier-based aircraft to foil enemy counter-stealth radar systems.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., have announced plans to award contract modifications to L-3 Technologies Communications Systems-West in Salt Lake City, and the Northrop Grumman Corp. Mission Systems segment in Bethpage, N.Y., for the Next Generation Jammer Low Band (NGJ-LB) program.

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

The effort is called NGJ-LB Increment 2 Demonstration of Existing Technologies (DET), and aims to increase the Navy's knowledge and understanding of existing technologies able to support an airborne wideband low radio frequency

(RF) band jamming application where significant SWaP and cooling constraints exist, such as those on the EA-18G.

EW experts at L-3 and Northrop Grumman will expand their analyses and design NGJ-LB controller, receiver, exciter (CRE), and power generation subsystems to carry out updated Navy program goals. L-3 and Northrop Grumman won a $35.8 million contract and a $35.2 million contract, respectfully, last October.

Low-band anti-stealth radar can be useful for detecting stealth aircraft like the U.S. F-35 joint strike fighter and B-2 bomber, and is needed urgently for the EA-18G, which virtually is the only dedicated electronic warfare aircraft in the U.S. inventory.

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

The contractors will help the Navy determine the milestone entry point for introducing low-band tactical jammer technologies to the Next-Generation Jammer, which is to replace the aging ALQ-99 tactical jammer on the EA-18G aircraft for airborne electronic attack.

The goal is to develop system-level alternatives for the best possible maritime electronic warfare capabilities, while making the most of existing and projected technologies.

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

The Navy will demonstrate these technologies on station 6 of the F/A-18E used as a surrogate for the EA-18G aircraft at Patuxent River NAS for antenna and radar cross section measurement. ←

For more information contact L-3 Communications Systems-West online at www2.l3t.com/csw, Northrop Grumman Mission Systems at www.northropgrumman.com.

General Dynamics to build additional WIN-T wide-area networking and military communications systems

BY **John Keller**

ABERDEEN PROVING GROUND, Md. – Military communications experts at General Dynamics Corp. will build components of the U.S. Army's tactical communications network backbone that provides data, voice, and video communications on the battlefield under terms of an $11.6 million contract.

Officials of the Defense Logistics Agency Land and Maritime division at Aberdeen Proving Ground, Md., awarded the multi-year tactical networking contract to General Dynamics Mission Systems in Taunton, Mass., for the Warfighter Information Network-Tactical Increment 1 system, which provides data, voice, and video communications to battalion and above echelons using satellite communications (SATCOM).

General Dynamics has received another contract to manufacture components of the U.S. Army's tactical communications network backbone that provides data, voice, and video communications on the battlefield.

WIN-T Increment 1, which was fielded between 2004 and 2011, establishes a network backbone that provides data, voice and video communications to battalion and above echelons using satellite communications nodes that set up at-the-quick-halt. General Dynamics is the WIN-T Increment 1 prime contractor.

Similar to a home Internet connection, WIN-T Increment 1 enables soldiers to pull over on the side of the road to communicate without setting up complicated infrastructure. It has three types of transportable network nodes that provide high-speed wide-area networking for secure voice, video and data exchange on the battlefield.

The Tactical Hub Node (THN) supports division headquarters; the Joint Network Node (JNN) supports brigade-level headquarters; and the Battalion Command Post Node (BnCPN) supports battalion-level headquarters. The fourth type of node, the Regional Hub Node (RHN), is a fixed installation equivalent to three THNs and supports theater-level operations.

WIN-T Increment 2 provides on-the-move capability and a mobile infrastructure with military and commercial SATCOM, as well as line-of-sight radios and antennas. It extends the network to company level for maneuver brigades.

WIN-T Increment 2 began fielding in October 2012. Army units that can operate with at-the-halt networking will continue using WIN-T Increment 1, while mobile units will receive WIN-T Increment 2, which enables mobile mission command from division to company in a mobile, ad-hoc, self-forming, self-healing network.

Later, WIN-T Increment 3 will develop network-operation software to simplify management of the tactical communications network to make communications systems easier to install, operate, maintain, and defend.

On this contract General Dynamics will do the work in Taunton, Mass., and should be finished by January 2021. For more information contact General Dynamics Mission Systems online at https://gdmissionsystems.com, or the Defense Logistics Agency Land and Maritime at Aberdeen Proving Ground at www.dla.mil/LandandMaritime/Locations/Aberdeen.

Army seeks to design vehicle-mounted sensors to detect and destroy small UAVs

BY **John Keller**

PICATINNY ARSENAL, N.J. — U.S. Army researchers are searching industry to find companies able to design vehicle-mounted sensors able to detect and track enemy small unmanned aerial vehicles (UAVs) and hand off targeting information quickly to other systems to shoot the UAVs down, or otherwise disable them.

Officials of the Army Contracting Command-New Jersey at Picatinny Arsenal, N.J., have issued a request for information (W15QKN19X05YK) for the Ballistic Low Altitude Drone Engagement (BLADE) 360 Degree Detection System.

The goal is to design vehicle-mounted sensors able to detect Group 1 UAVs over 360 degrees while the host vehicle is moving or parked. A Group 1 UAV weighs less than 20 pounds, can fly as high as 1,200 feet above the ground, and at speeds slower than 100 knots.

The Army Contracting Command is issuing this request for information on behalf of the Army Combat Capabilities Development Command (CCDC) Armaments Center at Picatinny Arsenal.

The sensor must be able to provide real-time alerts to targeting radar aboard nearby vehicles, helicopters, fixed-wing aircraft, of fixed sites. The cueing sensor could be radar or electro-optical sensors, and must be mountable to a wide variety of Army combat vehicles, ranging from Humvees to Abrams main battle tanks.

Army researchers want the UAV-detecting cueing sensor to be small, lightweight, affordable, and suitable for stationary and on-the-move operations.

Initial prototype sensors must be able to detect small UAVs out to a distance of nearly two miles; localize the target in azimuth and elevation to an accuracy of about 7.5 degrees; update at a rate of 1 Hz; be able to track five targets at once; must be able to differentiate small UAVs from birds; and work during the day, at night, and in bad weather.

Sensors should work on no more than 1 kilowatt of vehicle power; must be industrial-ruggedized; and provide data through standard communications channels.

Ultimately, Army researchers want a sensor that can localize the target within 7.5 degrees azimuth and elevation; detect targets at distances as far as more than three miles; detect at least 10 targets simultaneously; and be ruggedized to military specifications.

From industry, Army experts want to know how long it would take to develop such a cueing sensor; realistic enabling technologies; approximate costs; and alternatives for design approaches. ←

Companies interested were asked to email white papers by 10 May 2019, to the Army's Antonius Gill at antonius.gill.civ@mail.mil and to Elizabeth Horak at elizabeth.a.horak2.civ@mail.mil. More information is online at https://www.fbo.gov/notices/295f8755e33d97ad9e0005273d1fbb56.

The U.S. Army is looking for new enabling technologies for vehicle-mounted sensors that can detect and track enemy small UAVs and hand off targeting information to shoot them down.

Wanted: companies to build spacecraft, sensor payloads, and on-board data processing for small satellites

BY **John Keller**

WASHINGTON — U.S. intelligence researchers are surveying industry for companies able to design and build small satellites (smallsats) spacecraft, sensor payloads, on-board computer processing, and other subsystem technologies that range in maturity from basic concepts to demonstration by simulation.

Officials of the U.S. Intelligence Advanced Research Projects Agency (IARPA) in Washington have released a request for information (IARPA-RFI-19-05) for Innovative Technologies for Small Satellites project. IARPA experts want information on innovations in space-based research to mature the state of the art for smallsats.

This RFI is asking industry for capability statements on smallsats, subsystem technologies, and data collection and processing capabilities that are assessed to be at Technology Readiness Levels 1 to 6. IARPA is the research arm of the U.S. Office of the Director of National Intelligence.

Small satellites have a mass less than 1,102 pounds (500 kilograms), and are for low-cost applications with two-to-three-year delivery times from concept to launch. IARPA is seeking further reductions of the cost, risk, complexity, mass, and time to launch of small satellite technologies.

IARPA is asking industry to identify candidate smallsats technologies with game-changing potential, and validate these technologies in space or in a laboratory space simulation. Technologies must demonstrate capabilities not previously demonstrated with smallsats or in space.

IARPA also is trying to accelerate improvement or create new smallsat capabilities in machine autonomy, advanced communications, remote observation, space-based sensors, automated data processing, object recognition, or other on-board data processing and distribution capabilities. In addition, IARPA is asking industry to identify key technologies that incubate and enhance the market for smallsats.

Enabling technologies of interest include temporal and spectral imaging; synthetic aperture radar; artificial intelligence (AI); machine learning; on-board processing for payload and communications applications; RF and optical payload technologies; data fusion; complete spacecraft and smallsat constellations; command and data handling; mission operations; thermal management and cooling; power; propulsion; navigation; and autonomous operations.

IARPA is surveying industry for companies able to design small satellites, sensor payloads, and on-board computer processing.

Companies interested should email 10-page white papers in .PDF format no later than 31 May 2019 to IARPA at dni-iarpa-rfi-19-05@iarpa.gov. Email questions or concerns to IARPA's Torreon Creekmore at dni-iarpa-rfi-19-05@iarpa.gov. More information is online at https://www.fbo.gov/notices/c9ba24de15368045140df1a12bf58c09.

Military eyes megawatt-class laser weapon for ballistic missile defense

BY **John Keller**

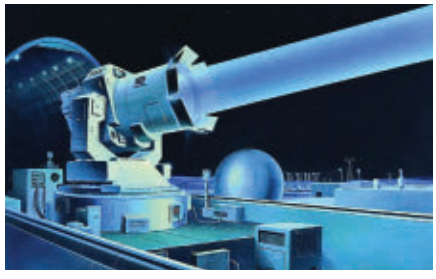
FORT BELVOIR, Va. — U.S. missile-defense researchers will brief industry later this month on a project to build a prototype megawatt-class laser weapon within the next seven years that can destroy incoming ballistic missiles, potentially in all phases of flight.

The Ballistic Missile Defense System (BMDS) Laser Scaling project of the U.S. Missile Defense Agency (MDA) will develop a prototype laser weapon system that will weigh no more than about four tons, including the laser, electric power, and thermal management subsystems. The project's focus is on reducing size and weight, and increasing power, electrical-to-optical efficiency, beam quality, and lasing runtime.

MDA officials have issued a request for information (HQ0277-19-RFI-0001) for the BMDS Laser Scaling project in efforts to understand industry's ability to demonstrate a 1,000-kilowatt electrically pumped laser sometime between 2025 and 2026.

Researchers also are interested in electrical power and thermal management subsystems for the prototype, and are not yet providing a specific platform or strategic mission. It is to be a ground demonstrator laser with technology maturation and light-weight engineering paths to potential future applications.

MDA officials envision a laser weapon able to shoot down incoming ballistic missiles with near diffraction-limited beam quality at 1 megawatt of laser power with a vertical beam quality of 1.1 at 0.25 lambda/D. It should have a laser wavelength shorter than one micron to offer high intensity on the target at long ranges.



The U.S. Missile Defense Agency is trying to develop one of the most powerful laser weapons within the next seven years.

The system should have a mass efficiency of two to four kilograms per kilowatt, including electric power and thermal management. Early prototypes may have a lower mass efficiency as long as they have clearly defined paths to increase mass efficiency.

The electrical-to-optical efficiency goal is at least 48 percent, and continuous laser shot durations must be from 2 to 60 seconds. The prototype must have an energy storage system able to supply power for two minutes at full power without recharging. ←

Email responses to the MDA BMDS Laser Scaling request for information no later than 5 June 2019 to Joseph Bonometti at joseph.bonometti@mda.mil, with a copy to Harris Brown at harris.brown@mda.mil.

For questions or concerns telephone Joseph Bonometti at 505-853-4324, or Harris Brown at 505-853-3307. More information is online at https://www.fbo.gov/notices/d476336c92b54a0c-3d5c92d508e34978.

British Army to buy Black Hornet 3 unmanned helicopters for surveillance

FLIR Systems Inc. in Wilsonville, Ore., has been awarded a $1.8 million contract by the British Army to deliver a tiny unmanned helicopter called the FLIR Black Hornet 3 Personal Reconnaissance System (PRS). Units delivered under the contract will support platoon- and troop-level surveillance and reconnaissance capabilities. They also will be used in part for a test and evaluation of nano Unmanned Aircraft System (UAS) capabilities to enhance warfighters' situational awareness on the front lines. At 32 grams (about 1.3 ounces) with a flight time up to 25 minutes, the nearly silent, pocket-sized Black Hornet 3 transmits live video and high-definition still images back to the operator. Its information feed provides soldiers with immediate covert situational awareness to help them more effectively complete their mission. FLIR has delivered more than 7,000 Black Hornets to military customers worldwide.

Cal-Berkeley builds photonic switch array for optical communications

Engineers at the University of California, Berkeley have built a photonic switch that can control the direction of light passing through optical fibers faster and more efficiently than ever. This optical "traffic cop" could one day revolutionize optical communications, and how information travels through data centers and high-performance supercomputers that are used for artificial intelligence and other data-intensive applications. The photonic switch is built with more than 50,000 microscopic "light switches," each of which directs one of 240 tiny beams of light to either make a right turn when the switch is on, or to pass straight through when the switch is off.

IARPA considers data fusion in multispectral imaging for intelligence analysis

BY **John Keller**

WASHINGTON — U.S. intelligence experts are considering a project to blend data from satellite-based multispectral imaging sensors and visible-light sensors to detect heavy building projects and highway construction from space.

Officials of the U.S. Intelligence Advanced Projects Agency (IARPA) in Washington issued a draft broad agency announcement (IARPA-BAA-19-04) for the Space-based Machine Automated Recognition Technique (SMART) project.

SMART will rely on geographical information from satellite cameras to develop multi–spectral and multi–temporal sensor processing to overlay data from infrared and multispectral sensors.

Many space and airborne sensors today can provide imagery suitable for geographical intelligence (GEOINT). SMART will demonstrate that GEOINT gleaned through data fusion is greater than previous methods.

While one sensor may have resolution sufficient to detect changes and man-made disturbances, intelligence experts still struggle with the inability to analyze images over time because of infrequent satellite orbits or weather cover. IARPA experts want to push the technology state of the art in high-performance analytics that scales to extremely large data sets; data mining, ranking and visualization; and image analyst tools like automated searches. ←

IARPA asked companies to review program details by 10 May 2019. More information is online at https://www.fbo.gov/notices/7dfd4ff68f5ece7c52871d91e05889ff.

The IARPA Space-based Machine Automated Recognition Technique (SMART) program seeks to blend multispectral and visible-light sensor data to detect construction projects from space.

PRODUCT applications

MISSION COMPUTERS

Navy taps Northrop Grumman for mission computers on AH-1Z, UH-1Y, and UH-60V helicopters

Avionics and flight computer experts at Northrop Grumman Corp. will provide as many as 503 new VME-based FlightPro Gen III scalable mission computers for UH-1Y, AH-1Z, and UH-60V military helicopters of the U.S. Marine Corps. and government of Bahrain.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are awarding the Northrop Grumman Mission Systems segment in Woodland Hills, Calif., a $104 million contract for as many as 503 technical refresh mission computers for Bahrain, the Marines, and for off-the-shelf spares at the U.S. Defense Logistics Agency.

The Northrop Grumman Gen III mission computers are the heart of the company's integrated avionics system that powers the glass cockpit avionics of the UH-1Y Venom and UH-60V Black Hawk utility helicopters, as well as the and AH-1Z Viper attack helicopter.

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

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

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

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

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

Dual mission computers are part of Northrop Grumman's integrated avionics aboard the AH-1Z, UH-60V, and UH-1Y. The mission computers provide centralized control of the helicopter avionics, displays, situational awareness, and health monitoring.

Additionally, the helicopter avionics and mission computers can accommodate future system upgrades; rapid insertion of new technologies; and integration of other avionics, communications, and survivability equipment. Northrop Grumman also provides the operational flight program software that controls the AH-1Z, UH-60V, and UH-1Y avionics.

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

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

ELECTRONIC WARFARE

Northrop Grumman gets order to build RF jammers to defend troops from IEDs

Electronic warfare (EW) experts at Northrop Grumman Corp. are building additional open-architecture RF jammers for infantry, land vehicles, and fixed sites to protect U.S. and allied warfighters from radio-controlled improvised explosive devices (IEDs).

Officials of the U.S. Naval Sea Systems Command in Washington announced a $245 million order to the Northrop Grumman Mission Systems segment in Herndon, Va., for Joint Counter-Radio-Controlled Improvised Explosive Device Electronic Warfare (JCREW) increment one block one (I1B1) systems full-rate production.

The JCREW I1B1, formerly known as JCREW 3.3, is the first-generation system that develops a common open architecture across all three capabilities and provides protection for worldwide military operations, officials say.

This integrated design for RF jammers makes the most of commonality across all capabilities, reduces life cycle costs, and provides increased

protection against worldwide threats, Navy officials say. It is for the U.S. Marine Corps, Navy, and Air Force, and is under supervision of Naval Sea Systems Command.

This order is a modification to a $57.7 million contract announced in July 2017 for JCREW I1B1 full-rate production. Last July Northrop Grumman won a $96.5 million JCREW I1B1 production order, a $23.2 million order in December 2017, and a $267.7 million order in September 2018. The original contract has options that could increase its value to $505.3 million.

CREW systems provide combat troops protection against radio-controlled IEDs, and are designed to provide protection for foot soldiers, vehicles, and permanent structures, Navy officials say.

Among the JCREW I1B1 systems is the Northrop Grumman Freedom 240 for Counter Radio-controlled IED Electronic Warfare Marine Expeditionary Unit Special Operation Capable (SOC), or CREW MEU.

The system jams a wide range of IEDs and creates a protective barrier around Marine Corps infantry and their equipment while minimizing disruption to friendly communications systems.

On this contract Northrop Grumman will do the work in San Diego and in Sierra Vista, Ariz., and should be finished by August 2022. For more information contact **Northrop Grumman Mission Systems** online at *www.northropgrumman.com*, or **Naval Sea Systems Command** at *www.navsea.navy.mil*.

SHIPBOARD NAVIGATION

Ultra Electronics to develop software-defined radar for shipboard navigation

U.S. Navy Surface warship radar experts needed requirements for a new software-defined surface-search radar system to replace existing radars that suffer from obsolescent technologies or an inability to meet current threats. They found their solution from the Ultra Electronics Ocean Systems segment in Braintree, Mass.

Officials of the Naval Surface Warfare Center Port Hueneme Division at Port Hueneme, Calif., announced a $28 million contract to Ultra Electronic Ocean Systems on Friday to develop Next Generation Surface Search Radar (NGSSR) qualification systems.

Navigation and situational awareness are basic functions of all surface warships and these seemingly routine tasks have become more difficult as the ocean becomes increasingly complex with the proliferation of inexpensive solid-state radar, Navy officials say.

Major shipping channels are jammed with ship and radio traffic as well as debris like floating transport containers. Even small fishing boat and pleasure craft operators today can afford navigation radar systems. Air traffic and land-based radar further crowd and confuse the radio spectrum.

To make matters worse, enemy ships, aircraft, and unmanned aerial vehicles (UAVs) can exploit this complex sensor picture to conduct surveillance or other operations undetected. The answer, experts say, will be the NGSSR.

This new radar will use of the latest digital technology and incorporate a software-based architecture at its core. NGSSR will have a suite of algorithms that extend, enhance, and optimize NGSSR's performance by exploiting the system's software-defined architecture.

The NGSSR's receiver and exciter will be implemented in software to the maximum extent possible, Navy officials say. The bulk of the non-processor hardware will be for A/D and D/A conversion, except for ancillary equipment like power supplies. Its software-defined capabilities are expected to enhance maintainability by reducing radar-specific hardware.

Its software-defined architecture also could implement functionality never before considered for such relatively simple rotating radar, such as extending the radar's range and navigation functions in bad weather; resisting enemy electronic warfare attempts to jam it; detecting UAVs, periscopes, floating debris, and floating mines; and improving collision avoidance in crowded waterways.

The new NGSSR software-defined radar ultimately will replace all variants of the Navy's current AN/SPS-67, AN/SPS-73, BridgeMaster E series, and commercial-of-the-shelf radar systems.

Ultra Electronics will help find a replacement for legacy systems due to current military threats and obsolescence issues. The contract aims to outline the requirements and approach for NGSSR development, testing, and manufacturing. This contract to Ultra Electronics has options that could increase its value to $34.6 million.

The AN/SPS-67 is a short-range, two-dimensional, surface-search and navigation radar system that provides surface and limited low-flyer detection and tracking. the AN/SPS-73(V)12 radar, likewise, is a short-range, two-dimensional, surface search and navigation radar system that provides contact range and bearing information, and helps determine own-ship position relative to nearby vessels and navigational hazards. The BridgeMaster E surface- search radar, meanwhile, provides navigation to commercial and military high-speed crafts and vessels.

The AN/SPS-73(V)12 is installed on about 100 Navy ships. ←

EMBEDDED COMPUTING

FPGA-based XMC for high-bandwidth data processing introduced by X-ES

Extreme Engineering Solutions Inc. (X-ES) in Verona, Wis., is introducing the XPedite2500 conduction- or air-cooled Switched Mezzanine Card (XMC), based on the Xilinx Kintex UltraScale field-programmable gate array (FPGA) for user-customizable, high-bandwidth data processing applications. The XPedite2500 offers a range of high-density and high-bandwidth I/O, and can interface to and process streaming data from a wide variety of inputs. The computer module for high-bandwidth data processing has as many as two x8 PCI Express Gen3 interfaces and as many as eight gigabytes of DDR4-2400 SDRAM available in four 32-bit channels. The x8 PCI Express Gen3 interface on the P16 connector optionally can be replaced with as many as eight High-Speed Serial (HSS) ports. LVDS I/O is available via P16, and an optional P14 connector can provide additional LVDS and LVCMOS I/O. The X-ES FPGA Development Kit (FDK) is provided to support high-performance, real-time, embedded, streaming-data applications and simplify FPGA development. For more information contact **X-ES** online at *www.xes-inc.com*.

ARTIFICIAL INTELLIGENCE

Joining forces on embedded computing for artificial intelligence

Curtiss-Wright Corp. and General Dynamics Corp. are joining forces to develop artificial intelligence (AI) commercial off-the-shelf (COTS) embedded computing hardware and software for signals intelligence (SIGINT) and electronic warfare (EW) situational awareness applications. Officials of the Curtiss-Wright Defense Solutions division in Ashburn, Va., announced they are collaborating with the General Dynamics Mission Systems segment in Fairfax, Va., for AI-based mission-critical embedded computing. Joining the General Dynamics SignalEye threat-detection software and Curtiss-Wright's Intel Xeon D processor-based CHAMP-XD1 embedded computing module provides system designers with a deployable COTS solution for RF spectrum situational awareness that automatically classifies signals by using machine learning. "By combining our SignalEye machine learning software with Curtiss-Wright's CHAMP-XD1 processor, we can provide warfighters with a greater understanding of the RF threats on the battlefield," says Bill Ross, vice president of RF and broadband products at **General Dynamics Mission Systems**.

MACHINE LEARNING

Design and development tool for machine learning introduced by Abaco

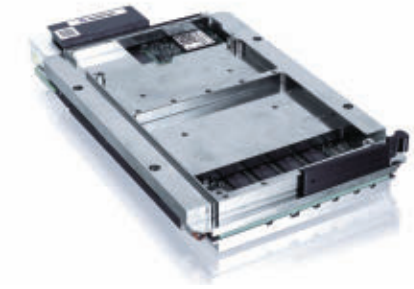
Abaco Systems in Huntsville, Ala., is introducing the Obox design and development evaluation system to help embedded computing designers reduce the time, expense and risk, of developing autonomous systems for military applications on land, in the air, and on the ocean. The rugged enclosure operates in temperatures from -40 to 71 degrees Celsius, and houses combinations of Abaco's latest 3U VPX single-board computers, field-programmable gate arrays (FPGAs), digital signal processors (DSPs), general-purpose graphics processing units (GPGPUs) to deliver as much as 14 TeraFLOPS of computing power. The Obox also has high-speed network switches to capture the input from sensors like lidar, radar, and cameras over Ethernet. It also drives actuators to control velocity and trajectory. The design and development system enables autonomous operations like detection, recognition, tracking, fusion, perception, planning, decision making, and effecting. The Obox uses Xeon processors from Intel; CUDA-enabled GPUs from NVIDIA; and FPGA technology from Xilinx. Software integration at the ground- and node layers enables designers to pre-consolidate image-processing and neural-network algorithms for machine learning and autonomous vehicle applications. For more information contact **Abaco Systems** online at *www.abaco.com*.

CHASSIS AND ENCLOSURES

OpenVPX embedded computing development chassis introduced by Elma

Elma Electronic Inc. in Fremont, Calif., is introducing the D-Frame OpenVPX development chassis to enable engineers not only

to build and deploy embedded applications quickly, but also to collaborate and share resources. The system can help design and demonstrate activities like board design, application development, data flow analysis, and troubleshooting in defense and rugged industrial environments. The D-Frame development system enables engineering teams to share knowledge and capabilities. As the embedded computing Sensor Open Systems Architecture (SOSA) and the Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) Modular Open Suite of Standards (CMOSS) become more widespread, the need for fast application development and collaboration among several departments will grow. The system can accommodate several board counts in 3U and 6U form factors, enabling developers to incorporate different backplanes from Elma's broad product line — several of which are OpenVPX-based and align with CMOSS requirements and the emerging SOSA standard. For more information contact **Elma Electronic** online at *www.elma.com.*



BOARD PRODUCTS

Intel Xeon-D-based 3U OpenVPX board for image processing introduced by Kontron

Kontron America Inc. in San Diego is introducing the VX305H-40G 3U OpenVPX single-board computer for high-performance sensor systems and demanding military signal- and image-processing applications. The VX305H-40G uses the Intel Xeon-D microprocessor and 40/10 Gigabit Ethernet networking in a package that aligns with the Sensor Open Systems Architecture (SOSA) standard, and is compatible with the U.S. Army Command, Control, Communications, Computers, Intelligence, surveillance and

PRODUCT & LITERATURE SHOWCASE

Reconnaissance (C4ISR) / Electronic Warfare (EW) Modular Open Suite of Standards (CMOSS) standard. Designed to the VITA 65 slot profile SLT3-PAY-1F1F2U1TU1T1U1T-14.2.16 compute-intensive embedded computing board profile, the VX305H-40G combines the computational power of the 12-core Intel Xeon D-1559 processor with several high-performance data pipes, including a 40 Gigabit Ethernet data plane, a second 10 Gigabit Ethernet data plane, a 10 Gigabit Ethernet control plane, and an 8-lane PCI Express Gen 3 expansion plane port. Other features of the VX305H-40G include a Kontron-designed VITA 46.11-compatible intelligent platform management controller (IPMC) to provide systemwide health management, sequenced system power-up, and temperature/power/performance management to handle image processing and other applications. For more information contact **Kontron** online at *www.kontron.com*.

INTERCONNECT PRODUCTS

Annapolis outfits boards with SV Microwave SOSA-aligned connectors

Annapolis Micro Systems Inc. in Annapolis, Md., is integrating SMPM VITA 67.3 connectors from SV Microwave in West Palm Beach, Fla., in several

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high-performance embedded computing boards, for maximum RF signal density and speed to the VPX backplane. The Annapolis Microsystems board products and SV Microwave connectors are for phased array radar, cyber security network processing, DRFM, beamforming, sensor processing, wireless communication, and radar signal processing. The SV Microwave RF connectors are a dense and rugged high-speed coax solution that is aligned with the Sensor Open Systems Architecture (SOSA) standard. The connectors are available in 11- and 14-port modules that accept coaxial cable as large as 0.086 inches, with SMPM minimum pitch of 0.228 inches. The VITA 67.3 connectors mount side-by-side with other standard VITA connectivity, including VITA 66 optical connectors and MULTIGIG RT3 connectors, which support embedded computing throughput of 25 gigabits per second. For more information contact **Annapolis Micro Systems** online at *www.annapmicro.com*, or **SV Microwave** at *www.svmicrowave.com*.

DATA BUSES

Upgraded MIL-STD-1553 avionics databus terminal introduced by DDC

Data Device Corp. (DDC) in Bohemia, N.Y., is introducing an upgraded version of the BU-67743LC Nano-ACE RT MIL-STD-1553 avionics databus terminal, to offer increased 32K-by-17 RAM including parity capability, autonomous built-in self-test, and the option to auto-initialize from an external EEPROM. The Nano-ACE BC/RT/MT uses a fast 50 MHz Serial Peripheral Interface (SPI) to reduce pin count and ultra-small package that enables systems designers to create more compact and higher density boards. The DDC Mini-ACE series has been in operation since 1999 with more than 800 million hours of in-service history. The BU-67833LC Nano-ACE's efficient 3.3-volt transceivers minimize power consumption and heat dissipation, enabling further avionics board miniaturization using smaller power and heat sinking components. Benefits include interoperability with a wide variety of processors; four-wire interface; 7-by-7-millimeter QFN package; can replace two transceivers, MIL-STD-1553 protocol core, and memory; support for BC or RT or monitor modes, and RT/monitor modes; built-in self-text with autonomous operation; and Software and register compatibility with ACE, Mini-ACE, Enhanced Mini-ACE, Micro-ACE, and Mini-ACE Mark3 series remote databus terminals. For more information contact **DDC** online at *www.ddc-web.com*.

RF AND MICROWAVE

Low-noise amplifiers for radar and test systems introduced by Pasternack

Pasternack Enterprises Inc. in Irvine, Calif., is releasing a line of input-protected low-noise amplifiers with no damage up to 30 decibel milliwatts (dBm) continuous wave input power for radar, electronic warfare (EW), military

microwave radio, wireless and satellite communications, and test and measurement instrumentation. The input-protected low-noise amplifiers consists of 12 different models that cover frequency bands ranging from 10 MHz to 3.5 GHz. These designs exhibit typical performance that includes low noise figure levels from 0.8 to 1.6 decibels, high-small signal gain ranging from 25 to 40 decibels, and voltage standing wave ratio (VSWR) levels from 1.3:1 to 1.5:1. This performance comes from hybrid microwave integrated circuit designs that incorporate PIN diode limiter circuitry and enhancement mode (Emode) gallium arsenide (GaAs) pseudomorphic high electron mobility transistor (pHEMT) semiconductor devices. These low-noise amplifiers operate with a bias voltage of 12 volts typical over temperatures from -40 to 85 degrees Celsius. For more information contact **Pasternack** online at *www.pasternack.com*.

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