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High-power microwave warfare PG. 4

Radiation-hardened electronics for space PG. 28

JUNE 2022

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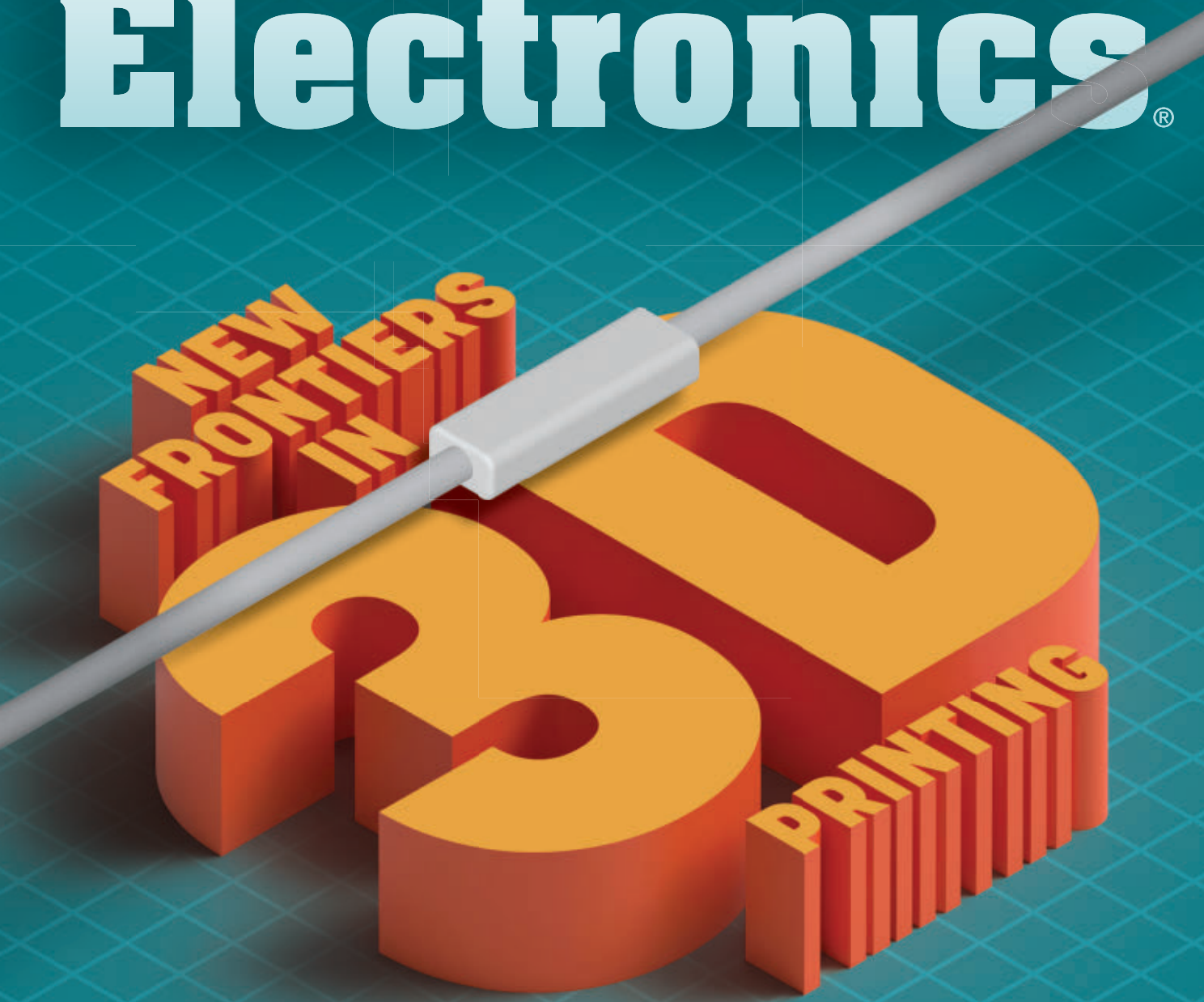

Military relies on additive manufacturing for systems designs and prototyping.

PG. 18

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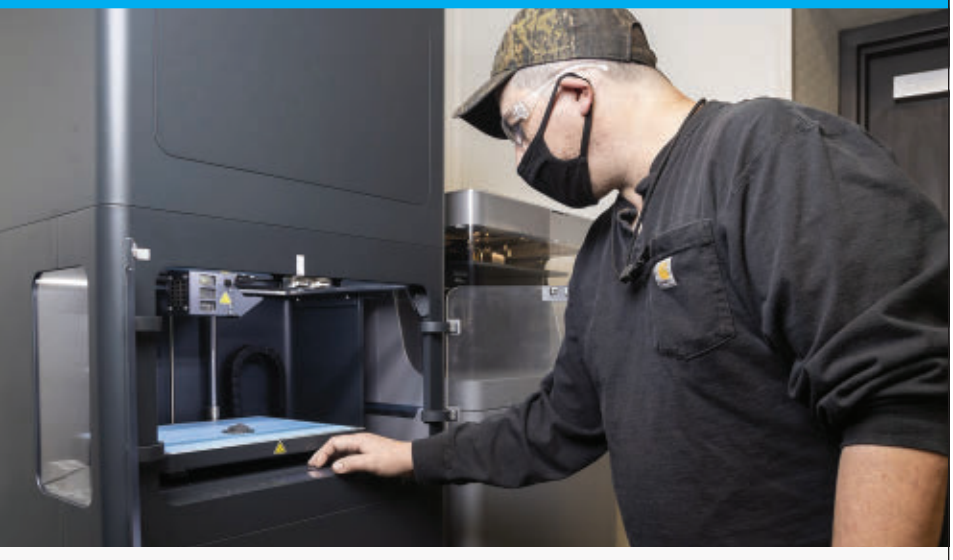

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Costs and reliability are main issues of NewSpace vs. traditional space

BY **John Keller**
EDITOR IN CHIEF

The concept of NewSpace, which describes largely private initiatives to place constellations of relatively inexpensive networked satellites in low-Earth orbit (LEO), is changing the definition of radiation-hardened electronics.

Where rad-hard used to involve exquisite satellite designs of expensive long-duration satellites, today it is evolving rapidly to mean good enough for expected space radiation exposure, with some extra testing and upscreening, with no gold plating.

This approach can involve some added risk, but industry consensus is that the expected risks are worth it. Traditional radiation hardened by design parts often lag at least one generation behind the state of the art, and sometimes more. Calculated risk can be worth the tradeoff for access to some of the latest and most powerful commercial off-the-shelf (COTS) processors, data conversion, power conditioning, and data storage components available.

These current and future constellations, such as the SpaceX Starlink, Amazon Project Kuiper, the Hughes Jupiter satellite constellations, the British OneWeb, and others, will rely on redundancy, shielding, error-correcting software, and other approaches to mitigate the effects of radiation-induced effects, but not always prevent them.

In today's space market, NewSpace is where the action is; this is the thrust of this month's Special Report in-depth feature on page XX. New space describes future large constellations of relatively low Earth orbit satellites with built-in redundancy and on-orbit spares to recover from spacecraft and system failures with few problems and at relatively low costs.

Suppliers for NewSpace applications often start with commercial off-the-shelf parts, as our Special Report feature details, and alter or special-test these parts to enable the parts to tolerate the radiation and space environment for a limited amount of time, in the interests of relative low costs and access to some of the latest generations of computer technologies.

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

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

Those involved in new space rarely are over-concerned with component longevity and flawless performance, because the relatively low costs of this market allow for on-orbit spare satellites.

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

Although demand today has become relatively soft, applications still exist for the most radiation-hardened electronics parts, despite their typically high costs, lag in technology, and long wait times. The market for large expensive satellites that must operate in high geosynchronous orbits (GEO) is stable, but not growing.

Linear InGaAs Optical Receiver Lab Buddy with Automatic Gain Control up to 56 Gbaud

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The DSC-R421 is available in Discovery's computer-controlled Lab Buddy instrument, where several critical parameters can be controlled and monitored locally or remotely using Standard Commands for Programmable Instruments (SCPI) compatible commands via standard RS232C-over-USB interface. The DC photocurrent can be monitored continuously over a nano-ampere (nA) to milli-ampere (mA) range on the Lab Buddy's digital display or via a custom GUI provided by Discovery. Additionally, the GUI can be used to control different functions of the DSC-R421 Lab Buddy.

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Industry asked for high-power microwaves, sensors, testing for electromagnetic warfare

BY John Keller

The Air Force is looking for test methods to determine the effects of next-generation electromagnetic warfare weapons.

KIRTLAND AIR FORCE BASE, N.M. – U.S. Air Force electromagnetic warfare experts are asking industry to perform vulnerability testing on several electronic systems to help determine the effectiveness of potential high-power electromagnetic (HPEM) weapons.

Officials of the Air Force Research Laboratory Directed Energy Directorate at Kirtland Air Force Base, N.M., have issued a broad agency announcement (FA9451-22-S-0001-CALL-002) for the High Power Electromagnetics (HPEM) Empirical Effects project.

HPEM Empirical Effects seeks to find a waveform for an effective electromagnetic weapon that is small size, weight, and power consumption (SWaP). This weapon is to help validate modeling tools and techniques.

This testing will involve a plan that describes appropriate instrumentation and sensors, best practices and industry standards, test and measurement approaches, cables, and sensors for the project.

This work will include capturing effects and waveform data, identifying new targets, developing surrogate electronic systems for testing, purchasing representative electronic subsystems, developing fault trees, building probability of effect curves for the electronic subsystems, and planning outdoor effects tests to characterize electromagnetic weapon effectiveness.

Electromagnetic weapons involve high-power microwaves and electromagnetic pulse (EMP) systems that are designed to destroy enemy electronics. The High Power Electromagnetics (HPEM) Empirical Effects project is part of the Air Force's High Power Electromagnetics Modeling and Effects program.

To a lesser degree, the HPEM Empirical Effects project will include research and tools that can help predict the effectiveness of HPEM waveforms by developing and testing of emerging technologies and state-of-the-art HPEM technologies to collect vulnerability data.

Work will include performing effectiveness modeling, including developing, executing, and validating computational models, to assess the effectiveness and military utility of an HPEM weapon, characterizing collateral damage, developing recuperation time models, and performing trade studies to compare different HPEM weapons.

This work will provide information to develop, identify, and integrate new and existing software and hardware for battle damage assessment and recuperation time, and battle damage indicators for an HPEM engagement. The Air Force will choose one company for this project, which could be worth as much as $20 million over the next five years.

Companies interested were asked to upload proposals by 16 June 2022 to the DOD SAFE website at https://safe.apps.mil. Companies should email their intents to submit proposals to the Air Force's Adan Dominguez at adan.dominguez.2@us.af.mil, or Julian Landavazo at julian.landavazo@us.af.mil. ←

Email questions or concerns to the Air Force Research Lab at afrl.rdh.acquisitionsmailbox@us.af.mil. More information is online at https://sam.gov/opp/efa1b1c4737c45c4999c2b33b8675d52/view.

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Industry to develop human-machine interface for autonomy in satellite control

BY **John Keller**

KIRTLAND AIR FORCE BASE, N.M. – U.S. Air Force researchers are asking industry to develop new kinds of human-machine interfaces to enable machine autonomy in reconnaissance satellite control that could enhance global surveillance capabilities.

▲ Air Force researchers want to increase the amount of machine autonomy technology in satellite-control facilities.

Officials of the Space Control Technology Branch of the air Force Research Laboratory Space Vehicles Directorate at Kirtland Air Force Base, N.M., have released a solicitation (FA9453-21-S-0001) for the Space Technology Advanced Research - Fast-tracking Innovative Software and Hardware (STAR-FISH) project.

The solicitation involves call four of the STAR-FISH project — Human to Machine Interface for Autonomous Satellite Systems — which seeks to enable seamless and agile human-machine interaction by establishing trust among satellite operators, and to boost satellite autonomy capabilities with advanced human-machine interface technology.

Air Force researchers seek to collaborate with industry to develop and integrate game-changing space capabilities by developing a new human-machine interface for autonomous satellite systems.

This collaboration is expected to enable the U.S. Air and Space forces to optimize machine autonomy and decision support with new features in advanced human-machine interfaces for satellite control.

Researchers are asking industry to submit white papers that outline human-machine interface concepts for autonomous satellite systems, as well as ways to modify existing satellite autonomy and control technologies.

As an example, researchers could set up one or more satellites in test beds to perform an inspection or docking orbit around another cooperative satellite. The system is envisioned to have three controllers: a primary automatic or autonomous controller;

a backup controller provided through a run time assurance wrapper; and a human operator.

In addition to these automatic controllers, the human operator will be able to override with a scripted command. The run time assurance watches the primary controller and scripted controller, and intervenes with a backup control when it detects a need to intervene to prevent satellite collisions and maintain satellite camera pointing restrictions.

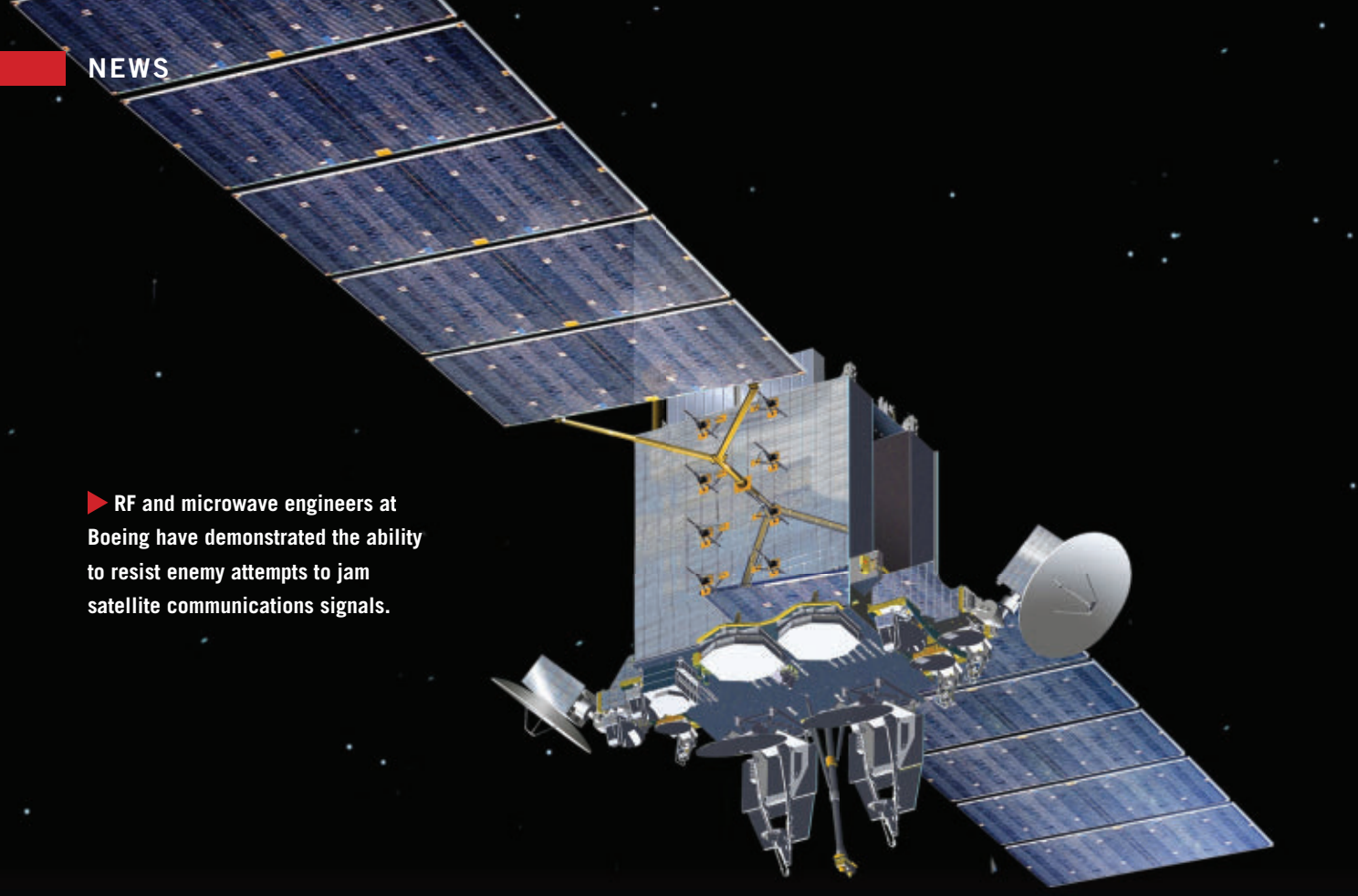
This training scenario will help scope the prototype human-machine interface work for this contract to create an intuitive human-machine interface that facilitates understanding and projection of the autonomous controller while making the most the directability and shared awareness among the human operator and the satellite autonomy capability.

This human-machine interface will be written in a widely available programming language such as Javascript, Java, Python, C, or C++; describe the physical characteristics of the operator interface, control, and design approach; provide transparency of autonomous control algorithms to include current state and projected future state; display run-time assurance outputs such as status of failure and interlock conditions; provide data to the autonomous controller such as fuel limits per mission, fuel limits per maneuver, time limits, optimal time to complete, and illumination requirements; and will display autonomous outputs such as status of failure and interlock conditions.

Industry white papers must describe the overall approach for developing a human-machine interface for an autonomous satellite; and software issues such as virtualized or containerized software using an industry-standard virtualization or containerization technology such as Docker.

Those submitting promising white papers will be invited to submit formal proposals. Companies interested were asked to upload white papers by 9 June 2022 to DoD Safe online at https://safe.apps.mil. Email contract specialist Avion Lourde at avion.lourde.1@spaceforce.mil at least three days before uploading to get a DoD Safe drop-off request.

Email questions or concerns to Avion Lourde at avion.lourde.1@spaceforce.mil; Robert Jefferis at robert.jefferis.1@spaceforce.mil; Michelle Simon at Michelle.simon.1@spaceforce.mil; or Michael Lopez at michael.lopez.44@us.af.mil. More information is online at https://sam.gov/opp/87dd122fc73e415d8f9c23682177bfc1/view.



RF and microwave engineers at Boeing have demonstrated the ability to resist enemy attempts to jam satellite communications signals.

Boeing demonstrates ground-based anti-jam satellite communications technology

BY Jamie Whitney

COLORADO SPRINGS, Colo. - The Boeing Co. in Chicago demonstrated ground-based anti-jam satellite capability the U.S. Space Force. The integrated Protected Tactical Enterprise Service (PTES) software works in-sync with a partner's terminal.

PTES is the ground-based anti-jam capability the U.S. Space Force is developing within the Protected Anti-Jam Tactical SATCOM (PATS) portfolio. Boeing also is developing a spaced-based PTW hub called the Protected Tactical SATCOM Prototype (PTS-P).

PTES provides ground-based Protected Tactical Waveform (PTW) processing, which enables secure operations and protected communications coverage over Wideband Global SATCOM (WGS) satellites – and eventually on commercial satellites – without spacecraft modification. PTW, the U.S. military's jam resistant waveform, provides security features for data protection.

The system mitigates interference and adversarial jamming for high-data-rate satellite communications in contested environments, which provides resiliency and enabling missions in otherwise denied areas.

"This incremental system demonstration provides valuable feedback from Space Force operators and other members of the user community, reducing development and integration risk, while ensuring system capabilities are adaptable to change," says Troy Dawson, Boeing's vice president of Government Satellite Systems. ←

"We're committed to the Space Force's mission to rapidly develop and deploy technology at operationally-relevant speed," Dawson continues. "Our PTES program demonstrates how stakeholder collaboration and agile development enable continued advancements to meet the evolving threats on the battlefield."

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Boeing and Honeywell move forward on F-15 computer avionics upgrades

BY John Keller

WRIGHT-PATTERSON AFB, Ohio – Military avionics experts at the Boeing Co. are starting full-rate production on Advanced Display Core Processor (ADCP) II in the avionics of the U.S. Air Force F-15 combat jet under terms of a $59.3 million order announced in April.

Officials of the Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, are asking the Boeing Defense, Space & Security segment in St. Louis to carry out full-rate production for the ADCP II mission computer. Boeing will oversee production and integration of the ADCP II boxes and related equipment into the F-15 aircraft.

Boeing is the prime systems integrator for all versions of the F-15 Eagle combat jet. The ADCP II flight computer comes from the Honeywell Inc. Aerospace segment in Phoenix.

The computer is based on commercial technology and provides multi-core processing capabilities. Its high-speed processing and interface designs enable advanced systems integration, increased mission effectiveness, augmented fault-tolerance, enhanced system stability, and aircrew survivability, Air Force officials say.

▲ Boeing and Honeywell have moved to full-rate production of the Advanced Display Core Processor (ADCP) II avionics computer for the U.S. Air Force F-15 jet fighter.

The ADCP II is pivotal to F-15 jet fighter upgrades to enable the 1970s-vintage aircraft to help maintain U.S. air superiority for the F-15's anticipated life cycle through 2040.

The computer provides mission processing for new advanced capabilities such as Eagle Passive/Active Warning Survivability System (EPAWSS), long-range infrared search and track capability (IRST), high-speed radar communications, and future software suite upgrades. ←

On this order Boeing will do the work in St. Louis; several other continental U.S. operating locations; and Lakenheath, England. For more information contact Boeing Defense, Space & Security online at www.boeing.com/company/about-bds, or the Air Force Life Cycle Management Center at www.aflcmc.af.mil.

Massachusetts-based airline invests in all-electric Alice aircraft

Eviation Aircraft, a global manufacturer of all-electric commuter aircraft based in Arlington, Wash., and Massachusetts-based Cape Air, a commuter airline, have announced plans to buy 75 all-electric Alice commuter aircraft. Eviation unveiled the Alice aircraft at the 2019 Paris Air Show. The Arlington, Wash.-based company worked with partners Honeywell (flight-by-wire systems), Siemens (EPUs), Hartzell (propellers), magniX (EPUs) and Magnaghi Aeronautica (LG) in outfitting the electric aircraft. The electric flyer can move the 11 people and a maximum payload of 2,500 pounds on board at 240 knots to a range up to 650 miles. Eviation says its Alice is the first FAR23 aircraft with a fly-by-wire, fully electronic flight control system with touchscreen displays. Alice is powered by a magniX-manufactured electric motor. "Truly sustainable aviation not only reduces the impact of air travel on the environment but also makes business sense," says Jessica Pruss, Vice President of Sales at Eviation. "Cape Air remains committed to sustainability, growth, and innovation, and our partnership with Eviation allows for these commitments to become a reality," adds Cape Air President and CEO Linda Markham.

TSA debuts state-of-the-art checked baggage inspection system at Long Beach Airport

The U.S. Transportation Security Administration (TSA) has completed certification on an upgraded automated checked baggage inspection system (CBIS) to screen the checked luggage of travelers departing Long Beach Airport near Los Angeles. The installation coincides with the completion of a new ticketing lobby, which opened to passengers last month. Both projects are part of recent upgrades to LGB's airport facilities. The CBIS features a network of conveyor belts that sorts and tracks travelers' checked luggage, moving it seamlessly from the airline ticket counter, through the security screening process and onto the area where the luggage is loaded onto the aircraft. By law, TSA is required to screen all checked luggage for explosives and other security threats that could be catastrophic on an aircraft. "This new, high-capacity upgrade will ensure that TSA's screening operations are efficient while delivering the highest level of security, which is something travelers have come to expect," says TSA Federal Security Director Keith Jeffries who oversees agency operations at LGB.

Army researchers eye unmanned and machine autonomy for special forces

BY John Keller

FORT DETRICK, Md. – U.S. Army researchers are asking industry to develop enabling technologies for battlefield situational awareness, reconnaissance and surveillance, and location technologies of potential benefit to special forces warfighters.

Army researchers are asking industry to develop a variety of sensing and unmanned systems technologies for special forces warfighters.

Officials of the Army Contracting Command at Fort Detrick, Md., issued a sources-sought notice last Friday (W911SR-22-S-NGIA) for the Next Generation Identification and Awareness Initiative (NGIA).

This is for companies interested in participating in projects sought by the United States Special Operations Command (USSOCOM) at MacDill Air Force Base, Fla., to develop state-of-the-art technologies in tagging, tracking, and locating; reconnaissance and surveillance; and unmanned systems. The NGIA seeks to develop special operations prototypes for demonstration and evaluation.

Tagging, tracking and locating involves ways to gain knowledge of when, where, and what the enemy is doing for mission planning in attacking high-value enemy warfighters and targets.

Solutions should provide over-the-horizon and line-of-sight day and night target tracking for long periods using ground-based, airborne, or satellite sensors. Of special interest are low-probability-of-intercept and -detection communications, new ways of removing soldiers from the battlefield, and new ways to survive austere high-conflict environments.

Reconnaissance and surveillance involves new ways to gain intelligence in areas where the terrain, weather, political sensitivities, and hostile forces make intelligence gathering difficult. This will involve new kinds of unattended ground sensors with machine vision and object recognition to gather

audio and video. These sensors should be able to evade enemy countermeasures.

Unmanned systems involve sensors on the ground and aboard small uncrewed aerial vehicles (UAVs) that weigh no more than 55 pounds. These sensors must be able to foil enemy attempts to eavesdrop on or jam their RF signals. Machine autonomy capabilities on these small UAVs should help reduce operator workload, and help these UAVs evade enemy attempts to jam, capture, or destroy them. ←

Companies interested should email capabilities and questions no later than 1 April 2025 to the Army's David Shriner at david.j.shriner3.civ@army.mil. For additional questions or concerns, contact the Army's Richard Totten by email at richard.w.totten2.civ@army.mil, or by phone at 301-619-2446. More information is online at https://sam.gov/opp/c069c6510a284e19907d3b409778155b/view.

TruWeather, Iris Automation team for ground-based weather surveillance for uncrewed aircraft

TruWeather Solutions in Reston, Va., and Iris Automation in Reno, Nev., will combine technologies in Iris Automation's Casia G ground-based surveillance system (GBSS). TruWeather is a data and analytics firm, while Iris Automation is an avionics safety technology company. This meshed network will provide real-time integrated communications, collision avoidance and micro-weather data to operators. Micro weather or low-altitude local atmospheric conditions can often substantially differ from that in higher altitudes, injecting uncertainty into the safety equation. This can significantly impact uncrewed aircraft systems (UAS) and advanced air mobility (AAM) operations and revenue. Incorporating weather sensors into Iris Automation's non-radar based passive ground based system, Casia G, simply made sense for both companies. Casia G is a ground-based detect and avoid solution, to allow operators to better detect approaching aircraft and avoid collisions.

Starlink is coming to Hawaiian Airlines in a bid to try and fix in-flight Wi-Fi

SpaceX is starting to make deals with airlines to provide its Starlink satellite internet to sky travelers everywhere. It announced a deal on Monday with Hawaiian Airlines, and has made a similar deal with charter carrier JSX. None of the involved parties shared the financial details of their deals, but both airlines did say they're planning to offer the in-flight Wi-Fi for free, which is both a semi-miraculous fact and a sign of hope that free Wi-Fi is becoming the industry standard. Delta meanwhile, confirmed last week that it's running "exploratory" Starlink tests. In Starlink's low-Earth orbit constellation of satellites, the latest of which use a laser mesh network, Hawaiian found its solution to ensure reliable, high-speed, low-latency connectivity on transpacific flights. Guests will be able to stream content, play games live with friends on the ground, work and collaborate in real-time, plan their vacation, or share their special island moments on social media. Connecting to the internet will be seamless when guests walk on board, without registration pages or payment portals. Hawaiian and Starlink are in the initial ←

Alliant Techsystems to redesign circuit card for AARGM-ER missile

BY John Keller

PATUXENT RIVER NAS, Md. – U.S. Navy airborne electronic warfare (EW) experts needed a company to design a new guidance processor circuit card assembly for the AGM-88G radar-killing missile. They found their solution from Alliant Techsystems Operations LLC, a subsidiary of Northrop Grumman Corp., in Northridge, Calif.

▲ The AARGM-ER radar-killing missile is set for a facelift with a redesigned guidance processor circuit card assembly that meets open-systems standards guidelines.

Officials of the Officials of the U.S. Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking Alliant Techsystems to redesign the guidance processor circuit card assembly of the AGM-88G Advanced Anti-Radiation Guided Missile-Extended Range (AARGM-ER) anti-radar missile.

Navy experts are asking Alliant Techsystems to use the open-system-architecture approach in support of the AGM-88 air-to-ground missile program, Navy officials say.

The new circuit card is part of a form, fit, and function replacement in the control section of the AARGM-ER. For this project Northrop Grumman experts will use an open-systems architecture approach.

The missile upgrade project also includes the integration and delta qualification of the NAVSTRIKE-M Global Positioning System (GPS) receiver and reprogramablity functionality on completion of an advanced configuration of the AGM-88E anti-radar missile.

The new circuit board design for the AARGM-ER will address parts obsolescence, system security enhancements, reprogramablity, and support future growth capabilities using an open-systems architecture. Improvements will be cut into the AGM-88G production during low-rate initial production (LRIP) III.

The Navy is awarding this order to Northrop-Grumman sole-source because the company, as the AARGM-ER prime contractor, is considered to be the only responsible source and no other supplies or services will satisfy military requirements.

The AGM-88G AARGM-ER is an advanced radar-killing missile designed to enable the Navy F/A-18G Growler and F-35C jet fighter-bombers, as well as the U.S. Air Force F-35A jet fighter-bomber, to suppress enemy air defenses preceding bomber attacks.

The AARGM-ER is an advanced and extended-range version of the High-Speed Anti-Radiation Missile (HARM). It is a new variant of the AGM-88E missile that equips Navy carrier-based fighter-bombers and electronic warfare jets. HARM was a replacement for the AGM-45 Shrike anti-radiation missile, which was in service from 1965 to 1992.

AARGM is a supersonic, medium-range, air-launched tactical missile compatible with U.S. and allied strike aircraft. The AARGM-ER missile features several upgrades to the AGM-88E that focus on extending the weapon's operational range and survivability.

The AARGM-ER replaces the missile's rocket motor and tail to increase its range, while keeping the sensors and electronics of the AARGM-88E, which are being upgraded in a separate project. The AARGM-ER missile is scheduled to achieve initial operating capability (IOC) and start being fielded to Navy squadrons in 2023.

AARGM-ER uses the existing guidance system and warhead of the AGM-88E with a solid integrated rocket-ramjet for double the range. The new missile uses the AARGM's warhead and guidance systems, and uses a more powerful propulsion system that reportedly increases range over the AGM-88E by 20 to 50 percent, which would give the AGM-88G a range of about 96 to 120 nautical miles. ←

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

Patriot3 to provide battery-powered electric thrusters for combat swimmers

BY John Keller

MacDILL AIR FORCE BASE, Fla. – U.S. special operations combat divers needed covert electric thrusters to help them move quickly and efficiently through the water. They found their solution from Patriot3 Inc. in Fredericksburg, Va.

Officials of the U.S. Special Operations Command at MacDill Air Force Base, Fla., announced a maximum $10 million contract to Patriot3 on Friday for Jet Boots Dive Propulsion Systems.

Jetboots uses low-noise brushless motors and lithium-ion batteries to achieve powerful propulsion for military divers at low total system weight.

Jetboots is a propulsion system for the military diver that uses low-noise brushless motors and lithium-ion batteries to achieve powerful propulsion at low total system weight.

Jetboots provide combat swimmers to move through the water with their full military gear for reconnaissance,

search and rescue, patrol, and hull inspection. The Jetboots system is compatible with standard issue military dive gear.

The Jetboots system includes dual knob control box; two gen5 thrusters; custom lithium ion battery; battery charger; adjustable harness system; buoyancy compensation device; spare parts kit; and transport case.

The control box is a ruggedized waterproof aluminum enclosure that controls the power and speed of the Jetboots. It includes a power switch, adjustable thrust knob, and a LED battery state of charge indicator light with mounted cover.

The control box connects to the thrusters and battery by underwater cables that are specially designed for harsh maritime environments. The battery is hot-swappable underwater and rated to 300 feet ocean depth.

The battery charger and a removable region power cord can accommodate 110- and 220-volt circuits. Each charger has a LED voltage readout, illuminated power button, and a terminal debris plug.

The thrusters contain heavy duty brushless motors protected by a hard anodized aluminum housing. A hermetically sealed magnetic coupling drive and a durable nylon propeller move combat swimmers through the water.

The Jetboots harness is a custom back-braced adjustable system that integrates the control box, thrusters, and battery. Each component mounts to the harness using MOLLE which allows the components to be adjusted to conform to the diver's equipment configuration.

A buoyancy compensation kit mounts to the inside of the harness, and uses closed-cell foam and two orally inflatable air bladders for variable buoyancy and to offset the weight of the Jetboots. The spare parts kit includes a small waterproof case for transport.

The Jetboots Runtime Software is a USB and software package that allows the operator to connect a thruster to a computer and monitor the total operating time of the thruster for maintenance purposes. ←

On this contract Patriot3 will do the work in Fredericksburg, Va., and should be finished by 2027. For more information contact Patriot3 online at www.patriot3.com, or U.S. Special Operations Command at www.socom.mil.

Toyon Research to provide aircraft electronic warfare (EW) and embedded computing

BY **John Keller**

RIDGECREST, Calif. – Airborne electronic warfare (EW) experts at Toyon Research Corp. in Goleta, Calif., will provide the U.S. Navy and Marine Corps with EW capability for fixed-wing aircraft, helicopters, and unmanned aerial vehicles (UAVs) under terms of an $11.7 million five-year contract.

◀ The Intrepid Tiger II EW pod and embedded computing subsystem provides airborne electronic warfare and electronic attack communications jamming capability for Navy and Marine Corps aircraft.

Officials of the Naval Air Warfare Center Weapons Division at China Lake Naval Weapons Station in Ridgecrest, Calif., are asking Toyon Research to provide AN/ALQ-231(V) Intrepid Tiger (IT II) family of systems production hardware and engineering support.

The Intrepid Tiger II EW pod and embedded computing subsystem provides airborne electronic warfare and electronic attack communications jamming capability for Navy and Marine Corps fixed-wing aircraft, helicopters, UAVs, ground-based systems, and laboratories.

The contract calls for Toyon Research to provide 24 (V) 4 maintenance stands; 18 (V) 4 radio frequency (RF) coupler sets (aft); 18 (V) 4 RF coupler sets (forward); seven IT II V3 direction finding array RF coupler sets; and seven IT II V3 RF couplers.

In 2012 Navy officials designated the AN/ALQ-231(V) Intrepid Tiger II as a rapid deployment capability to provide critical aircraft electronic attack capability to ground forces, Navy officials say.

General Micro Systems Inc. (GMS) in Rancho Cucamonga, Calif., provides the company's S902R Golden-Eye III and S905R Raider III rugged processor and data storage systems for the AN/ALQ-231(V).

GMS is the original source of the system's rugged general-purpose processors, and is the only company that can provide processors and components without a substantial duplication of cost to the government, Navy officials say.

The GMS Golden-Eye III is designed to provide rugged embedded computing for defense and UAV applications, as well as industrial and commercial applications, GMS officials say. It is widely deployed in Army vehicles, robots, and UAVs, and works with the Windows 7, Linux, and VxWorks operating systems.

The S902R Golden-Eye III small lightweight computer is conduction cooled and sealed, and operates in temperatures from -40 to 85 degrees Celsius without throttling, GMS officials say. The computer is based on the Intel i7 Core processor with as many as four physical CPU cores, as much as 16 gigabytes of SDRAM.

The S902R supports as many as five Gigabit Ethernet channels with TCP/IP offloading engine, six USB 2.0 ports, as many as four removable 2.5-inch solid-state drives, eight buffered digital I/O lines, dual video, four COM ports with RS232/422/485 options, and an audio headset jack with a one-watt audio amplifier to drive an 8-ohm speaker.

The Golden-Eye computer measures 5.38 by 6.88 by 2.13 inches, weighs 3.25 pounds, and consumes as little as 25 Watts of power.

The GMS S905R Raider III also is a rugged computer for defense and UAV applications that is designed for applications where a rugged computer is needed to provide the best possible performance per dollar per Watt, GMS officials say.

The Raider III supports the Intel i7 Core processor, and runs on the CANbus and MIL-STD-1553 databuses. Like its Golden-Eye cousin, it operates in temperatures from -40 to 85 C. It is a fanless system that can be mounted directly to a metal surface or be used as a stand-alone system. It measures 5.5 by 5.5 by 1.24 inches, weighs 1.9 pounds, and runs on as little as 25 Watts of power.

Toyon Research specializes in technology development and defense systems analysis, with a focus on antennas and RF systems; aerospace systems; RF products; ISR algorithms; homeland security; and autonomous systems.

On this contract Toyon Research will do the work in Goleta, Point Mugu, and China Lake, Calif.; and Yuma, Ariz., and should be finished by March 2027. For more information contact Toyon Research Technologies online at www.toyon.com; General Micro Systems at www.gms4sbc.com, or the Naval Air Warfare Center Weapons Division at www.navair.navy.mil/nawcwd.

Today's military relies ever-more on additive manufacturing for systems design, prototyping, and defense applications.

BY **Megan Crouse**

In February 2022 the White House named additive manufacturing to an updated list of critical and emergency technologies important for U.S. national security.

With 3D printing and additive manufacturing infrastructure solidifying over the last few decades, it's clearly a priority, so how is it used in military and aerospace electronics today? Systems design and prototyping in particular stand to benefit from new developments.

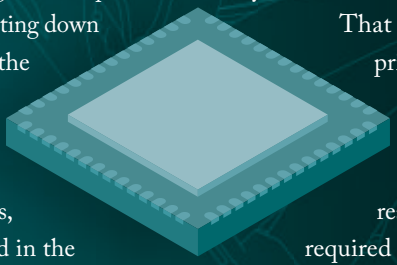
Systems design

In electrical and electronic systems design, 3D printing is becoming easier and less expensive to use. As is true with traditional manufacturing, the goal always is to reduce cost and reduce the time it takes to produce a part (or, in this case, a circuit board). Manufacturing speeds and costs must improve while performance remains the same. Impossible? When it comes to printed circuit boards, Electronics Point, a technology information clearinghouse in London, notes that it can be practical.

Printing enables manufacturers to make several versions of a board quickly, speeding up the rate at which they can iterate on a design. Printing also can be a cost-effective alternative to ordering from overseas manufacturers, Electronics Point notes, as it removes much if not all of the transport time.

Another benefit of 3D printing of circuit boards, according to Electronics Point, is the ability to print conductive and non-conductive material on the same layer with dual extruders. This means a manufacturer can create either an encapsulated or product-embedded circuit board, or to print components such as resistors, capacitors, and inductors.

Essentially, a whole circuit can come out of the 3D printer; it prints an electronic system as one object. An engineer can print a device with wires already embedded inside, cutting down on assembly time. This technique still is in the experimental stage — mostly in university settings — and with curiosity from industry leaders. However, it potentially could open up new 3D printing possibilities with switches, antennas, and even induction coils embedded in the part as it is being printed.



There's a new reason people are betting on 3D printing for semiconductors, too. 2022's supply chain problems have made it more valuable than ever to make manufacturing in this area easier. Benny Buller, CEO and founder of Velo3D in Campbell, Calif., points out that 3D printing chips themselves whole cloth simply isn't feasible; chips are built at the nanometer scale, and simply are too small for today's 3D printers to produce. Instead, 3D printing can fit in where replacement parts are needed not for the chips themselves, but for the fabrication plants that build them.

In 2020, Velo3D partnered with Lam Research Corp. in Fremont, Calif., to work on printing novel materials and designs in metal for the semiconductor industry. In particular, Lam Research experts are betting on 3D printing "the highest levels of repeatability and consistency to achieve precision control at atomic scale" for semiconductor capital equipment, says Velo3D's Buller.

ID 680821748 © luplupme | Getty Images

3D printing for prototyping

Similarly, rapid prototyping enables engineers to print parts faster and for less cost during the prototyping stage; they can print several iterations from the same machine. 3D printing specialist Stratasys Ltd. in Eden Prairie, Minn., notes that while printed prototypes may not look aesthetically like the final product (or may require post-production in order to look that way), they can be designed to perform just as the end product will.

In applications that include a lot of feedback from the end users, including military applications, prototyping like this is becoming more common, says Eric Schnell, CEO of 3D printing startup Craitor Inc. in San Diego. His company is working with the U.S. Marine Corps and approaching other branches of the U.S. military to test 3D printed spare parts in the field.

ID 530842063 © korayneriz | Getty Images

"What 3D printing really allows for is a tactical-level view of rapid prototyping and development of Department of Defense systems," Schnell says. "What we have seen in the rapid prototyping side is this warfighter side-development and optimization of systems they use every day. We've seen several cases of Marines and various other service members looking at systems they use on a day-to-day basis, reverse engineering systems but also optimizing systems."

That might mean using the capabilities of 3D printing to reduce the number of components that go into a specific part, or building tools they normally wouldn't have access to in the field, Schnell says. A Marine he worked with realized that a part for landing gear that usually required three people to unlatch and remove could be rebuilt so that one person could handle it alone. With the help of 3D printed prototypes, the new part was officially approved for use.

"Rapid prototyping, while traditionally looked at as something on the contractor or engineer side, is being done at the tactical level or is even being reverse sent back up the chain to the contractor saying 'we want this capability' or to refine this part," Craitor's Schnell says.

Carrying spare parts

Another major application for 3D printing today is for spare parts. GE Additive in Cincinnati in 2021 worked on a metal 3D-printed sump cover for the GE F110 engine (the engine used in the F-16). The parts were printed with cobalt-chrome powder on GE Additive's Concept Laser M2 machine.

"Part of that process involved exploring how to quickly eliminate the associated risks with castings, and how metal additive might replace it for those parts that are either no longer in production or where we need smaller production runs to keep our platforms flying," Melanie Jonason, chief engineer for the propulsion sustainment division at Tinker Air Force Base, Okla., told AutomationWorld.

As Craitor's Schnell points out, one of the appealing elements of 3D printing for military applications is the ability of people with different skill levels to manufacture parts.

Digital databases and twins

For the Marine Corps, that means a digital repository of blueprints for 3D printed parts. In 2021, the Marines started working on

ID 1339045936 © Slim3D | Getty Images

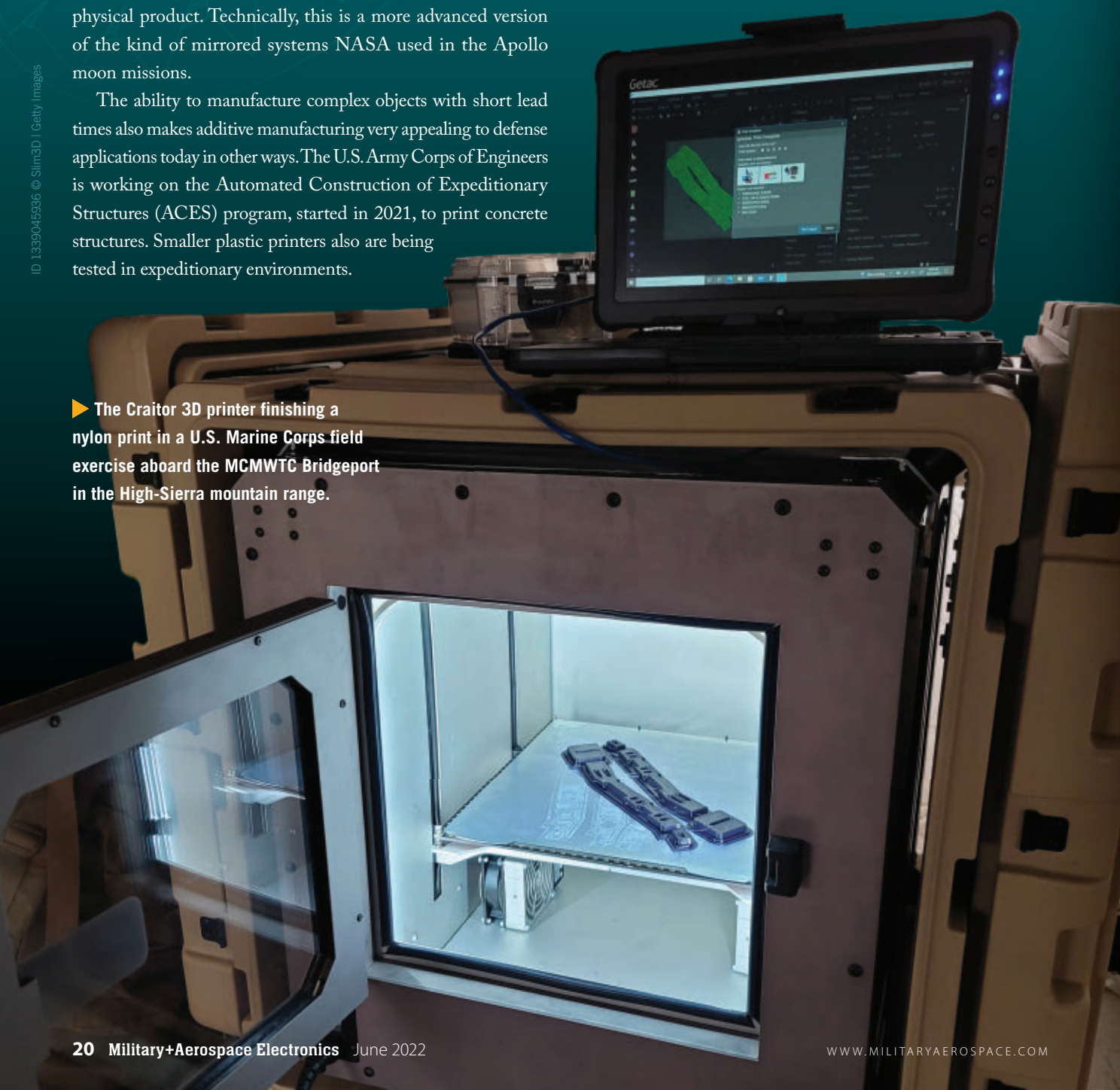
organizing digital files and technical information that already exist but are not easily searchable or thoroughly organized.

The proposed Digital Manufacturing Data Vault will be "a one-stop-shop for approval process, version control, approved part drawings and technical data packages," says Kristin Holzworth, chief scientist at the Quantico, Va.-based Advanced Manufacturing Operations Cell of Syscom Inc.

The Air Force also is adopting digital twinning by creating a functional virtual representation of a physical product. There have been some suggestions that the Department of Defense could mandate a contractor provide a digital twin for any approved physical product. Technically, this is a more advanced version of the kind of mirrored systems NASA used in the Apollo moon missions.

The ability to manufacture complex objects with short lead times also makes additive manufacturing very appealing to defense applications today in other ways. The U.S. Army Corps of Engineers is working on the Automated Construction of Expeditionary Structures (ACES) program, started in 2021, to print concrete structures. Smaller plastic printers also are being tested in expeditionary environments.

For Craitor's Schnell, adapting to requirements like digital twinning is the core of his business, and he predicts requirements will mature over time. "There will be requirements that a certain number of parts or, if it is reasonable, a certain number of systems should be able to be manufactured in emergency situations by the warfighter in the field, or if not specifically in the field with assets that belong to the DoD, to improve readiness and limit the issues we see today with supply chain issues," he says. "We're not just seeing that in the DoD, we're seeing that in mind in the market."



The Craitor 3D printer finishing a nylon print in a U.S. Marine Corps field exercise aboard the MCMWTC Bridgeport in the High-Sierra mountain range.

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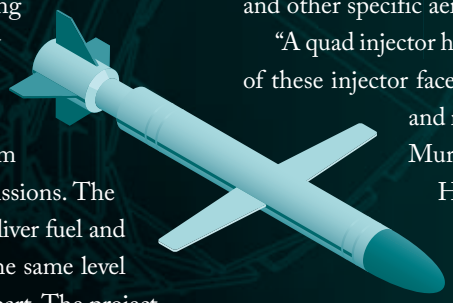
In general, he predicts 3D printing will continue to be part of the conversation about readings and cost reduction. "What that means for the contractor, how I hear that, is that digital twin is here to stay," Schnell says. "I doubt it will be 'all parts must be shared, all 3D files must be kept' and so forth. I think it will become more exclusive on certain considerations."

Not all parts will be able to be 3D printed, no matter how good the technology gets, Schnell cautions. However, he predicts contractors will begin to have more conversations about how reasonable it is to 3D print any given part.

3D printing rocket parts

Meanwhile, Velo3D is working with Aerojet Rocketdyne in Sacramento, Calif., to bring 3D printing to space. Company engineers recently completed a project and started a second stage that focuses on printing a quad injector for a reaction control system that could fly on future NASA moon missions. The challenge was to print a part that could deliver fuel and oxidizer for the combustion chamber at the same level of functional performance as the original part. The project was a collaboration between several organizations.



As well as Velo3D and Aerojet Rocketdyne, Velo3D also collaborated with nTopology Inc., an engineering design software company in New York, that can enable complicated internal geometries.

"Every single pound of material you can remove from a spacecraft saves money on launch costs," says James Horton, aerospace engineer and mission architect at Aerojet Rocketdyne. "That's why we turned to nTopology for help with optimizing the design, and then Velo3D to build it for us."

Velo 3D collaborated with Launcher on orbiter propellant tanks.

It's a matter of manufacturing and design coming closer than before, says Zach Murphree, vice president of global sales and business development at Velo3D.

"One of the things that has been true at least throughout my career in additive manufacturing is that design and manufacturing tools have co-evolved to support each other," says Murphree. "AM could for a while print things that were incredibly different to design and there were ways to design things that traditional manufacturing had no chance of making."

The collaboration here was a good example of that. The initial study for the same product didn't leverage either advanced design tools or new capabilities enabled by the partnership. And Velo3D has a lot of experience with fluid transfer, heat exchange and other specific aerospace capabilities.

"A quad injector has a built-in manifold that goes out to each of these injector faces, so that manifold tubing is complicated and requires some unique capabilities to print," Murphree says.

He says Velo3D is seeing a shift in the way aerospace companies work with manufacturers and printing companies overall. There is a shift away from asking for specific printing capabilities and toward general production, he says. Now, a lot of interest in AM comes from companies seeking scalability.

"Scaling into production has unique requirements traditional AM wasn't built to address," Murphree says. "At Velo3D, we've architected our system to really address some of those challenges, so the ability to print the same build file consistently and repeatedly at distributed manufacturing facilities geographically with different machine serial numbers and to do that with a high level of confidence is kind of the next step in AM becoming a truly distributed production solution."

Process repeatability still is a big concern and limitation in AM in general, Mark Kirby, additive manufacturing business manager for Renishaw Canada Ltd. in Mississauga, Ontario, told nonprofit manufacturing association SME. That means standardizing the build environment, powder and laser management, and processing software so that you can print the same part to the same standards and with the same characteristics on different machines.

Metal printing

Metal 3D printing had been a manufacturing white whale for some time, but it's a practical offering today.

3D printing specialist EOS in Krailling, Germany, pioneered direct metal laser sintering in 1994 with a blend of metal powders, followed by a powder bed system in 2004. The initial problem was how to melt the mix of metals, which was solved first by including

one metal with a low enough melting point to form a binding matrix and later by a more powerful laser. From there, metal printing leapfrogged as the hardware and the CAD software used to build the internal geometries improved hand-in-hand.

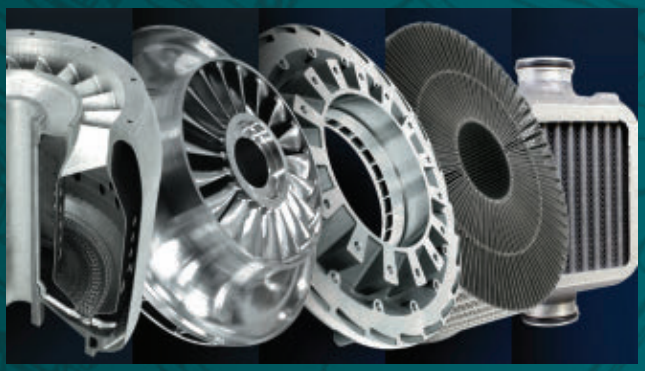
One of the metals the aerospace industry is keeping an eye on for printing today is titanium, says Murphree. Velo3D has worked with launch vehicle and spacecraft company Launcher printing titanium pieces with very low overhangs, an engineering challenge today.

Another challenge with titanium is it tends to disappear just when you think you've hit the jackpot. If it's not treated properly, the metal will "tear itself apart," Murphree says.

"If you were to just print a titanium part and leave it on a desk it might just crack after a few days of sitting there because it has this alpha phase material that is really brittle," he says. "But the process we use to print titanium specifically controls how the metal cools down in such a way that it prevents this cracking from happening."

The in-situ heat treatment also works hand-in-hand with the developments in complicated geometries mentioned above: they're enabled by the heat treatment just as the metal's solidity is.

New types of printing also have appeared on the scene in the last few years, such as atomic diffusion additive manufacturing, demonstrated by Markforged Inc. in Billerica, Mass., and by HP Metal Jet printing from HP Development Co. L.P. in Palo Alto, Calif. Organizations continue to jockey for leadership in printing metal quickly and reliably. Velo3D also is seeing high demand for the Sapphire XC, their newest large machine. It offers a high production rate that expands the possibilities for what products companies might be able to print at competitive cost.



ID 1325312795 © blacklight_trace | Getty Images

Examples of the wide range of metal AM components that can be manufactured with Velo3D's Sapphire system.

WHO'S WHO IN 3D PRINTING

Aerojet Rocketdyne
Sacramento, Calif.
https://www.rocket.com

Craitor Inc.
San Diego
https://www.manufactureanywhere.com

EOS GmbH
Krailling, Germany
https://www.eos.info/en

Electronics Point
London
https://www.electronicspoint.com

GE Additive
Cincinnati
https://www.ge.com/additive/

HP Inc.
Palo Alto, Calif.
https://www.hp.com

Lam Research Corp.
Fremont, Calif.
https://www.lamresearch.com

Launcher
Hawthorne, Calif.
https://www.launcherspace.com

Markforged Inc.
Watertown, Mass.
https://markforged.com

nTopology
New York
https://ntopology.com

Stratasys
Eden Prairie, Minn.
https://www.stratasys.com/en/

Velo 3D
Campbell, Calif.
https://velo3d.com

Velo3D also is starting to work with a copper-chromium-niobium alloy called GRCop-42 — a NASA-developed, high conductivity, high-strength dispersion strengthened alloy.

"We've seen a lot of requests for it," says Murphree. "It maintains good strength at high temperature and it's very good at conducting heat where you can't want heat." They're currently in parameter testing with this copper alloy and hope to move forward with it as it opens up a new application space for Velo3D.

Printing in the field

Organizations working on military applications for printing also are redefining what types of products can be printed. For Craitor, their focus on expeditionary machines means pivoting to meet what warfighters in the field need. They print with plastic and ultra polymers, nylon carbon fiber, nylon fiberglass, carbon fiber and other materials.

"We focused from the beginning to make the system a tactical 3D printer, but in expeditionary environments you can't expect an environment to be a clean, climate controlled atmosphere where you need it most," Schnell says. "We focused from the very beginning to make it not only durable but able to print just as reliably as any other 3D printer in any environment you may find it in."

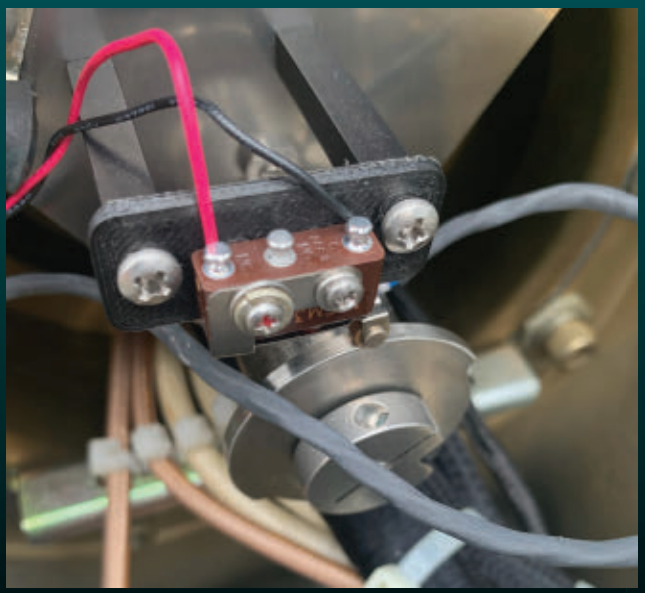
Craitor's project needed to be able to be carried by two people, so it has a print space of just under a foot cubed. It also needed to be able to operate under transport conditions in the field, being jostled in the back of a vehicle or subjected to natural temperature, dust, wear and tear. They've applied known military adaptations to their product, sealing the enclosure and using conformal coating and potting (or embedment) to protect it during transport.

"Our entire system from the ground up has inspiration from our warfighters," Schnell says. Testing the printer on site with the people intended to use it have given them a chance to get 'in on the ground floor' with military adaptations for today and the future.

"Our choices of components, our UI/UX, our basic power systems [are designed to keep in mind] not only the military power supplies we see today but where they're going," says Schnell. "We know several services are moving toward running higher wattage power supplies within aircraft, for example. So we're designing our system to be backwards compatible to not only where the DoD is now but where it's going."

Working out in the field also means the design needs to be done there. Ideally, the printer is a procurement solution as well as a tool. Contractors should look at "ease of use and automation for this capability for the warfighter" as much as anything else, he says.

"One of the advantages we've built into the system is a fully integrated reverse engineering and post processing suite directly into our case," says Schnell. "That's all the kits and tools a marine might need in the field to take measurements, do design work and build out a part but then actually do post processing of that



This small part printed on the Craitor 3D printer in nylon carbon fiber was part of a $2.5 million communications system, with collaboration between the U.S. Marine Corps and the Craitor team.

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Aluminum 3D printed chassis can help build and demonstrate designs quickly

BY Atrenne Computing Solutions, A Celestica company

Keeping a new deployable system on schedule is a constant challenge. Closely related is demonstrating progress to a customer. These hurdles become even more formidable when significant customization is required.

When optimized defense electronics customization leads to development of a unique capability, an aluminum alloy 3D printed chassis may be a solution. This process creates real, deployable enclosures, not just prototypes, which can be ready in weeks, not months.

Aluminum alloy 3D printing

Also referred to as metal additive manufacturing, metal 3D printing enables mechanical engineers to create complex parts without the design constraints of traditional manufacturing. Initially seen as only a prototyping technology, 3D printing has matured rapidly for production components in the aerospace, biomedical, and automotive industries. Examples range from hip cup replacements to engine manifolds in high-performance cars. The underlying economics make 3D printing technology well suited for prototypes, one-off custom parts, and low-volume production runs.

Most of the electronic systems chassis deployed on today's defense platforms are made from aluminum alloys, with metal sections joined by dip-brazing. These materials deliver a combination of structural strength, light weight, and thermal conductivity. Metal 3D printing also can use aluminum alloys.

Metal 3D printing works by addressing very thin layers of metal powder with a laser beam that fuses the particles together. Each layer of metal powder is approximately two-thousandths of an inch thick, or half the thickness of a human hair. The laser fuses just the particles that define the design's cross-section for that layer, then another layer of powder is put down and another defined cross-section is fused.

This automated process, moving layer by layer, can complete a chassis as one metal piece that matches the computer-aided design model input with precision. Shapes and contours in the design are not limited by the capabilities of a CNC machining tool and there are literally no joints between sections.

Business and technical advantages

Aluminum alloy 3D printed chassis deliver several advantages, the most obvious of which is a significantly reduced system development schedule. After completion of the CAD design, experts can create a new custom-designed chassis using 3D printing in about six weeks. This compares with roughly more than 26 weeks from completed design to delivery for a chassis created from milled sections joined via dip brazing.

While the six-week chassis development schedule does not include time to fabricate a backplane and assemble the electronic components, it is not extended for situations that involve unique chassis shapes. 3D printing can create a chassis to fit any defined space.

The fast development time means a prime contractor can get something tangible in front of a customer during a project's initial stages. This builds confidence allows a physical fit check to ensure the chassis dimensions and cable connections are compatible with the platform. Constructed from aluminum alloy, the same chassis used for the fit check also can be used for system testing, after integration of the backplane, electronics, and power supplies.

3D printing means that any required physical changes are identified early, and can create a modified chassis version without delay. Because a 3D printed chassis is one unit, there are no anomaly with seams between sections. In contrast, brazements seams sometimes have tiny holes that make a chassis less than watertight.

One of the most exciting characteristics of 3D printing is the ability for chassis designers to use innovative material shapes. Lattice structures are the prime example, delivering strength with reduced weight, as well as heat dissipation based on size increases in exposed surface areas.

Atrenne, a Celestica company in Brockton, Mass., specializes in rugged electronics chassis, enclosures, and backplanes for aerospace, defense, and industrial applications. Contact the company online at https://www.atrenne.com.

Jeff Thompson, toolmaker supervisor, operates a 3D printer in the machine and weld shop at Anniston Army Depot an Anniston, Ala.

part into a bigger assembly. That is something we knew might be useful but actually talking to our warfighter told us it was kind of a requirement and if we could fit it all into a single case it would be even better."

In general, military customers are looking for systems that are as easy as possible to deploy. They want "ecosystems of capability" that can be operated by a minimal number people with minimal training, not necessarily by specialists. There might be one large printer at a base and several smaller ones at the 'tip of the spear.'

Like Velo3D, Craitor also is working on expanding its roster of possible materials. Schnell says he is excited for new materials and post-processing capabilities. A company might be able to use the same material they have used for five or ten years, but develop new methods of post-processing that will make that same material double the strength.

"There is so much research going into not only entirely new polymers but new ways of printing certain polymers with the same old methodologies that create entirely new parts capabilities," says Schnell. "If you're really trying to gauge the lay of the land, just look at the different materials that are coming out and how they're being combined in new and interesting ways."

Radiation hardening meets smart satellites

BY **John Keller**

Radiation-hardened processors, memory, power supplies, and other components for space applications have gone through big changes over the past several years, beginning with a transformation from expensive radiation-hardened-by-design parts to full commercial off-the-shelf (COTS) parts to accommodate a new generation of small satellites and cubesats for new-space uses.

Today, however, the pendulum is starting to swing slowly back in a conservative direction, with more designed-in radiation hardening and test procedures than have been evident in the recent past. The Wild West of anything-goes small satellites with full-COTS parts appears to be coming to a close, as systems designers, component manufacturers, and radiation-hardened test houses report their customers are moving back in the direction of space-reliable parts — at least more than they have in the past several years.

They're not going back nearly as far as the old days of monolithic spacecraft with super-rad-hard parts and a money-is-no-object design approach. Instead, today the space industry is seeing a move to enhance reliability for the space environment, but still are requiring plastic-packaged parts, with some enhanced testing.

Radiation testing is crucial for finding electronic parts that can survive in space. Pictured is the Radiation Test Solutions SEREEL2 test system for single-event upsets.

This is a noticeable departure from the early days of the NewSpace era, when full-COTS parts were the norm, and the prevailing attitude centered on quick spacecraft replacements in case of on-orbit failures. Now the approach is somewhere in the middle, with the need to keep costs down, accommodate some of the latest high-performance computing components, and enhance reliability such that on-orbit glitches are somewhat rare, and operators can compensate for problems as they crop up.

NewSpace refers to the emergence of the private spaceflight industry, spanning areas such as private launch companies, small satellite constellations, or sub-orbital tourism, as well as other efforts that aim to reinvent the traditional space industry supply chain.

Ruggedizing COTS parts

Recent experiences of placing pure-COTS parts in space has led NewSpace designers to put more thought into some levels of ruggedization for space components. This is not to say the COTS approach has been abandoned — far from it — but industry consensus is coming around to some levels of value-add for space parts.

"One of the biggest trends I'm seeing is with some of the small satellites they are becoming more stringent, and trying to demand more from the satellite," says Anton Quiroz, CEO of radiation-hardened parts supplier Apogee Semiconductor in Plano, Texas. "We are starting to see customers leverage radiation-hardened parts more — but they still want them in plastic packages."

Systems designers have found that using pure-COTS parts can be risky, depending on the application, and has led to unanticipated on-orbit failures that can destroy or degrade the performance of NewSpace satellites. "When you think of COTS, you don't know what you're going to get," Quiroz says. "Even if it's the same

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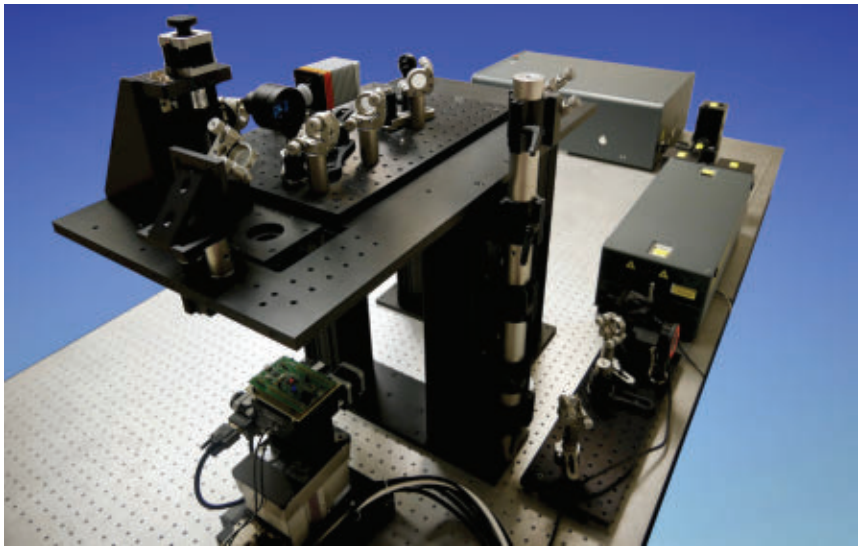


Radiation Test Solutions uses laser technology to determine if electronic parts can survive the radiation environment of space.

part number, it could have completely different radiation performance; it can vary greatly from lot-to-lot."

The solution often involves starting with pure-COTS parts and designing a test and measurement regimen to help prevent unexpected on-orbit systems failures or performance degradation. "You don't want to throw up a bunch of space junk," Quiroz says. "We want to stay below radiation rates of components, so upscreening can be imperative — and that is expensive."

Instead, Apogee Semiconductor is turning to automotive-qualified electronic components from different chip fabs, which often can provide adequate ruggedization to survive the space environment. "We want to use the low-cost commercial nature of these parts," Quiroz says. "We package all our parts in plastic, rather than in ceramic, and we use automotive-type test and screening."

The trick is testing just enough to meet the application and the radiation environment. "We see the amount of commercial space, where most customers are not looking for a full [reliability] screening, and we are giving them a touch of radiation screening," says Marti McCurdy, CEO of radiation-tolerant integrated circuit designer Spirit Electronics in Phoenix. "We do a bit of dynamic burn-in, and then some burn-in. We are not seeing full-MIL-883 testing as much as we used to."

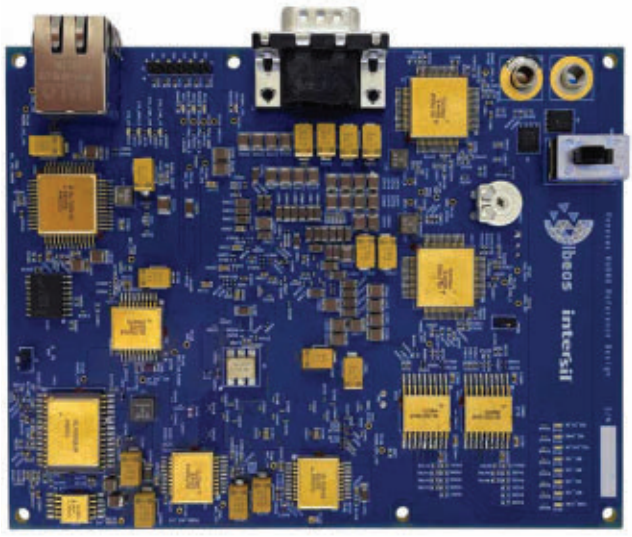
Negotiating the middle ground between extensive radiation testing and non-tested full-COTS use can provide "faster time to market and is less expensive than running the full gamut of testing," McCurdy says. Selective radiation testing also encourages space systems designers to pay close attention to specific space applications that may or may not require addition radiation testing, he says.

Balancing risk and costs

Systems designers must balance the risks, costs, and potential payoffs of which parts they choose ultimately for their spacecraft. "If a constellation needs 40 small satellites, and you have to get them into orbit, single-event upset might mean the loss of one spacecraft. They will risk that one loss, because they have 39 other satellites up there. They need to make a choice of moving forward or not launching at all," McCurdy says.

In addition, Spirit Electronics experts find different means of enhancing the reliability of electronic parts intended for space.

Micropac Industries specializes in radiation-tolerant optocouplers that help isolated circuits communicate with one another. Pictured is the Micropac JANSR 4N49U



Renesas Electronics Corp. engineered a radiation-hardened power-management solution for the Xilinx XQKU060 Ultrascale field-programmable gate array (FPGA).

"We will collect all published data and make an assumption of whether the part will meet or exceed the customer specification," McCurdy says. "The market also is asking for commercial products that are radiation-tested. We are meeting commercial space applications with COTS products with radiation data, so these parts can be flown in space."

Word is out that space systems designers are taking a second look at space-qualified components. "We are seeing more and more requests for our radiation-assured parts; we are seeing that from a lot of customers," says Mike Tsecouras, product line manager for optocouplers, sensors, and displays at space electronics supplier Micropac Industries Inc. in Garland, Texas.

Micropac specializes in radiation-tolerant optocouplers, which are semiconductors that enable transmission of electrical signals between two isolated circuits. Optocouplers have two parts: an LED that emits infrared light, and a photosensitive device that detects light from the LED.

"The trend is, from the optocoupler side, that industry has been looking to see how well it will work in the space environment. Micropac is going after that directly, and we offer DLA [U.S. Defense Logistics Agency]-certified optocouplers." Tsecouras says his company is trying to fill a need in the radiation-hardened electronics industry.

"It was often the case in the past that companies may provide parts, and the onus is on the customer to do their own testing and qualification, based on their program needs. We want to shorten that, and make it easy for the customer to get access to, buy, and use parts managed by the Defense Logistics Agency. Micropac is investing in die banking and pre-testing to ensure these products are readily available."

In addition to demonstrated radiation performance, Tsecouras says Micropac's customers are looking for part traceability to help document systems designs so satellite manufacturers and the government can learn from what works in space, and what doesn't.

"They are trying to do their designs quickly, and part of parts selection is even based on what's available on the market. They can't take a build-to-order custom part; they don't have the schedule for that. They need radiation traceability to each device number."

The different orbits in which NewSpace satellites must operate, ranging from relatively benign low-Earth orbit (LEO) to geosynchronous and polar orbits, which have much higher exposure to space radiation. "In our parts selection, we know the degradation that these different orbit environments will cause, and we pre-select device that will incur the degradation and still be spec-compliant," Tsecouras says.

Traditional space

It's clear that NewSpace is driving today's radiation-hardened electronics applications in largely private ventures that involve widespread Internet access, Earth observation, on-demand

Renesas Electronics Corp. has created a radiation-hardened version of the Microsemi RTG4 field-programmable gate array (FPGA).

entertainment, and space-based research. NewSpace is time- and cost-driven, and differs significantly from government-funded space initiatives in which costs and the speed of deployment often are not top concerns.

Nevertheless, traditional space initiatives still are viable concerns — especially for crewed and uncrewed deep-space exploration missions, government-sponsored large-area weather observation and forecasting, and military-sponsored reconnaissance and surveillance satellite projects.

"We also support traditional space, and our process enables us to do that," says Apogee's Quiroz. "We have product releases in different radiation levels, ranging from LEO to deep space. Traditional space isn't going away. There is a continued need for geostationary satellites with a high level of radiation tolerance."

The extreme radiation environments of geosynchronous orbits, polar orbits, and deep-space missions are not the places for enhanced COTS electronic components; these represent a need for components that are designed from the ground-up to be radiation hardened. These applications typically are long-duration, impossible to repair once lofted into space, and are subject to some of the harshest-known radiation environments.

"For LEO, most of the satellites have some protection from the Earth's magnetic field, so the devices have some protection," says Steve Singer, product marketing manager of Renesas Electronics, a rad-hard chip designer in Palm Bay, Fla.

"Harsher environments are in geosynchronous orbits," Singer continues. "Our customers are still building satellites for geosynchronous orbits, so that market is not going away."

WHO'S WHO IN RAD-HARD ELECTRONICS

3D Plus, a Heico company
San Leandro, Calif.
https://www.3d-plus.com/index.php

Aitech
Chatsworth, Calif.
http://www.rugged.com

Apogee Semiconductor
Plano, Texas
https://apogeesemi.com

BAE Systems
Manassas, Va.
https://www.baesystems.com/en-us/productfamily/space-systems

Cicoil Corp.
Valencia, Calif.
https://www.cicoil.com

Cobham Advanced Electronic Solutions Inc. (CAES)
Colorado Springs, Colo.
https://caes.com

Curtiss-Wright Defense Solutions Aerospace Instrumentation
Newtown, Pa.
https://www.curtisswrightds.com/company/locations-newtown.html

Data Device Corp. (DDC)
Bohemia, N.Y.
http://www.ddc-web.com

GSI Technology Inc.
Sunnyvale, Calif.
https://www.gsitechnology.com

Honeywell Aerospace
Clearwater, Fla.
https://aerospace.honeywell.com/en/markets/space

Infineon Technologies
El Segundo, Calif.
https://www.infineon.com

Lucid Circuit Ind.
Santa Monica, Calif.
https://lucidcircuit.com

Maxwell Technologies
San Diego
http://www.maxwell.com

Mercury Systems
Phoenix
https://www.mrcy.com

Microchip Technology Inc.
Chandler, Ariz.
https://www.microchip.com

Microelectronics Research Development Corp.
Colorado Springs, Colo.
http://www.micro-rdc.com/index.htm

Micropac Industries Inc.
Garland, Texas
https://www.micropac.com/markets/space

Microsemi
Aliso Viejo, Calif
https://www.microsemi.com

Nissha GSI Technologies
Burr Ridge, Ill.
https://www.gsitech.com

Northrop Grumman Corp.
Manhattan Beach, Calif.
http://www.northropgrumman.com

pSemi Corp.
San Diego
http://www.psemi.com

Radiation Test Solutions Inc.
Colorado Springs, Colo.
https://www.radiationtestsolutions.com/home

Renesas Electronics Corp.
Palm Bay, Fla.
https://www.renesas.com/us/en/

Scientic Inc.
Huntsville, Ala.
https://www.scientic.com

Space Micro
San Diego
http://www.spacemicro.com/index.html

Spirit Electronics
Phoenix
https://www.spiritelectronics.com

Triad Semiconductor Inc.
Winston-Salem, N.C.
https://www.triadsemi.com

VORAGO Technologies Inc.
Austin, Texas
https://www.voragotech.com

VPT Components
Lawrence, Mass.
https://www.vptcomponents.com

VPT Inc.
Blacksburg, Va.
http://www.vptpower.com

VPT Rad
Chelmsford, Mass.
http://www.vptrad.com

Xilinx Inc.
San Jose, Calif.
https://www.xilinx.com

The Renesas radiation hardened power management solution for the Xilinx XQKU060 Ultrascale FPGA.

High-performance space computing

Another force behind today's space electronics is the emerging need for high-performance computing in orbit to handle growing demand for digital signal processing, image processing, advanced networking, and the artificial intelligence (AI) and machine learning that will define the next generation of space missions.

To get there, the spacecraft industry needs radiation-hardened high-performance general-purpose processors, field-programmable gate arrays (FPGAs), general-purpose graphics processing units (GPGPUs), A/D and D/A converters, optocouplers, and many other kinds of components.

"High-performance computing in space is a big focus for our customers," says Renesas's Singer. "They are looking for their satellites to be smarter, with a higher level of intelligence and machine learning. Then we see commercial space applications that are about potential data centers in space, which involves new architectures and processors — traditional rad-hard processors, and some new FPGAs that are high-performance and rad-tolerant. There also is a large customer base looking for rad-tolerant ASICs [application-specific integrated circuits]."

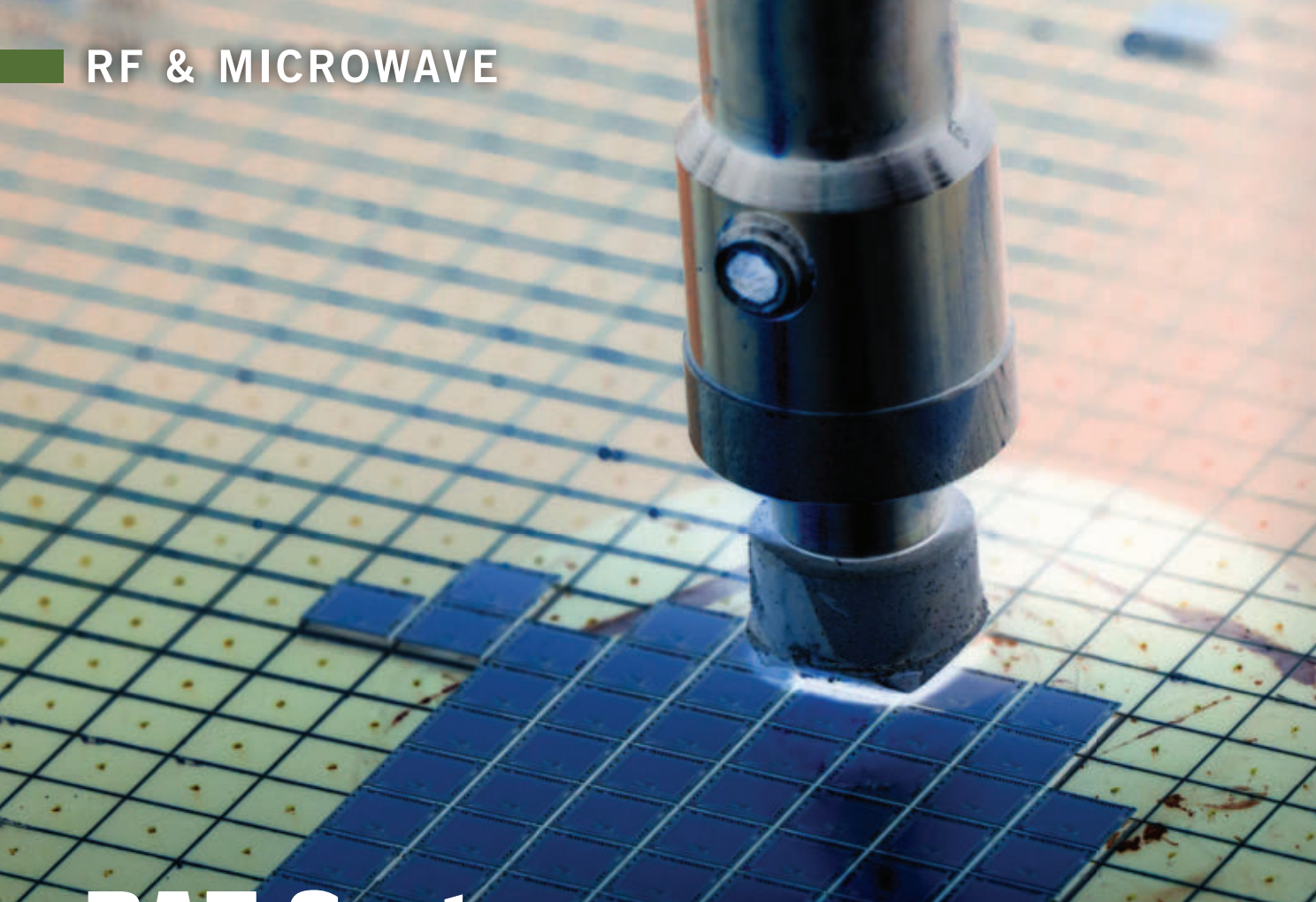
Such capabilities are not limited only to NewSpace applications. "Even on the government side we are seeing a need for AI and machine learning to enable satellites that can respond with little human interaction," Singer says. "The need is for processors that have multiple cores and operate at high clock speeds. The architectures for cell phones are making their way into space applications, and people are trying to make them rad-hard."

The need for AI and machine learning in satellites isn't just for image and signal processing, experts point out. AI and machine learning also will be central to the kinds of machine autonomy technologies that will enable large and exquisite satellites of previous generations with constellations of small satellites that must operate reliably as teams.

"How do you manage a large satellite? I takes a lot of people on the ground," points out Michel Sika, CEO of Lucid Circuit Inc. in Santa Monica, Calif. "We will need to replace each large satellite with several smaller ones, with a limited number of ground stations, and that will be very challenging. We must have management capabilities aboard each satellite, with edge AI capabilities to have satellites take care of basic parts of satellite management."

The key enabling technology for achieving this will be trusted AI. "How can you enable the satellite to manage operations, test it, and make sure that it is reliable? Now we have the problem of trusted AI," Sika says. "As AI makes a decision, a human on the ground validates the decision the AI agent makes. Over time the AI agent will be more effective, and can put more management on the satellite."

In this kind of distributed satellite architecture, satellites must communicate among themselves and aggregate their sensor capability. "That is the next challenge," Sika says — and all the circuitry necessary to do so much be radiation tolerant.



BAE Systems eyes developing RF analog and digital integrated circuit

NASHUA, N.H. – Microelectronics experts at BAE Systems are moving forward on a project to develop integrated radio frequency (RF) electronics with wide spectral coverage, high resolution, large dynamic range, and wideband information processing.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA in Arlington, Va., have awarded a $5 million contract to the BAE Systems Electronic Systems segment in Nashua, N.H., to start the second phase of the Technologies for Mixed-mode Ultra Scaled Integrated Circuits (T-MUSIC) program.

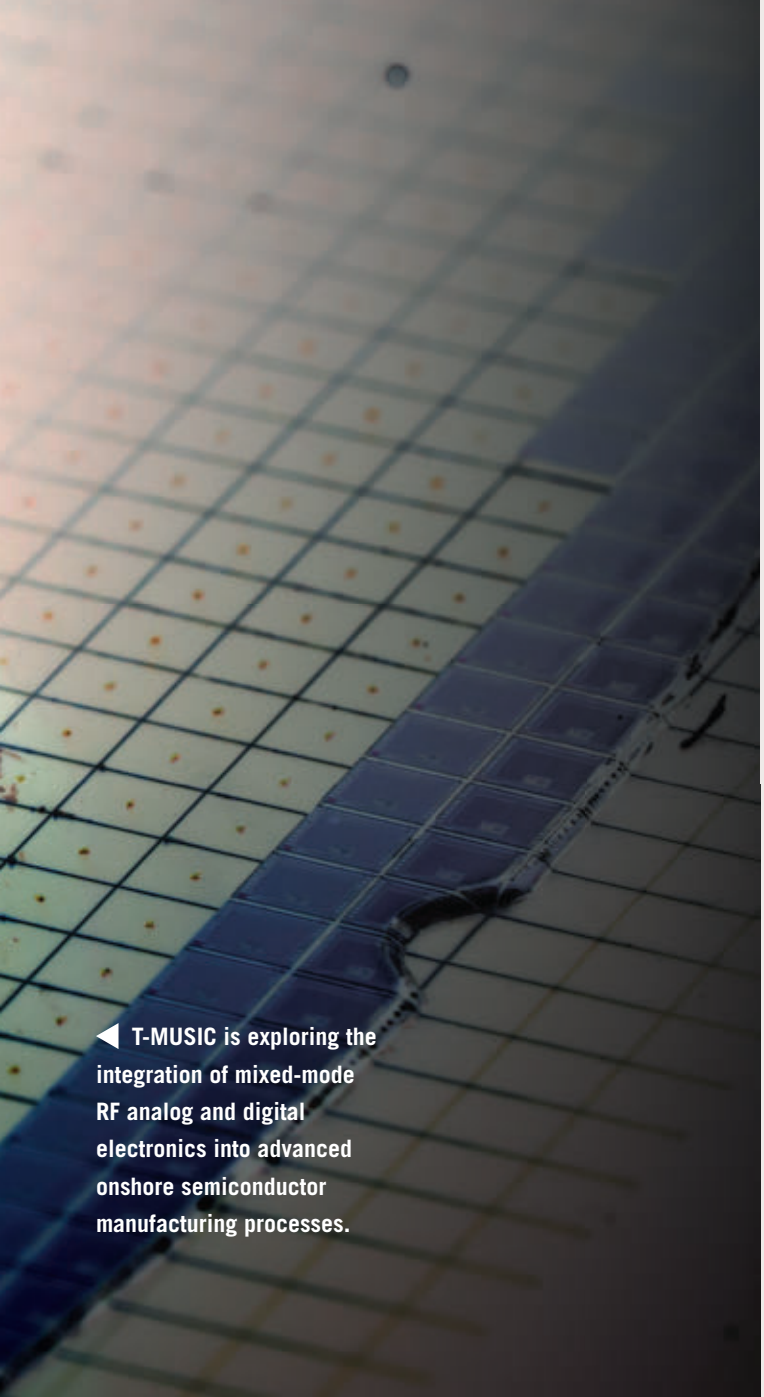
The second phase will refine enabling technologies for RF mixed-mode technologies by integrating RF analog electronics with digital electronics on the same wafer for future military communications, radar, and electronic warfare (EW) applications.

T-MUSIC technology could enable wide spectral coverage, high resolution, large dynamic range, and high information processing bandwidth. These capabilities can cut through electronic signal clutter.

T-MUSIC, which is part of the DARPA Electronics Resurgence Initiative (ERI), is exploring the integration of mixed-mode RF analog and digital electronics into advanced onshore semiconductor manufacturing processes, and seeks to establish a domestic manufacturing capability for high-performance RF mixed-mode systems on chip (SOC).

In addition to BAE Systems, the first phase of the T-MUSIC project involved four other research teams led by Raytheon Technologies Corp.; University of California-Los Angeles; University of California-San Diego; and University of Utah.

The five circuit design teams worked close with two foundry partners selected to support the development of advanced



◀ T-MUSIC is exploring the integration of mixed-mode RF analog and digital electronics into advanced onshore semiconductor manufacturing processes.

mixed-mode technologies in U.S. onshore CMOS foundries. The foundry partners are Global Foundries in Santa Clara, Calif., and Tower Semiconductor in Migdal HaEmek, Israel.

A third group of researchers have explored foundational breakthroughs in ultra-broadband transistors, pushing well beyond current near-term advances in foundry technology. Research teams from the University of California-Los Angeles and University of California-Berkeley looked at new types of RF mixed-mode transistors to demonstrate transistor-switching speed to 1 GHz in scalable CMOS. ←

On the T-MUSIC phase-two contract, BAE Systems will do the work in Merrimack, N.H.; Lexington, Mass.; and Manassas, Va. For more information contact BAE Systems Electronic Systems online at www.baesystems.com.

STMicroelectronics adds 20 MHz, low-offset op amp in its 5-volt family

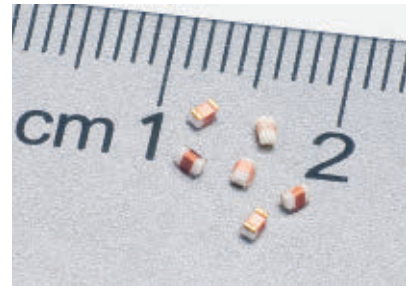
The STMicroelectronics TSV772 dual operational amplifier (op amp) combines high accuracy, low power consumption, and the option of a small 2-by-2-millimeter DFN8 package. The TSV772 has rail-to-rail inputs and outputs, 20 MHz gain-bandwidth (GBW), and is unity-gain stable. The maximum input-offset voltage of 200 microvolts at 25 degrees Celsius ensures accurate handling of low-amplitude signals. The TSV772 is characterized for an output capacitance of 47 picofarads, simplifying use as an A/D converter input buffer. Capable of operating from a supply voltage as low as 2 volts, the TSV772 can connect to the same rail as a low-power microcontroller. The low minimum voltage also allows longer operation with a deeply discharged battery. The TSV772 is suited for applications such as smoke detectors. The op amp also enables accurate current measurement as the starting point for efficient power conversion in systems such as solar generators, telecom infrastructure equipment, and computer servers. More information is online at http://www.st.com/TSV772.

Raytheon to upgrade MK 15 Close-In Weapon System (CIWS)

Shipboard weapons experts at Raytheon Technologies Corp. will upgrade and overhaul computer-controlled and radar-guided Gatling guns that defend surface warships from anti-ship missiles, manned aircraft, and drones under terms of a $93.6 million order. Officials of the Naval Sea Systems Command in Washington are asking the Raytheon Missiles & Defense segment in Tucson, Ariz., for MK 15 Close-In Weapon System (CIWS) upgrade, conversion, overhaul and hardware. CIWS is a fast-reaction radar-guided terminal shipboard air defense against low- and high-flying, high-speed maneuvering anti-ship missile threats that have penetrated all other defenses. It's a high-volume Gatling gun, deployed since the early 1980s, designed to throw out a curtain of bullets that shred incoming missiles and aircraft. At sea, the CIWS is designed to defeat anti-ship missiles and other close-in threats that have pierced other lines of defense. It also has a land use as a counter-rocket, artillery, and mortar system that detects and destroys incoming rounds. A self-contained package, the CIWS shipboard weapons automatically handle search, detection, threat evaluation, tracking, engagement, and kill assessment. For more information contact Raytheon Missiles & Defense online at www.raytheonmissilesanddefense.com, or Naval Sea Systems Command at www.navsea.navy.mil. ←

High-current ceramic core chip inductor introduced by Gowanda

GOWANDA, N.Y. – Gowanda Electronics in Gowanda, N.Y., is introducing the SMP0603 ceramic core chip inductor series for power electronics in military test and measurement, industrial control, automotive applications.



These high-performance chip inductors were designed to address the power electronics market need for ceramic chip inductors with high current handling. An inductor with a high current rating is essential for DC-DC converters and switching power supplies used in electric vehicles and charging stations.

This chip inductor series also is suited for RF applications such as communications, guidance, security, and radar.

Gowanda's SMP0603 inductor series performance range provided by the 37 discrete parts within the SMP0603 series includes Inductance from 1.8 to 27 nanohenries DCR Ohms from 0.01 to 0.04, and current rating milliamps DC from 1750 to 3400.

This series, meets a total mass loss outgassing requirement of 1 percent when tested in accordance with ASTM E595. Standard terminations are gold-plated nickel and RoHS-compliant.

The SMP0603 inductors are designed with a flat top cover for pick-and-place assembly and they are suitable for reflow soldering for radar and test applications. Operating temperature range is -40 to 125 degrees Celsius.

For more information contact Gowanda Electronics online at www.gowanda.com.

Handheld spectrum analyzers for field test of radar and SATCOM offered by Rohde & Schwarz

MUNICH – Rohde & Schwarz in Munich is introducing base models for the rugged R&S Spectrum Rider FPH spectrum analyzers that take spectrum analysis capability up to 44 GHz for field applications such as verification of radar, defense, satellite communications (SATCOM), 5G, and broadcast.

They combine the functionality of benchtop instruments and the lightweight portability of a handheld instrument, with intuitive features to make high performance measuring on the go fast and simple.

A new 44 GHz model has test and measurement frequencies from 5 kHz to 6, 13.6, and 26.5 GHz. In addition, three new versions with tracking generators are available with measurement frequencies to 13.6, 26.5, and 44 GHz.

Rohde & Schwarz is introducing spectrum analyzers that take spectrum analysis capability up to 44 GHz for verification of radar, defense, satellite communications (SATCOM), 5G, and broadcast uses.

Large buttons and multi-touch gesture screen make it easy to operate. The new models support. Weighing seven pounds for 44 GHz model, the R&S Spectrum Rider is optimized for mobile use. Its battery lasts for 4.5 hours, and its backlit keypad enables users to work in the dark. The non-reflective display supports a daylight mode for improved readability in direct sunlight.

This handheld spectrum analyzer family has a large capacitive touchscreen to adjust settings such as frequency, span and reference level, and to set markers.

Large buttons and a multifunction wheel facilitate operation with gloves in outdoor environments. Users can control the analyzer via USB, or LAN and the R&S MobileView app for iOS or Android. For more information contact Rohde & Schwarz online at www.rohde-schwarz.com.

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Navy upgrading obsolescent avionics test equipment until replacements come online

BY **John Keller**

LAKEHURST, N.J. – Test and measurement experts at Lockheed Martin Corp. will continue to upgrade, maintain, and support obsolescent U.S. Navy combat avionics test equipment under terms of a $34.5 million order.

Officials of the Naval Air Warfare Center Aircraft Division in Lakehurst, N.J., are asking the Lockheed Martin Rotary and Mission Systems segment in Orlando, Fla., to provide performance-based logistics maintenance and support for as many as 400 Consolidated Automated Support System (CASS) avionics test stations and 150 Reconfigurable Transportable CASS (RTCASS) stations.

U.S. Navy avionics test and measurement experts will continue to upgrade the old Consolidated Automated Support System (CASS) until its replacements come online.

CASS has been a Navy standard automatic test equipment family supporting electronics on naval aircraft. Originally fielded in the 1990s, CASS includes mainframe CASS stations installed in aviation intermediate maintenance departments (AIMDs) ashore and afloat worldwide. RTCASS support forward-deployed Marine Corps aviation logistics squadrons.

All mainframe CASS systems are being replaced by electronic CASS (eCASS) due to approaching obsolescence. The eCASS is a technologically-advanced system to replace mainframe CASS in support of the Fleet for the next 20 years.

Until eCASS replaces all necessary CASS avionics test equipment, Navy leaders must ensure that the older CASS equipment remains working reliably.

CASS is designed to help warfighters troubleshoot and repair aircraft assemblies at sea or ashore and return the avionics to service quickly. At its peak usage around 2000, CASS was the world's largest automated test support program, and was the Navy's standard test equipment for avionics on aircraft carriers and in depots throughout the U.S.

CASS production started in 1990 to replace specialized avionics testers at sea. When they were procured originally the CASS mainframes cost about $1 million each.

The test and measurement systems were designed with open-systems architectures to detect and isolate faults in avionics equipment on such carrier-based aircraft as the E-2C radar surveillance turboprop, F/A-18 fighter-bomber, and SH-60 helicopter.

Prior to CASS this function required 25 separate old testers. CASS systems at sea are installed on all the Navy's aircraft carriers and most amphibious assault ships.

Lockheed Martin delivered the first modernized eCASS station to replace older CASS equipment in late 2014 to support all the aircraft in the Navy's fleet, including the F-35 Lightning II joint strike fighter.

On this order Lockheed Martin will do the work in Orlando, Fla., and should be finished by April 2023. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com, or the Naval Air Warfare Center Aircraft Division-Lakehurst at www.navair.navy.mil/lakehurst.

AeroVironment to build Puma AE hand-launched unmanned reconnaissance planes for Ukraine

BY John Keller

REDSTONE ARSENAL, Ala. – The Ukraine armed forces needed a hand-launched unmanned aerial vehicle (UAV) for battlefield surveillance and reconnaissance. They found their solution in the RQ-20 Puma AE (all-environment) from AeroVironment Inc. in Simi Valley, Calif.

Officials of the U.S. Army Contracting Command at Redstone Arsenal, Ala., announced a $19.7 million contract to AeroVironment last week for RQ-20 Puma AE systems; reconnaissance, surveillance, and target acquisition kits; spare parts; logistics and training support the country of Ukraine.

The Ukraine armed forces will use the AeroVironment Puma hand-launched unmanned aircraft in the country's war with Russia.

The Puma AE is a small UAV designed for land-based and maritime operations. Capable of landing in the water or on land, the Puma AE is durable with a reinforced fuselage construction, human-portable, and requires no auxiliary equipment for launch or recovery.

It carries an electro-optical (EO) and infrared (IR) camera and illuminator on a mechanical gimbaled payload, which enables the operator to keep his eyes on the target.

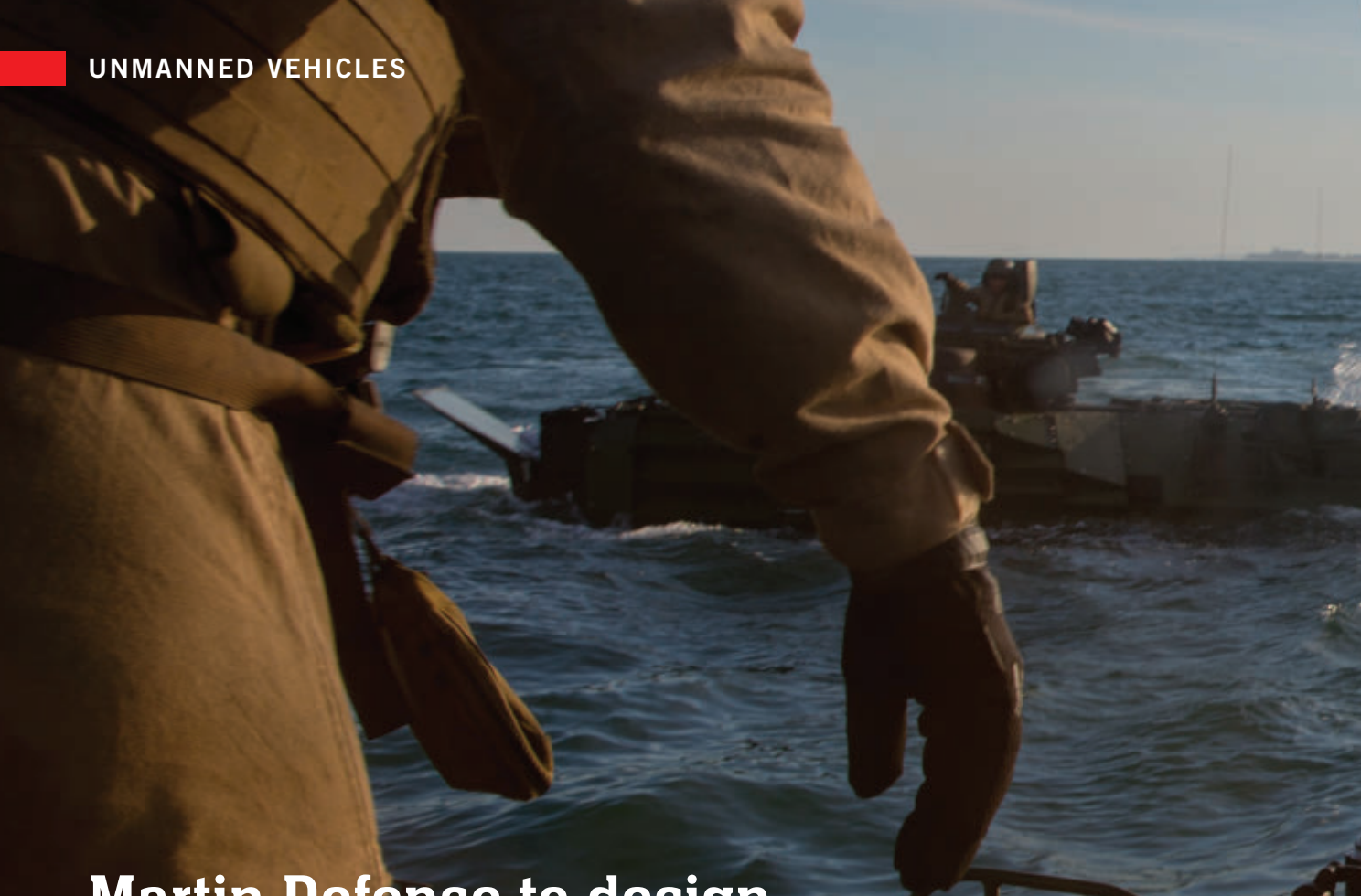
The system is quiet to avoid detection and operates autonomously, providing persistent intelligence, surveillance, reconnaissance, and targeting data (ISRT). The Puma AE delivers more than 3.5 hours of flight endurance, with smart battery options. It is easy to launch, especially at high altitudes and in hot climates.

For increased payload capacity, an optional under-wing transit bay is available for integration of third-party payloads like communications relays, geo locations, or laser markers. The Puma AE can perform battle damage assessment, maritime patrol, search and rescue, and drug interdiction missions. U.S. forces have used the Puma AE in Afghanistan. The US Air Force and Marine Corps also ordered Puma AE systems through an existing US Army contract.

The Puma AE is not the most sophisticated model of the AeroVironment RQ-20. The Puma LE (long-endurance) UAV, for example, also is launchable by hand or by bungee, and provides flight endurance of as long as 6.5 hours, and provides an operational range of 37.3 miles over land and water when used with the AeroVironment long-range tracking antenna.

In addition to Ukraine, international militaries using the Puma AE are Albania; Belgium; Canada; Czech Republic; Denmark; Egypt; Estonia; France; Germany; Latvia; Netherlands; New Zealand; Norway; Kosovo; Spain; Sweden; and the United Kingdom. ←

For more information contact AeroVironment online at www.avinc.com, or the Army Contracting Command-Redstone at https://acc.army.mil/contractingcenters/acc-rsa/.



Martin Defense to design unmanned amphibious vehicle to deliver fuel to Marines

BY John Keller

ARLINGTON, Va. – Machine autonomy experts at Martin Defense Group LLC in Honolulu are designing an unmanned amphibious vehicle to help deliver fuel to U.S. Marines fighting on attack beaches.

Officials of the U.S. Office of Naval Research in Arlington, Va., announced a $15 million contract to Martin Defense in April for the Amphibious Vehicle for Unmanned Surface Mobility (AVUSM) project.

The AVUSM system is to enable the U.S. Marine Corps autonomously to deliver a lay-flat fuel line hose from an embarkment platform floating offshore, through the surf-zone, to dry land on attack beaches.

This unmanned amphibious vehicle is to deliver a sustained fuel supply for armored combat vehicles, electric generators, and logistics operations for Marines who are fighting their way inland from attack beaches.

Martin Defense also is working with the U.S. military on a $54.8 million project to develop enabling technologies for future large-size unmanned underwater vehicles (UUVs) with long endurance and large payload capacity, as part of the Manta Ray program of the U.S. Defense Advanced Research Projects Agency (DARPA).

Manta Ray is to open a design space for future UUVs that are capable of long-duration missions and large payload capacity, as well as to advance key technologies that will benefit other naval designs such as low-cost UUV operations, long duration undersea power management, biofouling reduction, and long-duration navigation.

The Manta Ray program seeks to demonstrate critical technologies for a new class of long-duration, long-range, payload-capable UUVs to give extra capacity to military commanders without disrupting their operations. Key aspects of the Manta Ray program are classified.

▲ Martin Defense Group is designing the Unmanned Surface Mobility (AVUSM) amphibious vehicle to deliver fuel to U.S. Marines fighting on attack beaches.

Manta Ray also will investigate mission-management technologies for extended UUV operations; high-efficiency undersea navigation; and new ways to mitigate biofouling, corrosion, and other material degradation for long-duration missions.

Martin Defense specializes in machine autonomy solutions for amphibious vehicles, as well as aerial, ground, surface, and undersea vehicles that must operate in combat conditions.

The company's core expertise involves cognitive systems for artificial intelligence (AI)-based autonomy that enables uncrewed vehicles to perform high-level reasoning and adapt to unexpected events, Martin Defense officials say.

Martin Defense Group autonomy research seeks to embed intelligence and reasoning on unmanned vehicles to enable operators to manage several unmanned vehicles at once.

Martin Defense also develops digital twins of systems and subsystems on U.S. military platforms for hull structural health monitoring, self-healing autonomous machinery, and smart electrical grids.

Martin engineers seek to apply the company's understanding of AI and machine learning to the development of efficient and accurate virtual worlds.

This contract to Martin Defense was procured competitively under the Office of Naval Research long range broad agency announcement (BAA) for Navy and Marine Corps science and technology. On this contract Martin Defense will do the work in Honolulu, and should be finished by April 2025. ←

For more information contact Martin Defense Group online at https://mdefensegroup.com, or the Office of Naval Research at www.onr.navy.mil.

Navy asks 13 companies for prototypes in sensors and autonomous vehicles

BY **John Keller**

NEWPORT, R.I. – U.S. Navy undersea warfare experts are looking to 13 electronics companies to develop research prototype systems related to sensors, arrays, sonar, undersea warfare, and autonomous vehicles

Officials of the Naval Undersea Warfare Center (NUWC) Division in Newport, R.I., have awarded contracts to 13 companies for the Sensors and Sonar C15 Rapid Prototyping Development project. These companies will share $49 million.

These 13 companies will develop research prototypes for applications on submarines, surface warships, aircraft, surveillance, autonomous vehicles, distributed networks, submerged cables, and irregular warfare.

▲ Research involves autonomous vehicles, submarines, surface warships, aircraft, surveillance, distributed networks, submerged cables, and irregular warfare.

The 13 companies are:

- Booz Allen Hamilton Inc. in McLean, Va.;
- Advanced Systems/Supportability Engineering Technologies And Tools (ASSETT) Inc. in Manassas, Va.;
- Cardinal Engineering LLC in Washington;
- In-Depth Engineering Corp. in Fairfax, Va.;
- L3Harris Technologies in Palm Bay, Fla.;
- Leidos Inc. in Reston, Va.;
- QinetiQ North America in Waltham, Mass.;
- Raytheon Technologies Corp. in Portsmouth, R.I.;
- Sedna Digital Solutions LLC in Manassas, Va.;
- Sonalysts Inc. in Waterford, Conn.;
- Ultra Electronics Ocean Systems Inc. in Braintree, Mass.;
- Venator Solutions LLC in San Diego; and
- WPL Publishing in Rockville, Md.

These research prototypes are to enable sensors, arrays, sonar, undersea warfare and autonomous vehicles to develop a sufficient understanding of alternative solutions considered deemed critical for improved performance, accelerated capability, or in response to an identified new enemy threat.

Prototypes will be for performance demonstrations, concept of operations development, maturing technology, refining requirements, and otherwise reducing the risk of current or anticipated capability gaps, Navy researchers say.

The 13 companies will pursue research prototypes in sensors, hydrophones, transducers and optical systems; arrays, networks and underwater communications; signal processing, algorithms, intelligent agents and electronics; mechanical systems, handling equipment, and cables; and polymers, coatings, and materials.

Sensors, hydrophones, transducers, and optical systems involves prototype sensors, hydrophones, transducers, and optical systems to reduce size, weight, cooling, and power consumption. Optical systems include *Continued on page 44*

Raytheon to simulate the tracking of crewed and uncrewed aircraft

BY **John Keller**

ARLINGTON, Va. – Raytheon Technologies Corp. is moving forward with a project to develop a virtual and live testbed for combat airspace management under terms of a $10.1 million order announced in April.

Raytheon is developing a virtual lab testbed to model, simulate, and virtualize military airspace management in a common software framework that supports virtual and real-world environments.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., are asking the Raytheon Intelligence & Space segment in Tewksbury, Mass., to carry out the second phase of the Airspace TacticaL Automation System (ATLAS) effort supporting the Air Space Total Awareness for Rapid Tactical Execution (ASTARTE) program.

Raytheon experts will refine a virtual and live testbed for airspace management systems, algorithms for airspace planning and operations, and a sensor network for real-time spatial and temporal tracking of crewed and uncrewed aircraft.

Raytheon won a $7.6 million contract for the project's first phase in February 2021. This contract modification brings the total value of the contract to $17.7 million. Systems & Technology Research LLC (STR) in Woburn, Mass., also is involved in the project's first phase.

Raytheon engineers will continue developing a virtual lab testbed to help model, simulate, and virtualize current joint military airspace management systems with interfaces to connect real-world hardware and software in a common software framework that supports virtual and real-world environments.

The overall ASTARTE program seeks to provide real-time, low-risk joint deconfliction between airspace users and joint fires at an Army division-level to enable responsive support to tactical units and build a resilient air picture in an anti-access/area denial (A2/AD) environment while conducting joint all-domain command and control (JADC2) operations.

ASTARTE enabling technologies will handle sensor tasking, data processing, multi-modal data fusion, and near-real time dissemination to enable dynamic spatial and temporal airspace management and operations.

The ASTARTE program has three parts. First is understanding and decision algorithms that identify and predict airspace usage conflicts, determine restricted operating zones, propose alternative airspace de-confliction courses of action with assessed risk levels, and dynamically planning and tasking sensors to create an airspace picture.

Second, the project is developing sensors that in real time can detect and track crewed and uncrewed aircraft, missiles in-flight, unmanned balloons, and other potential flight hazards.

Third is a virtual lab testbed that enables modeling, simulation, and virtualization of military airspace management systems, and connects to connect real-world hardware.

The current approach to airspace planning and control predominately involves manual and static procedures that allocate lanes and zones over the battlefield, which can prohibit adaptive re-tasking and reapportionment.

This approach also can be over-previsioned to provide any flexibility, but can cause very inefficient use of available airspace, causing slow or inaccurate coordination between fires and airspace users, which allows an adversary to fire and maneuver unchallenged.

Prior attempts to create a more dynamic, joint picture of the airspace relied on an overly complex and burdensome centralized approach that attempted to force all operations, data, command, and control into a common framework.

Instead, ASTARTE seeks to gather data, form a refined airspace picture, and re-plan by exception as necessary to support dynamic joint-service operations.

ASTARTE focuses on the most challenging airspace problem: the airspace above an Army division under battlefield airspace that measures about 360 square miles, and extends from the ground to about 18,000 feet in altitude.

This area contains Army, Air Force, Navy, Marine Corps, Special Operations, allied, and enemy crewed and uncrewed aircraft and munitions passing through the airspace. It also contains forces conducting fire missions and close air support. The airspace also may include commercial aircraft and other hazards.

Still, the system must be aware of adjacent air spaces and the airspace above the division airspace to include high-altitude aircraft, satellites and manned spacecraft.

On second phase of the ASTARTE program, Raytheon will do the work in Tewksbury and Cambridge, Mass; Cedar Rapids, Iowa; Fulton, Md.; Dulles, Va.; and Durham, N.C., and should be finished by June 2023.

For more information contact Raytheon Intelligence & Space online at www.raytheonintelligenceandspace.com, Systems & Technology Research at www.str.us, or DARPA at www.darpa.mil.

Navy asks 13 companies for prototypes in sensors and autonomous vehicles

Continued from page 42

lasers; optical sensors; photodetectors; high-speed cameras; pointing, tracking, and beam steering subsystems; fiber optics; mirrors; and lenses.

Arrays, networks, and underwater communications involves shipboard hull-mounted arrays, towed arrays and distributed networks to increase channel density and numbers; extend frequency ranges; improve reliability, accuracy, and manufacturability; reduce size, weight, cooling, and required power; supporting open architectures; reducing active source sizes; developing secure communications and clandestine operations; and information assurance.

The topic also includes developing underwater communication systems; navigation and range measurement systems; power and data services; and network connectivity.

Signal processing, algorithms, intelligent agents, and electronics involves signal processing strings; information processing algorithms; intelligent agents and electronics to improve detection, classification, localization and tracking of contacts; reducing false alarms; improving operations in cluttered environments; enhancing operator performance; unmanned operations; improving reliability and manufacturability; supporting open-systems architectures; supporting testing; reducing cooling requirements; and cyber security.

Test and evaluation improvements involves embedded computing evaluation and reporting; real time analysis; improved visualization of test events; accurate reconstruction; off range reconstruction; data reduction; and post-test analysis.

Prototypes will involve sensor electronics, hardware, software, and firmware. Sensor electronics will include amplifiers, energy storage, impedance matching electronics, transmit controllers, signal conversion, telemetry and hardware signal processing, data gathering, data storage, and real time playback.

Mechanical systems, handling equipment, and cables involves the launch, retrieval and stowage of sonar arrays, sensors, measurement devices, payloads, autonomous vehicles, towed bodies, and distributed networks.

Contractors seek to reduce size, weight, cooling, and required power; improve safety, reduce required manning, improve control, improve reliability and manufacturability and reduce total ownership cost.

Polymers, coating, and material involves specialized coatings and polymers to protect hardware from corrosion and biofouling, reduce water absorption and water permeability, exhibit acoustic properties such as acoustic transparency or acoustic damping, improve operations in harsh environments and exposure to fuels.

For more information contact the Naval Undersea Warfare Center-Newport online at www.navsea.navy.mil/Home/Warfare-Centers/NUWC-Newport.

Draper researchers find new way to ruggedize electro-optics for harsh environments

CAMBRIDGE, Mass. – Engineers at the Charles Stark Draper Laboratory Inc. in Cambridge, Mass., have developed new techniques to ruggedize electro-optical components for assured positioning, navigation and timing (PNT) systems that must operate in environments with extreme temperature, shock, and vibration.

Harsh environments tend to have large temperature swings and high amounts of shock and vibration, Draper experts say. Such dynamic environments can compromise the performance of electro-optics assembled and packaged for less-dynamic environments.

The U.S. military relies on PNT data for many kinds of missions, systems, and weapons. Information from PNT data especially can be critical in aerospace and defense applications where Global Positioning System (GPS) satellite signals are unavailable.

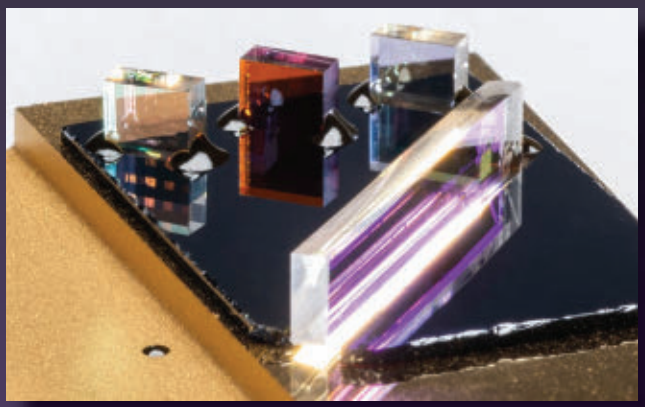
Draper experts say the electro-optical devices embedded within PNT devices such as the interferometric fiber-optic gyroscope (IFOG) can benefit from new manufacturing methods to support applications in harsh environments.

Draper researchers have made a technological breakthrough in ruggedizing PNT systems by reducing the complexity, labor requirements, and manufacturing costs of assembling and packaging electro-optics. This makes them suitable for systems intended for operation in harsh environments.

The new approach is an advance on the current assembly method that relies on robotic alignment and bonding of several optical components and individual miniature mounts to a ceramic substrate, Draper officials say.

Traditional electro-optical manufacturing can make components vulnerable extremes in temperature, shock, and vibration because it relies on adhesives to bond components to a substrate. These adhesives tend to be gooey, sensitive to temperature and humidity, and difficult to dispense and manipulate at the microscale.

Instead, Draper researchers used the company's in-house microfabrication facility to fabricate silicon optical benches,



Draper Lab researchers have found new ways to ruggedize electro-optical components that must operate in extreme temperatures, shock, and vibration.

which are wafer-level platforms composed of precision-etched surface features. This approach uses a passive alignment method that requires fewer steps.

Draper's method enables electro-optical component designers to drop several lenses and beam splitters onto the etched silicon surface. It uses pieces of solid glass frit that melt at low temperatures. These pieces are prefabricated into 3-D shapes like rectangular blocks and circular doughnuts.

These 3-D shapes register and anchor the optical components, and then simultaneously fuse them in a one melt-and-cool step. This new process replaces the slow and expensive combination of precision robotics and liquid adhesives.

The new capability represents a new way to assemble several microscale optical components closely together in one device, says Gilbert Feke, Draper's technical director of the project. ←

The new method is available to Draper's customers. Draper funding the work was funded by Draper and its internal research and development program. For more information contact Draper online at www.draper.com.

Lockheed Martin to build six LRASM missiles with infrared and radar-homing sensors

BY John Keller

EGLIN AIR FORCE BASE, Fla. – U.S. Air Force airborne weapons experts are asking Lockheed Martin Corp. to build six next-generation AGM-158C Long-Range Anti-Ship Missiles (LRASM) for use against high-priority enemy targets like aircraft carriers, troop transport ships, and guided-missile cruisers.

Officials of the U.S. Air Force Life Cycle Management Center at Eglin Air Force Base, Fla., has announced a $17.6 million order to the Lockheed Martin Corp. Missiles and Fire Control segment in Orlando, Fla., to build six LRASMs.

▲ Lockheed Martin will build six more LRASM anti-ship missiles for use against enemy aircraft carriers, troop transport ships, and guided-missile cruisers.

The LRASM can be guided toward enemy ships from as far away as 200 nautical miles by its launch aircraft. The missile employs a multi-mode sensor suite, weapon data link, and enhanced digital anti-jam Global Positioning System (GPS) to detect and destroy important targets within groups of ships at sea.

The missile can receive updates via its datalink, or can use onboard sensors to find its target. LRASM will fly towards its target at medium altitude then drop to low altitude for a sea skimming approach to counter shipboard anti-missile defenses.

The LRASM uses on-board targeting systems to acquire the target independently without the presence of intelligence or supporting services like GPS satellite navigation and data links. Lockheed Martin is designing he missile with advanced counter-countermeasures to evade hostile active defense systems.

Lockheed Martin is in charge of LRASM overall development, and the BAE Systems Electronic Systems segment in Nashua, N.H., is developing the LRASM onboard sensor systems.

The BAE Systems-designed seeker and guidance system integrates jam-resistant GPS and inertial navigation sensors (INS), an electro-optical imaging infrared seeker with automatic

scene- and target-matching recognition, a data-link, passive electronic support measures (ESM) with passive radar homing, and radar warning receiver sensors.

Artificial intelligence (AI) software combines these features to locate enemy ships and avoid neutral shipping in crowded areas. The missile automatically disseminates target RF and infrared emissions data, and classifies, locates, and identifies these emissions for planning its path of attack.

LRASM's data-link enables other systems to feed the missile a real-time electronic picture of the battlefield to enable several of the missiles to work together by sharing data to coordinate an attack in a swarm.

Aside from short low-power data-link transmissions, the LRASM does not emit signals for low detectability. A LRASM also can find its own target autonomously by using its passive radar homing to locate sea and land targets.

LRASM is a joint project of the U.S. Defense Advanced Projects Agency (DARPA) in Arlington, Va., the Navy, and the Air Force to design an advanced anti-ship missile that can launch from the Navy F/A-18E/F Super Hornet jet fighter bomber, as well as from the Air Force B-1B Lancer long-range strategic bomber.

In the future LRASM also will launch from the P-8A Poseidon maritime patrol aircraft, the F-35 Lighting II joint strike fighter, as well as from the Navy Mark 41 shipboard Vertical Launch System. Submarine-launched versions are under consideration.

The missile travels at high subsonic speeds that enable the missile to fly low near the surface of the ocean. This enables the missile to hide in the curvature of the Earth from enemy air-defense radar for most of the missile's flight.

LRASM is designed to detect and destroy high-priority targets within groups of ships from extended ranges in electronic warfare jamming environments. It is a precision-guided, anti-ship standoff missile based on the Lockheed Martin Joint Air-to-Surface Standoff Missile-Extended Range (JASSM-ER).

The Lockheed Martin LRASM has a 1,000-pound penetrator and blast-fragmentation warhead, multi-mode sensor, weapon data link, and enhanced digital anti-jam global positioning system to detect and destroy selected surface targets within groups of ships.

LRASM development is in response to a gap in Navy anti-ship missile technology identified in 2008. The standard Navy anti-ship missile is the subsonic Harpoon, which has been in the inventory since 1977. ←

On this contract Lockheed Martin will do its work in Orlando, Fla., and Troy, Ala., and should be finished by March 2025. For more information contact Lockheed Martin Missiles and Fire Control online at www.lockheedmartin.com, or the Air Force Life Cycle Management Center at www.aflcmc.af.mil.

F-22 jet fighter could get infrared search and track sensor it was promised

The U.S. Air Force has kicked off plans to integrate an infrared search and track (IRST) sensor on the stealthy F-22 Raptor jet fighter. The F-22 originally was to have an infrared sensor, which is passive and immune to electronic warfare (EW) jamming, to detect and track other aircraft at long ranges. This plan ultimately was dropped on cost grounds. Now, the service is at least looking at ways to insert the capability back into the jet. One of the items in a document newly released under the Small Business Innovation Research (SBIR) program calls for submissions related to an apparent new IRST capability for the F-22, among other new upgrade requirements. The same document also asks industry for F-22 cyber intrusion detection and prevention; predictive maintenance; synthetic data generation; sensor fusion; improved radar; manned-unmanned teaming; pilot-assisted autonomy; alternative navigation to GPS; Scorpion helmet-mounted display; Red Air threat replication application; optimized intercept; real-time debriefing; and combat identification.

Army testing laser weapons on combat vehicles for possible deployment by next fall

The first set of Stryker combat vehicles equipped with 50-kilowatt laser weapons will be delivered to a unit of Army soldiers at Fort Sill, Okla., by next fall, says the head of the service's Rapid Capabilities and Critical Technologies Office at Redstone Arsenal, Ala. The Army calls its Directed Energy Maneuver-Short Range Air Defense system "Guardian." Army leaders say they plan to conduct more tests this month, after testing the first prototype last spring at White Sands Missile Range, N.M., against one-, two-, and three-class unmanned aircraft, rockets, artillery, and mortars. Tests will continue through early February. The Army learned from soldier feedback of the first prototype at White Sands and through computer simulations. The Army first awarded a contract in mid-2019 to Kord Technologies Inc. in Huntsville, Ala., to be prime contractor for the first laser-equipped Stryker armored combat vehicles prototypes. Kord subsequently awarded subcontracts to Northrop Grumman Corp. and Raytheon Technologies for the laser module.

L3Harris to integrate electro-optical sensors for ship self-defense

BY John Keller

WASHINGTON – Shipboard electronics systems integrators at L3Harris Technologies will design and build a wide-field-of-view electro-optical system to help protect surface warships from advanced enemy anti-ship cruise missiles under terms of a potential half-billion-dollar contract.

Officials of the Naval Sea Systems Command in Washington announced a $205.9 million contract to the L3Harris C5 Integrated Systems segment in Camden, N.J., to develop shipboard electro-optical sensors technologies as part of the Shipboard Panoramic Electro-Optic/Infrared (SPEIR) program.

The contract has options that could increase its value to $593.1 million, and extend the duration of the contract to March 2031. The contract involves integrating technologies in visible-light cameras, infrared sensors, and laser-based sensors such as laser rangefinders and light direction and finding (lidar) systems.

SPEIR seeks to field an integrated narrow- and wide-field-of-view detection and cueing capability for anti-ship cruise missile defense, to counter-fast attack craft and fast inshore attack craft, counter-unmanned aerial vehicles (UAVs), enhance mobility, and to conduct anti-terrorist and force-protection operations.

SPEIR focuses on speeding the fielding of advanced electro-optical and infrared capability to provide passive surveillance, detection, and weapons cueing for the Navy surface warship fleet. The system initially is for Arleigh-Burke-class destroyers, Ticonderoga-class cruisers, and future Constellation-class frigates.

The ship self-defense program has an incremental approach for increasing capability as electro-optical technologies continues to mature, Navy officials say. SPEIR seeks to capitalize on proven mature electro-optical technologies to help defend Navy surface warships from a wide variety of enemy threats.

SPEIR will deliver systems to the fleet as quickly and affordably as possible, and provide modularity where it makes sense for future capability enhancements, Navy officials say. ←

On this contract L3Harris will do the work in Mason, Ohio; Northampton, Mass.; Bothell, Wash.; Hamilton, Ontario; Austin, Texas; Tulsa, Okla.; Norfolk, Va.; and other U.S. locations, and should be finished by November 2025. For more information contact L3Harris online at www.l3harris.com, or Naval Sea Systems Command at www.navsea.navy.mil.

L3Harris C5 Integrated Systems is developing shipboard electro-optical sensors technologies for the Navy Shipboard Panoramic Electro-Optic/Infrared (SPEIR) program.

U.S. and allies race to develop avionics for sixth-generation jet fighters

The American development and deployment fifth-generation stealth jet fighters like the F-35 Lightning is one of the central stories of today's security zeitgeist. But behind the scenes, several countries already are looking ahead to the design of a sixth-generation jet. Driving the relentless pace of research into avionics and other enabling technologies is less combat experience — of which there is little — and more a sober assessment that developing a successor will take several decades and is better started sooner rather than later. The sixth-generation fighter developers divide into two categories: the U.S., which has developed and deployed two stealth fighter types, and countries that have skipped or given up on their attempt to build Fifth Generations jets. Currently, the U.S. has two projects: the Air Force's 'Penetrating Counter-Air' — a long-range stealth fighter to escort stealth bombers — and the Navy's FA-XX. So far, Boeing, Lockheed-Martin, and Northrop-Grumman have unveiled sixth-generation concepts.

Kord Technologies to prototype laser weapons on armored combat vehicles

In an effort to modernize the battlefield, the U.S. Army is working with Kord Technologies in Huntsville, Ala., to put laser weapons on the ground. The new Directed Energy Maneuver Short Range Air Defense system (DE M-SHORAD), a 50 kilowatt laser weapon on Stryker armored combat vehicles, is designed to shoot down threats like unmanned aerial vehicles (UAVs), rockets, and mortars without using guns and heavy artillery. Following a successful combat shoot-off earlier this year, Kord Technologies is preparing four prototypes of the laser weapons mounted on Strykers for deployment to the field in September 2022. Once soldiers begin using this system in tactical environments, KBR engineers will take back any lessons learned from the first four prototypes and start optimizing and tailoring them for future use in defending against unmanned vehicles, rockets, artillery shells, and mortar rounds.

Teledyne FLIR introduces Hadron 640R dual thermal-visible camera for uncrewed systems

Teledyne FLIR in Wilsonville, Ore., is introducing the high-performance Hadron 640R combined radiometric thermal and visible dual camera module. The Hadron 640R design is optimized for integration into uncrewed aircraft, unmanned ground vehicles (UGV), robotic platforms, and emerging AI-ready applications where battery life and run time are mission critical. The 640 x 512 resolution Boson longwave infrared (LWIR) thermal camera inside the Hadron 640R can see through total darkness, smoke, most fog, glare, and provide temperature measurements for every pixel in the scene. The addition of the high definition 64 MP visible camera enables the Hadron 640R to provide both thermal and visible imagery compatible with today's on-device processors for AI and machine-learning applications at the edge. The Hadron 640R reduces development costs and time-to-market for integrators and original equipment manufacturer (OEM) product developers by offering a complete system through a single supplier, Teledyne FLIR. This includes offering drivers for market-leading processors from NVIDIA, Qualcomm, and more, plus industry-leading integration support and service from a support team of experts. It also offers flexible 60 Hz video output via USB or MIPI compatibility. Hadron 640R is a dual use product and is classified under US Department of Commerce jurisdiction. To learn more visit www.flir.com/hadron640r.

Opto-diode unveils infrared light-emitting diode for covert aircraft lighting

Opto Diode Corp. in Camarillo, Calif., is introducing the OD-669 infrared light-emitting diode (IRLED) for covert aircraft lighting or covert anti-collision lighting in aviation applications. The OD-669 comes in a TO-66 package for heat sink attach, and is a high-power gallium aluminum arsenide (GaAlAs) IRLED illuminator with a peak emission of 880 nanometers with wide angle of emission. Designed with nine chips connected in series, the robust device for covert aircraft lighting and anti-collision is housed in an electrically isolated case for covert aircraft lighting. Total power output ranges from a minimum of 390 milliwatts to a typical level of 500 milliwatts under test conditions at 300 milliamps. The spectral bandwidth at 50 percent is 80 nanometers, and the half-intensity beam angle typically is 120 degrees for covert aircraft lighting and anti-collision applications. The forward voltage of the OD-669 ranges from a typical level of 13.5 volts to a maximum of 15 volts. The reverse breakdown voltage is a minimum of 5 volts and 30 volts typical. Capacitance is 11 picofarads, and the rise and fall time typically is 3 microseconds. Thermal parameters of the infrared light-emitting diode (IRLED) include the storage and operating temperature ranges of -55 to 100 degrees Celsius and the maximum junction temperature of 100 C. For more information contact Opto Diode online at https://optodiode.com/pdf/OD669DS.pdf.

RADIO COMMUNICATIONS

Thales and L3Harris to upgrade SINCGARS military radios in encryption modernization

U.S. Army battlefield communications specialists are choosing two major U.S. manufacturers of military radios to update the venerable Single-Channel Ground and Airborne Radio System (SINCGARS) to improve the radio's performance against near-peer adversaries.

Officials of the Army Contracting Command at Aberdeen Proving Ground, Md., announced a potential total $6.1 billion contract to Thales Defense and Security Inc. in Clarksburg, Md.; and to the L3Harris Technologies Inc. Integrated Communications Solutions segment in Rochester, N.Y., to modernize SINCGARS radios to align with U.S. National Security Agency crypto modernization requirements.

Thales and L3Harris will compete for orders over the next 10 years to modernize SINCGARS radios to align with the National Security Agency crypto modernization requirements.

SINCGARS is a combat networked radio for voice and data communications that comes in vehicle-mount, backpack, airborne, and handheld versions. Designed in the 1980s the radio uses rapid frequency hopping to maintain signals security.

These nearly-40-year-old military radios have grown long in the tooth, however, and military experts doubt their ability to operate effectively against powerful potential adversaries like Russia, China, and other industrialized nations without substantial upgrades.

That's where Thales and L3Harris come in. Thales and L3Harris will consider new-frequency hopping capabilities and cryptographic modernization that includes Tactical Secure Voice Cryptographic Interoperability Specification (TSVCIS) and Advanced Encryption Standard (AES) 256, experts say.

Of primary interest to the Army is upgrading the service's single- and dual-mounted vehicle radios and personal radio manpack. Army leaders say they plan to use SINCGARS radios to support fires and air defense in contested environments where data capabilities are limited.

SINCGARS uses 25 kHz channels in the very high frequency (VHF) FM band, from 30 to 87.975 MHz. It offers single-frequency mode, as well as frequency hopping mode that hops 111 times a second.

ITT Corp. originally developed the SINCGARS beginning in 1983. ITT became Exelis Inc. in 2011, and Harris Corp. acquired Exelis in 2015, bringing the legacy SINCGARS line into Harris. The merger of Harris Corp. and L3 Technologies into L3Harris was completed in 2019.

On this contract L3Harris and Thales will do the work at locations to be determined with each order, and should be finished by March 2032. For more information contact Thales Defense and Security online at www.thalesdsi.com, L3Harris Technologies Integrated Communications Solutions at www.l3harris.com, or the Army Contracting Command at Aberdeen Proving Ground at https://acc.army.mil/contractingcenters/acc-apg/about-us.

WEAPONS GUIDANCE

Raytheon sensor seeker upgrade kits to turn Tomahawk munition into an anti-ship missile

U.S. Navy guided missile experts are asking Raytheon Technologies Corp. to provide missile seeker upgrade kits for the BGM-109 Tomahawk missile Block 5A to enable the weapon to hit moving ships at sea.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $40.4 million order to the Raytheon Missiles & Defense segment in Tucson, Ariz., to build low-rate production Maritime Strike Tomahawk sensor seeker suites to provide midcourse and terminal guidance to enable the Maritime Strike Tomahawk (MST) to attack enemy ships from Navy surface warships and submarines.

The Maritime Strike Tomahawk, also called Tomahawk Block 5A, was introduced in 2021 with improvements to navigation and in-flight targeting that give the long-range subsonic weapon anti-ship missile capability. The missile fires from Navy surface warships and submerged submarines.

The seeker suites will be installed in recertified Tomahawk missiles for the Navy. The maritime-strike Tomahawk Block-5A has updated seeker technology and processing capabilities to enable the missile to hit moving targets at sea.

Navy joint task force commanders increasingly face long-range anti-ship missiles that threaten their surface forces and potentially deny access to mission-critical areas of operation, so they need a near-term capability to counter hostile surface forces. Without this, the Navy could face loss of life or critical mission failure, Navy officials say.

The Maritime Strike Tomahawk will augment the newer and more sophisticated U.S. Navy and Air Force AGM-158C Long-Range Anti-Ship Missile (LRASM) that can launch from the Navy F/A-18E/F Super Hornet jet fighter bomber, as well as from the Air Force B-1B Lancer long-range strategic bomber.

LRASM also is being considered for launch from the F-35 Lighting II joint strike fighter, the P-8A Poseidon maritime patrol jet, as well as from the Navy Mark 41 shipboard Vertical Launch System and for submarine launchers.

The LRASM travels at high subsonic speeds, and for some future uses likely will give way in the future to expected new generations of hypersonic missiles. Submarine-launched versions are under consideration.

For the Maritime Strike Tomahawk, Raytheon can integrate a new sensor suite into the Tomahawk missile that consists of a new seeker, processor, software, and a new inertial measuring unit for terminal maneuvers, as well as redesigned power budget and system cooling.

On this order Raytheon will do the work in Tucson, Ariz.; Boulder, Colo.; Dallas; North Logan, Utah; Pontiac, Mich.; and other continental U.S. locations, and should be finished by October 2024. For more information contact Raytheon Missile Systems online at www.rtx.com/our-company/our-businesses/rmd, or Naval Air Systems Command at www.navair.navy.mil.

SATELLITE COMMUNICATIONS

China Airlines selects Inmarsat and SITA for airline passenger broadband communications

China Airlines in Taoyuan City, Taiwan, needed an in-flight high-speed broadband Internet equipment provider. They found their solution from Inmarsat in London, and its partner SITA in Geneva.

China Airlines received delivery of its first Airbus A321neo and put it into service in March. When the airline took to the skies, it was equipped with Inmarsat's GX Aviation in-flight Wi-Fi and SITA's Internet ONAIR technology.

The GX network currently consists of five Ka-band satellites while Inmarsat plans to add seven more satellites as part of the company's technology roadmap. This includes two commercial communication Inmarsat-6 satellites, both of which are scheduled to enter service next year. They will be followed by three additional satellites in geostationary orbit, which will allow for broadband service for aircraft flying in higher elevations and across the Arctic.

In addition, China Airlines has ordered a total of 25 Airbus A321neos as part of a narrow-body fleet replacement program. All of the aircraft will be equipped with Inmarsat's GX Aviation and SITA's Internet ONAIR, alongside other new cabin features, including 4K high-solution displays.

"Providing a digital and touchless onboard experience will be the key to increasing passenger confidence as air travel recovers from the COVID-19 pandemic," says Katrina Korzenowski, Asia Pacific Vice President at SITA's aircraft technology business. "Our Internet ONAIR technology, coupled with Inmarsat's GX Aviation connectivity, offers China Airlines the perfect blueprint for a world-class inflight broadband offering onboard its Airbus A321neo aircraft and we're proud to be working together to achieve this. It also means that SITA is now providing a full suite of services, from cockpit to cabin, to China Airlines."

AVIONICS

Universal Avionics and Trimec Aviation team on Falcon 2000/EX flight deck upgrades

Universal Avionics (UA), an Elbit Systems company in Tucson, Ariz., has collaborated with Trimec Aviation in Fort Worth, Texas, to provide integrated avionics for all Dassault Falcon 2000/2000EX aircraft equipped with Collins Aerospace's Pro Line 4.

The solution will include UA's InSight Flight Display System, SBAS-Flight Management Systems (FMS), SkyLens head-wearable display (HWD), and UniLink Communications Management system. Completion of the Supplemental Type Certificate (STC) is expected on the First of Type aircraft in the first quarter of 2023.

The integration will deliver a feature set for enhanced situational awareness and improved safety, increasing payload by more than 200 pounds (91 kg) and resolves concerns from operators on the obsolescence of CRT displays.

Features include a second-generation 3D Synthetic Vision System (SVS), an interactive and integrated digital map, a head-up navigation solution for all phases of flight with 360 degrees of enhanced terrain awareness, and the latest in Human Machine Interface (HMI) design including touch control interactions to reduce crew workload.

The solution also supports RNP 0.3 approaches and enables CPDLC/DCL/FANS 1A+/ATN B1, saving 15 minutes or more for a typical flight. Trimec will provide the integration and certification of the system on the Falcon 2000/2000EX, which sets the stage for deployment on other aircraft with Pro Line 4.

"Replacing existing flight deck displays with the InSight Flight Display System is an economical and sustainable initiative that extends the service life of both the flight deck

and the aircraft while enhancing capabilities to meet global airspace compliance," said Dror Yahav, CEO of Universal Avionics. "Whether you own the aircraft for just a few years or decades to come, we believe this holistic approach complements the rising demand and value of the F2000/F2000EX aircraft."

ANTENNAS

Navy chooses circular antenna array from BAE Systems for shipboard IFF system

U.S. Navy aerial warfare systems experts needed special circular shipboard antenna arrays for the AN/UPX-29(V) identification-friend-or-foe (IFF) interrogator system aboard surface warships. They found their solution from the BAE Systems Electronic Systems segment in Nashua, N.H.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $13 million order to BAE Systems to provide six OE-120B electronically steerable antenna (ESA) groups.

The BAE Systems OE-120 antenna group is an electronically steerable antenna that shipboard operators can redirect within 50 microseconds to interrogate any target on the horizon. The antenna array supports IFF interrogator as well as air traffic control beacon systems, and is designed for surface ships and land-based installations.

The antennas are for the AN/UPX-29 shipboard interrogator, which is a centralized IFF system that employs a challenge and reply technique to distinguish friendly platforms in a multi-target environment.

This contract modification exercises an option to procure six OE-120B antenna groups — four for the Navy and one for the government of Canada; and four OE-120B antenna group retrofit kits for the Navy and associated data.

The antenna group supports a wide range of systems, including IFF, secondary surveillance radar, and air traffic control radar. The system offers constant fleet protection for navies around the world.

The OE-120B antenna groups offer instantaneous, multiple target identification supports defense against today's sophisticated air threats. It accommodates all standard IFF modes.

The antenna system adapts to land and sea applications to support a variety of mission environments, and its electronically steered system architecture offers increased reliability and reduced maintenance. Its array configuration allows for smooth performance degradation in the event of a failure.

The OE-120 electronically steerable antenna is suitable for the Navy's Ticonderoga-class cruiser (CG 47), the Arleigh Burke-class destroyer (DDG 51), the Wasp-class amphibious assault ship (LHD 1), the San Antonio-class amphibious transport dock (LPD 17), aircraft carriers, and the Japanese Kongo-class destroyer (FMS DD 173) — a version of the U.S. Burke-class destroyer.

The AN/UPX-29(V) shipboard IFF interrogator, for which the OE-120B antenna is part, distinguishes friendly vessels and aircraft nearby during combat operations.

The AN/UPX-29(V) can process and store as many as 400 targets, provide instantaneous interrogation on a target within 25 microseconds, electronically evaluate Mode 4 replies, call up operator-designated target information, display IFF targets synchronized with as many as four radars at 22 displays, and interface with shipboard computers.

At the heart of the OE-120 system is the AS-3134/UPX antenna array, which consists of 64 vertical radiating dipole antenna element pairs arranged in a circle on the ship's mast. The system uses electronic beam steering to scan all areas around the ship. The dipole antenna element pairs can produce either directional or omnidirectional beam patterns.

The system can aim its RF energy at any target of interest located at any point on the horizon within microseconds. Operators also can scan the antenna's output rapidly over a designated sector of interest. During normal surveillance operations the antenna group scans the horizon at 90 revolutions per second.

The OE-120's CV-3372/UPX antenna positioner receives commands from the C-10063/UPX controller, distributes RF power to the radiators, and digitally controls the system's output mode and boresight direction. The system's C-10063/UPX antenna controller, meanwhile, is located below decks and translates synchronized data continuously from the ship's environmental sensors.

On this order, BAE Systems engineers will do the work in Nashua, N.H., and should be finished by November 2024. For more information contact BAE Systems Electronic Systems online at www.baesystems.com, or Naval Air Systems Command at www.navair.navy.mil.

RUGGED COMPUTERS

▲ Rugged embedded computing system for sensor processing introduced by Elma

Elma Electronic in Fremont, Calif., is introducing the Jetsys-5320 rugged artificial intelligence (AI) embedded computing system for mobile data-intensive applications. It provides complex general-purpose graphics processing unit (GPGPU) inference computing at the edge of the battlefield for AI and machine learning in intelligent video analytics, virtual reality, augmented reality, and unmanned vehicles. The Jetsys-5320 increases visual intelligence throughout defense and transportation applications such as high-resolution sensor processing, movement tracking security systems, automatic target recognition, threat location detection, and condition-based monitoring and predictive maintenance. At the heart of the JetSys-5320 is the NVIDIA Jetson TX2i system on module. Paired with a dual-core Denver 2 64-bit microprocessor, quad-core ARM A57 Complex, and 256 CUDA cores, NVIDIA's Pascal architecture delivers 1.3 trillion floating point operations per second (TFLOPs) of performance. The rugged embedded computing system also provides high-definition serial digital interface (HD-SDI), Gigabit Ethernet with Power-over-Ethernet, USB 3.0 interfaces for video capture, and mini PCI Express expansion slots. It operates in temperatures from -40 to 71 degrees Celsius, offers IP67-rated ingress protection, and meets MIL-STD-810G for harsh environments. For more information contact Elma Electronic online at www.elma.com.

CAMERAS

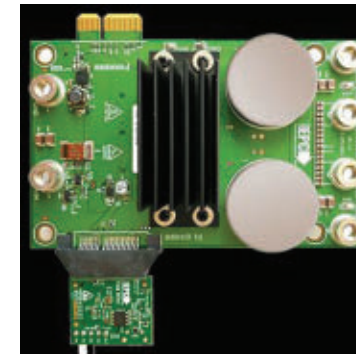
▶ Camera for aerial imaging, machine vision, and automation introduced by Teledyne Dalsa

Teledyne DALSA in Waterloo, Ontario, is introducing the Falcon4-CLHS M4480 camera, based on the Teledyne e2v Lince 11.2M monochrome sensor for industrial imaging applications requiring high-speed data transfer. The camera is for aerial imaging, machine vision, industrial automation, flat panel display inspection, semiconductor inspection, circuit board automated optical inspection. The Falcon4-CLHS model delivers an easy-to-use CLHS interface camera that can reach a frame rate as fast as 609 frames per second in 11.2 MP resolution, and several thousands of frames per second in partial scan mode. The sensor's binning mode can reach a pixel full well capacity of more than 160Ke. The Falcon4-CLHS for aerial imaging leverages standard cabling technology such as CX4 and fiber optic (AOC) cables to maximize length and speed. For more information contact Teledyne Dalsa online at www.teledynedalsa.com.

POWER CONTROL

▶ DC-DC converter demonstration board offered by Efficient Power Conversion

Efficient Power Conversion Corp. (EPC) in El Segundo, Calif., is introducing the EPC9163 two-kilowatt and two-phase 48- and 12-volt DC-DC converter demonstration board for efficient, small, and fast bidirectional converters in mild-hybrid cars and battery backup units. These power electronics devices use gallium nitride field effect transistors (GaN FETs), and operate with 96.5 percent efficiency in a small footprint. The design is scalable, in that its two converters can be paralleled to achieve 4 kilowatts, or three converters can be paralleled to achieve 6 kilowatts. The board features eight EPC2218 100-volt eGaN FETs and is controlled by a module that includes the Microchip dsPIC33CK256MP503 16-bit digital controller.



The fast-switching and low losses of the EPC9163 DC-DC converter demonstration board enables the converter to operate at 500 kHz to reduce its size. The high switching frequency capability enables the use of the extremely small IHTH-1125KZ-5A Vishay inductor in this design. For more information contact Efficient Power Conversion online at https://epc-co.com.

MISSION COMPUTERS

▲ Rugged Raspberry Pi-powered mission computer introduced by Curtiss-Wright

Curtiss-Wright Corp. Defense Solutions Division in Ashburn, Va., is introducing the Parvus DuraCOR Pi Raspberry Pi-powered mission computer for defense and aerospace applications. The small-form-factor DuraCOR Pi is ruggedized to deliver optimal performance in harsh operating environments, and is compatible with the Pi Developer Ecosystem in a military-rugged sealed housing. Based on the industrial Raspberry Pi Compute Module 4 (CM4), the DuraCOR Pi provides defense and aerospace system designers with a stackable unit that is compatible with software developed by the RPi environment's user base. The rugged computer is small enough to fit in the palm of a hand; it weighs 0.5 pounds and measures 1.2 by 2.49 by 3.34 inches. It can be stacked to extend functionality and performance via an expandable ring system design that enables system designers to configure the mix of DuraCOR Pi mission computers and hardware attached on top modules. The DuraCOR Pi also can combine in a stack with the miniaturized Parvus DuraNET 20-11 network switch, which provides carrier-grade Ethernet software Level-2+ management and support for IEEE-1588v2 precision timing protocol. DuraCOR Pi is able to run Pi operating systems such as NSA STIGd Raspian Linux, VxWorks, Windows and IoT Core, as well as Pi toolsets, and programming frameworks like Python, Java, C, and C++. For more information contact Curtiss-Wright Defense Systems online at www.curtisswrightds.com.

TEST AND MEASUREMENT

▶ Small 5G test and measurement instrument introduced by Rohde & Schwarz

Rohde & Schwarz in Munich is introducing the CMX500 5G radio communications tester to help designers eliminate the complexities of 5G NR device testing by combining ease-of-use and performance in one test and measurement instrument. The CMX500 enables even complex test setups for all 5G NR deployments, supporting many present and future 3GPP band combinations. The simplified setup results in an extremely small footprint in the lab. The CMX500 supports all 5G NR deployments covering LTE, 5G NR FR1 and FR2 in non-standalone and standalone mode, for FDD and TDD. Manufacturers of 5G NR capable chipsets and devices, and certification providers, can cover the product life cycle with the CMX500 from early research to end-to-end application testing, including device certification. Rohde & Schwarz has integrated sub-8 GHz RF units for FR1 into the CMX500. In combination with the remote radio heads, which cover millimeter wave frequencies to 50 GHz in FR2 to enable designers to simulate challenging 5G NR band combinations. High-order carrier aggregation with 8CC combinations of FR1 and FR2 in downlink is possible, which can achieve data rates of 10 gigabits per second and beyond on the IP layer. Data-hungry enhanced mobile broadband (eMBB) applications like 8K video streaming or augmented and virtual reality will call for data rates as high as 10 gigabits per second in uplink and 20 gigabits per second in the downlink. For more information contact Rohde & Schwarz online at www.rohde-schwarz.com.

DATA STORAGE

▶ DIGISTOR releases self-encrypting drives for securing data at rest

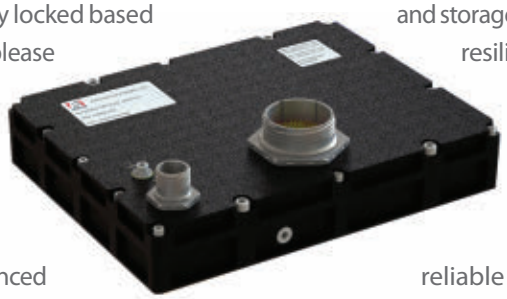
DIGISTOR in Vancouver, Wash. is announcing that the company's the C-series self-encrypting drives are available for retrofit or integration through DIGISTOR OEM and integrator partners. The C-series self-encrypting drives protect sensitive data on laptops, desktops, and other user endpoint devices. Suitable for zero-trust architectures, C-series self-encrypting drives are available in two versions, including the C-series select, which provides data invisibility, tamper-proof credentials, and zero trust file access controls. The select series is available in form factors based on the company's off-the-shelf TCG Opal and FIPS 140-2 L2 validated self-encrypting drives. Also available is the C-series advanced, which includes select capabilities plus additional firmware

that provides verified data destruction, secure access logs, and keep-alive heartbeat. C-series advanced is available in the FIPS 140-2 L2 M.2 NVMe form factor. The C-series self-encrypting drives augment DIGISTOR self-encrypting drives with file-level encryption and allow users to choose whether files are always locked or dynamically locked based on AI threat detection. For more information, please visit https://digistor.com/.

SPACE COMPUTING

Aitech releases rad-tolerant Ethernet switch for space missions

Aitech Systems in Chatsworth, Calif., has announced the S-A6640 standalone small form factor (SFF) Ethernet switch designed and tested for near-Earth orbit (NEO) and low-Earth orbit (LEO) space missions. The is a managed Ethernet switch/router with 12 1-Gigabit Ethernet copper ports and uses IP and Ethernet protocols to improve communication speeds for small satellite constellations as well as for manned missions. The S-A6640 operates as the main connectivity hub for any small satellite or human-rated space mission, operating as a scalable network architecture for all on board computing and communication equipment. Specific uses of the S-A6640 include connectivity for GPGPU, edge computing and storage as well as network protection, resiliency and scalability in NEO/LEO space applications, especially in applications with two redundant S-A6640s installed. The switch offers several advantages to ensure reliable communication. Fast Boot means operation is restored immediately in the event of power spike/outage. In addition, the IPv4/IPv6 dual stack routing enables the S-A6640 to be used in any type of IP network and the secure SSH & HTTPS interfaces facilitates easy remote management access. For more information please visit https://www.aitechsystems.com.



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