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BY **JOHN KELLER**, EDITOR IN CHIEF

Pentagon budget cut fears unfounded; the defense industry can breathe a sigh of relief

The U.S. defense industry can breathe a collective sigh of relief after the first U.S. Department of Defense (DOD) budget request to Congress from the Biden Administration last month soothed fears of potential Pentagon budget cuts.

The Biden Administration is asking Congress to allocate $715 billion for the U.S. Department of Defense (DOD) in federal fiscal year 2022, which would be a modest increase of $9.6 billion over the 2021 request of $705.4 billion in the last year of the Trump Administration. Federal fiscal year 2022 begins next 1 Oct.

The military spending request also is heartening news for military technology development, and proposes spending $112 billion for defense research, development, test, and evaluation — a 5.1 percent increase over 2021 — which Biden Administration officials say would be the largest-ever Pentagon research budget.

In addition, DOD leaders say they plan to invest $874 million next year in artificial intelligence (AI)-related technologies to boost deterrence against potential adversaries like China.

Pentagon experts are asking Congress for AI funding in several projects. The Pentagon's AI efforts now number more than 600, which is up about 50 percent over current-year levels, DOD officials say.

In efforts to keep technological pace with adversaries, DOD is leveraging technological advantages and investing in cutting-edge technologies like AI, hypersonic technology, cyber, and quantum computing, among others.

If this DOD budget request is any indication, then the nation's defense executives should have few worries over the course of Biden Administration's first term.

The U.S. Navy would spend $22.64 billion next year on technology research, up from $20.14 billion this year. The Navy wants to spend $134.3 million in operational systems development to upgrade and modernize the RQ-4 Global Hawk long-range surveillance unmanned aircraft; $133.5 million on anti-radar missile improvement; $132.2 million to upgrade the Tomahawk cruise missile and Tomahawk Mission Planning Center (TMPC); $176.5 million to improve the Cooperative Engagement Capability (CEC) system; $177.1 for strategic submarine weapons systems; and $114.5 million to improve the MK 48 advanced capability torpedo.

The U.S. Army wants to spend $12.8 billion on research next year, which is down from $14.14 billion this year. Included is $233.5 million for Indirect Fire Protection Capability Increment 2 - Block 1; $213.3 million for 155-millimeter self-propelled howitzer cannon improvements; and $211.5 million for combat vehicle improvement programs.

Army officials also want to spend $188.5 million for the Precision Strike Missile (PrSM); $111.5 million for hypersonic weapons development; $63.9 million for the Guided Multiple-Launch Rocket System (GMLRS); $57.7 million for the AN/TPQ-53 counter-fire target acquisition radar system; $8.9 million for anti-tamper technology; $5.7 million for electronic warfare system development; and $1.2 million for a family of biometric systems.

Defense agencies within the Pentagon have asked Congress for $25.86 billion in 2022, which is down from current-year levels of $26 billion. The largest spender would be the U.S. Missile Defense Agency (MDA), which has asked for $7.16 billion, which is down from $7.86 billion this year. Next is the Office of the Secretary of Defense, which has asked for $5.23 billion. The Defense Advanced Research Projects Agency (DARPA) has asked for $3.53 billion, while the Space Development Agency has asked for $808.8 million; the Special Operations Command for $695.6 million; the Defense Threat Reduction Agency for $634.9 million; the Defense Information Systems Agency (DISA) for $377.8 million; and the Defense Logistics Agency (DLA) for $251.9 million.

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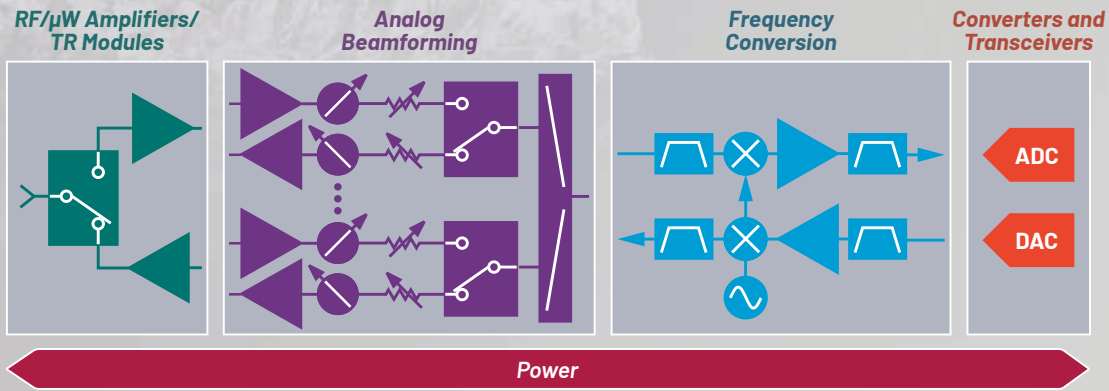

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The proposed fiscal 2022 Pentagon budget would boost military spending by $9.6 billion compared to this year.

Proposed 2022 DOD budget would increase defense spending to $715 billion

BY **John Keller**

WASHINGTON — The administration of U.S. President Joseph Biden is asking Congress for $715 billion for the U.S. Department of Defense (DOD) in federal fiscal year 2022, which would be a modest increase of $9.6 billion over the 2021 request of $705.4 billion in the last year of the Trump Administration.

This increase would be an increase of 1.36 percent over last year's request. Of the 2021 request, submitted in February 2020, Congress enacted $703.7 billion. Federal fiscal year 2022 begins next 1 Oct.

In a nod to military technology development, The 2022 DOD budget request proposes spending $112 billion for defense research, development, test, and evaluation — a 5.1 percent increase over 2021 — which Biden Administration officials say would be the largest-ever Pentagon research budget.

Much of the military research budget would go for technological priorities like microelectronics, hypersonic missiles, artificial intelligence (AI), cyberspace capabilities, and a military 5G network, DOD officials say.

The 2022 DOD budget request includes $20.4 billion for missile defense, which represents a slight reduction over the $20.9 billion enacted in 2021.

The DOD budget request also has $6.6 billion for long-range fire support; $52.4 billion for fourth- and fifth-generation fighter aircraft; $34.6 billion for a hybrid fleet of manned and unmanned naval vessels; $12.3 billion for ground weapons and next-generation combat vehicles; $20.4 billion for cyberspace activities; and $122.1 billion for training, installation support, and support to U.S. allies.

The Biden Administration is asking Congress to authorize the purchase of 85 Lockheed Martin F-35 joint strike fighter aircraft next year for $12 billion, which would be a reduction from the $12.9 billion enacted in 2021 for 96 F-35 military planes.

The budget proposes spending $6.9 billion for two new Virginia-class (SSN 774) fast-attack submarines in 2022,

which would be a slight decrease from 2021's $7.2 billion. It also would spend $5 billion next year for developing the future Columbia-class ballistic missile submarine, which is down from 2021's $4.5 billion.

Pentagon leaders also want to spend $3 billion next year developing the future B-21 Raider strategic heavy bomber aircraft, which is up from $4.5 billion in 2121. Likewise, military officials next year want to spend $2.9 billion developing the future Ford-class aircraft carriers, which is equal to 2021.

The proposed budget would spend $2.6 billion to continue the Next-Generation Overhead Persistent Infrared (NG OPIR) strategic missile warning system to blend mature resiliency features to increase survivability in a contested environment. Additionally, the U.S. Space Force would carry out a technology refresh of the sensor NG OPIR sensor to assure missile warning capabilities equal to or greater than today's SBIRS.

In other major projects, the 2021 DOD budget proposal would spend $2.5 billion on the KC-46 aerial tanker; $2.4 billion to buy one new Arleigh Burke-class Navy destroyer; $1.8 billion on Global Positioning System (GPS) improvements; $1.7 billion on National Security Space Launch capability; and $1.7 billion to develop the CH-53K King Stallion heavy-lift helicopter.

Little chance for Pentagon to eliminate programs in 2022 DOD budget

If you were expecting the Biden administration to cancel a raft of weapons programs inherited from the Trump years, guess again. The U.S. Department of Defense (DOD) investment priorities revealed by the White House in last Friday's budget release are nearly identical to those of the Trump administration. The story being floated by Pentagon officials is that the proposed DOD budget for fiscal 2022 is a placeholder until Biden and company have time to think through their true priorities, which will be reflected in the 2023 budget. Don't hold your breath waiting for that to happen. The more likely outcome is that little will change, for three reasons: First, the proposed 2023 budget will become public in the same year that midterm elections occur, and nobody at the White House wants to rub voters the wrong way by trying to eliminate programs that generate thousands of jobs; there is a striking degree of similarity in the priorities of military experts from both parties; and President Trump generally deferred to those priorities in building his own military budgets.

Army, NSA approach industry for quantum computing research

The U.S. Army Research Office (ARO) in Durham, N.C., and the National Security Agency (NSA) Laboratory for Physical Sciences (LPS) at Fort Meade, Md., have launched a research hub intended to connect scientists and engineers to explore the limits of quantum computing information technologies. In a solicitation to industry, ARO and LPS officials describe early research areas to be pursued via a project called the LPS Qubit Collaboratory, or LQC, and invite proposals to push forward experimental efforts that make sense for cooperative approaches. "Substantial progress on solving the most difficult and long-term Quantum Information Science & Technology (QIST) research problems that unleash further rapid progress in the field will constitute LQC success," officials wrote in the solicitation. QIST involves probing and manipulating subatomic phenomena with the intent to transform how humans process and move data. It is expected to usher in new forms of sensing, communications and trusted-computing, and has inspired interest across the government. Passed at the end of 2018, the National Quantum Initiative outlines a coordinated federal plan to accelerate and advance quantum technology-centered studies and applications in the United States.

U.S. Navy's hypersonic kinetic-kill electromagnetic railgun project faces axe

After some 16 years of research and development, the U.S. Navy appears poised to kill its electromagnetic railgun program. The service has not asked for any new funding for the project in its latest budget request and says it will wrap up all the work it has planned now by the end of the current fiscal year, before effectively putting what's left of this effort into storage. Since the Office of Naval Research (ONR) formally began work on the railgun project in 2005, funding has come through different line items. In the past, this sometimes caused confusion and led to erroneous reports that the program had been canceled. The Navy's plans now seem to be clear.

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It may be next year before electronics supply chain recovers from COVID-19 pandemic

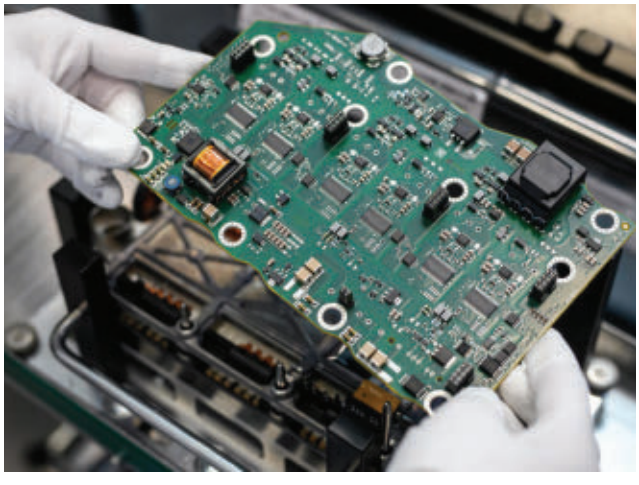
BY **John Keller**

FORT WORTH, Texas — While U.S. electronics manufacturing is starting to recover from the COVID-19 pandemic, aerospace and defense systems designers are confronting new market conditions that are making the defense electronics supply chain perhaps as difficult as it was during the depths of the pandemic.

Those involved in the military electronics industry know it's difficult to find components and raw materials for many kinds of electronic systems and subsystems. This time, though, it's not the pandemic that's slowing down the supply chain; it's competition with the commercial electronics industry, which is ramping-up far more quickly than defense manufacturing.

"Most factories have manufacturing back to normal," says Don Akery, president of electronics distributor TTI Americas in Fort Worth, Texas. "What's changed is the suppliers of these components for aerospace and defense have seen only a slight increase in demand, but all the other markets are seeing unusually large increases in demand."

While demand for aerospace and defense electronic components is up 6 percent from the pandemic year of 2020, automotive bookings, for example, are up 60 percent, industrial demand is up 30 percent, communications is up 80 percent, and computing is up 30 percent.



The lingering pandemic-induced delays and long lead times in the defense electronics supply chain may last until next year.

"Demand in all these other segments are increasing at those levels, and in those factories they have been loaded-up with non-aerospace and defense components, so we have to compete for those components," Akery says.

"That's been the lingering impact on the supply chain that started with the pandemic," Akery continues. "Coming out of the pandemic, this increased demand has continued to make the supply chain very tough. Prices have gone up and continue to accelerate."

The weather freeze in Texas last February didn't help, Akery says. "The freeze actually shut down a lot of manufacturing plants, and some of those plants are still not fully operational. Raw materials are not recovering, with connectors most prevalent. Those shortages and prices on resins have gone up dramatically."

One factor that has eased pressure on the electronics supply chain is the pandemic-induced drastic slowdown in commercial aircraft manufacturing. "Commercial aviation has been down as commercial air traffic came virtually to a stop during the pandemic," Akery says. "That actually helped the supply chain because it freed-up capacity."

There's some good news for component lead times — or the time it takes to receive component shipments after ordering. "I do believe that lead times are not getting additional push-outs; they have stabilized," Akery says. "By the end of this year we will see lead times come down, and it will be next year before they come down to pre-pandemic levels.

Lead times for some components — particularly for electronic connectors — continue to be hard-hit. While lead times for interconnect products were eight to ten weeks during the first quarter of 2020, today connector lead times can be as high as 16 to 18 weeks. Those waiting for complex connectors today may have to wait for as long as 36 weeks.

Akery recommends that systems integrators give as much information to their suppliers about their future demands so suppliers can plan for the necessary raw materials, and evaluate capacity in effort to keep supply disruptions to a minimum.

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The Pentagon is proposing a 2022 budget for research, development, and technology that may be at an all-time high.

2022 DOD budget proposes record spending for military research

BY **John Keller**

WASHINGTON — U.S. Department of Defense (DOD) leaders are asking for a record amount of money next year — nearly $122 billion — to fund technology development in microelectronics, hypersonics, artificial intelligence (AI), cyber security, and similar high-priority military capabilities.

Pentagon experts are asking Congress for $111.96 billion in federal fiscal year 2022 for research, development, test, and evaluation (RDT&E), which would be a 4.2 percent increase from the $107.45 billion that Congress allocated in 2021. Federal fiscal year 2022 begins next 1 Oct.

The U.S. Navy, Air Force, and Space Force all would receive spending increases for research in the 2022 DOD budget, while the U.S. Army, and defense-wide agencies would receive modest cuts.

The Air Force would be the biggest research spender next year, with a request of $39.18 billion — up 7.8 percent from current-year levels of $36.36 billion.

One of the largest Air Force research programs is the future Next-Generation Overhead Persistent Infrared (NG OPIR) strategic missile warning system to blend mature resiliency features to increase survivability in a contested environment, for which Air Force experts want to spend $2.45 billion for advanced component development and prototypes.

The Air Force also wants to spend $264.3 million for military research on GPS III Follow-on satellite navigation system development and demonstration; $221.5 million on National Security Space Launch Program full-scale development; $127.9 million on Polar MILSATCOM satellite communications; and $127 million on Space Situation Awareness Systems.

The U.S. Navy would spend $22.64 billion next year on technology research, up from $20.14 billion this year. The Navy wants to spend $134.3 million in operational systems development to upgrade and modernize the RQ-4 Global Hawk long-range surveillance unmanned aircraft; $133.5 million on anti-radar missile improvement; $132.2 million to upgrade the Tomahawk cruise missile and

Tomahawk Mission Planning Center (TMPC); $176.5 million to improve the Cooperative Engagement Capability (CEC) system; $177.1 for strategic submarine weapons systems; and $114.5 million to improve the MK 48 advanced capability torpedo.

Navy officials also want to spend $1.37 billion on the Conventional Prompt Strike (CPS) non-nuclear hypersonic weapon system; $343.5 million on Standard Missile improvements; $243.9 million to develop the Next-Generation Jammer (NGJ) Increment II; $144.8 million to develop medium and large unmanned surface vehicles (USVs); $109.5 million on open-ocean frigate development; $102.8 million on developing a ground-based anti-ship missile; $99.8 million on advanced submarine systems development; $88.1 million on large unmanned undersea vehicles; $84.7 million on small and medium unmanned undersea vehicles; $81.8 million on directed-energy and electric weapon systems; $60 million on medium unmanned surface vehicles (MUSVs); $58 million on surface and shallow-water mine countermeasures; $17.6 million on anti-submarine warfare (ASW) technology; and $13.4 million on non-lethal weapons development.

The U.S. Army wants to spend $12.8 billion on research next year, which is down from $14.14 billion this year. Included is $233.5 million for Indirect Fire Protection Capability Increment 2 - Block 1; $213.3 million for 155-millimeter self-propelled howitzer cannon improvements; and $211.5 million for combat vehicle improvement programs.

Army officials also want to spend $188.5 million for the Precision Strike Missile (PrSM); $111.5 million for hypersonic weapons development; $63.9 million for the Guided Multiple-Launch Rocket System (GMLRS); $57.7 million for the AN/TPQ-53 counter-fire target acquisition radar system; $8.9 million for anti-tamper technology; $5.7 million for electronic warfare system development; and $1.2 million for a family of biometric systems.

Defense agencies within the Pentagon have asked Congress for $25.86 billion in 2022, which is down from current-year levels of $26 billion. The largest spender would be the U.S. Missile Defense Agency (MDA), which has asked for $7.16 billion, which is

Continued on page 11

10 companies that will compete for cyber security systems engineering support jobs over the next two to eight years.

Navy picks 10 computer companies to provide cyber security software development

BY **John Keller**

SAN DIEGO — U.S. Navy information warfare experts are naming 10 companies that will compete for cyber security systems engineering support jobs over the next two to eight years under terms of a potential $178.4 million contract.

Officials of the Naval Information Warfare Center Pacific in San Diego are hiring these cyber security companies in a $47.3 million two-year contract, which has software development and hardware options that with options could extend through 2018.

The companies are:

- Advanced Sciences and Technologies LLC in Berlin, N.J.;
- Bart & Associates Inc. in McLean, Va.;
- Dark Wolf Solutions LLC in Chantilly, Va.;
- Data Intelligence LLC in Marlton, N.J.;
- Grove Resource Solutions Inc. (GRSi) in Frederick, Md.;
- ODME Solutions LLC in San Diego;
- Solute Inc. in San Diego;
- Sugpiat Defense LLC in Anchorage, Alaska;
- Timitron Corp. in Portsmouth, Va.; and
- Vector Planning & Services Inc. (VPSI) in San Diego.

In addition to cyber security systems engineering support, these companies will provide software development and training, hardware engineering, network engineering, configuration management, and information assurance planning.

The companies will compete for task orders during the ordering period. This two-year contract includes one three-year option period and one two-year option.

On this contract the 10 companies will do the work in Philadelphia, Washington, and San Diego. For more information contact the Naval Information Warfare Center Pacific-San Diego online at www.niwcpacific.navy.mil.

2022 DOD budget proposes record spending for military research

Continued from page 9

down from $7.86 billion this year. Next is the Office of the Secretary of Defense, which has asked for $5.23 billion. The Defense Advanced Research Projects Agency (DARPA) has asked for $3.53 billion, while the Space Development Agency has asked for $808.8 million; the Special Operations Command for $695.6 million; the Defense Threat Reduction Agency for $634.9 million; the Defense Information Systems Agency (DISA) for $377.8 million; and the Defense Logistics Agency (DLA) for $251.9 million.

The Missile Defense Agency wants to spend $745.1 million on the ballistic missile defense midcourse segment; $732.5 million on Aegis shipboard ballistic missile defense technologies; $603.4 million on ballistic missile defense command and control; $553.3 million for ballistic missile defense targets; $224.8 million on ballistic missile defense sensors; $147.2 on the sea-based X-band radar; and $247.9 million on hypersonic missile defense.

The Office of the Secretary of Defense wants to spend $623.1 million on trusted and assured microelectronics; $168.8 million on high-energy laser weapons research; $51.3 million for joint hypersonic technology development; $31.6 million for cyber resiliency and cyber security policy; $18.2 million for joint electronics advanced technology; and $15.4 million for cyber security research.

DARPA would spend $584.8 million on network-centric warfare technology; $474.1 million on basic and advanced electronics technologies; $294.8 million for sensor technology; and $251.8 million for command, control, and communications systems.

Special Operations Command would spend $173.5 million on special-ops aviation systems; $32.8 million on intelligence systems development; $19.1 million on upgrades to the MQ-9 unmanned aircraft; $18 million on unmanned intelligence, surveillance, and reconnaissance; $7.7 million on special forces tactical vehicles; and $6 million on distributed common ground and surface systems.

DISA, meanwhile, would spend $196.7 million on joint artificial intelligence programs; $19.3 million for defense spectrum organization; $10.3 million on long-haul communications; $5.7 million for the Information Systems Security Program; and $4.9 million for the Minimum Essential Emergency Communications Network (MEECN).

Artificial intelligence (AI), cyber warfare, quantum computing, hypersonics, electronic warfare (EW), avionics, and secure communications are among the topics in a new U.S. naval aviation research initiative.

Wanted: research in artificial intelligence (AI), cyber, and hypersonic technologies

BY **John Keller**

PATUXENT RIVER NAS, Md. — Artificial intelligence (AI), cyber warfare, quantum computing, hypersonics, electronic warfare (EW), avionics, and secure communications are only a few of the topics in a new U.S. naval aviation research initiative.

Officials of the Naval Air Warfare Center Aircraft Division (NAWCAD) at Patuxent River Naval Air Station, Md., have released an officewide research solicitation (N00421-21-S-0001) for research topics that also include avionics, sensors and electronic warfare; aeromechanics; power and propulsion systems; systems engineering; data science and visualization; and warfare analysis.

The FY21 Naval Air Warfare Center Aircraft Division (NAWCAD) Office-Wide Broad Agency Announcement will be open for one year, and involves white paper submissions and invitations for a select number of companies to submit formal proposals who previously offered promising white papers.

The 17 research topics involved in this solicitation are:

- AI and machine learning, which involves autonomous system development, testing, evaluation, verification and validation tools, collaborative autonomy, complex reasoning, agent based decision making, deep reinforcement learning, neural networks, and demand forecasting;
- data science and visualization, which involves predictive modeling algorithms, complex big-data environments, data access, storage and retrieval, data visualization techniques, and statistical analysis;
- cyber, which involves cyber effects modeling, reverse engineering, applied cryptology, behavioral analysis, intrusion, adaptive cyber security, simulation and interface research, concolic testing and systems configuration management;
- quantum, which involves secure communication and sensing capabilities, nitrogen vacancy diamond sensing, quantum encryption, and quantum computing;
- hypersonic systems, which involves testing and evaluation, high temperature and specific strength materials and structures, propulsion, and multidiscipline, high-fidelity modeling and simulation;
- test and evaluation engineering, which involves telemetry, communications, data links and data

acquisition, signature technologies, mission system testing, system of systems testing environments, virtual reality (VR), augmented reality (AR), extended reality (XR), target engineering, airborne threat simulation, integrated battle-space simulation (Live Virtual Constructive Environments), hardware-in-the-loop testing, flight instrumentation, ground radar analysis, test article configuration, navigation, and identification, manned-unmanned teaming, advance training systems to include instructional techniques and strategies, and game-based training;

- avionics, sensors and EW, which involves passive/active sensor systems (RF, EO/IR, and acoustic), advanced/alternative precision navigation and timing (PNT), advanced computational/open system architectures, advanced signal and image processing, flight information and control systems, and advanced concepts in electronic warfare systems;
- secure communications and networks, which involves resilient data and communications networks for Command and Control, platform/system health monitoring, effective data transfer of both communications and video, all with consideration for autonomous applications, while performing in dynamic and contested environments;
- warfare analysis, which involves operational suitability, signal extraction, clutter reduction, modeling and simulation, maritime effectiveness, vulnerability and capability based assessment, and conceptual aircraft design;
- readiness and sustainment, which involves automated sustainment environment, diagnostics and prognostics, predictive maintenance, digital thread integration, logistics modeling and simulation, and condition based maintenance improvements;
- materials and aircraft structures, which involves additive manufacturing, corrosion prevention, non-destructive inspection, metals and ceramics, polymers and composites, analysis and simulation of aircraft structures, structural mechanics, and life management of airframes;
- aeromechanics, which involves aerodynamic and flight controls (manned and unmanned), aeromechanics modeling and analysis tools, flight performance, rotorcraft aerodynamics and performance, ship/aircraft aerodynamic interactions, and unmanned aviation and integration including pilot augmentation and automation and UAV autonomous landing flight mechanics;
- mechanical systems, which involves fire and ice protection, fuel containment, hydraulic systems, pneumatic systems and landing gear systems analysis;
- power and propulsion systems, which involves reliability engineering, fuel systems, prognostics and diagnostics, energy storage/efficiency, air-breathing engines, fuels and lubricants, electrical power generation, auxiliary power, low observable signature technologies, propulsion life management, and mechanical and drive systems;
- human systems, which involves human performance assessment and modeling, cognitive performance/workload, human-machine interface/teaming, protective equipment, controls and displays, ergonomics, anthropomorphic measurement, virtual environments, and human factor engineering (social, behavioral, health, and cultural);
- support equipment, which involves launch and recovery equipment, electro-magnetics, high-energy generation and control, environmental sensing, prognostics and health monitoring, automatic testing of hardware and software, displays, advanced maintenance technologies, information systems and intelligent agents, and advanced computer and data processing applications; and
- systems engineering, which involves integrated modeling environments, model based systems engineering methodology, integration of system models and physics-based models, systems safety engineering, air platform development and integration, system of systems architectures, aviation/ship integration, combat survivability, reliability and maintainability engineering, anti-tamper engineering, electromagnetic environmental effects engineering, manufacturing and cost analysis. NAWCAD may also consider submissions outside these areas if the white paper involves the development of novel-based capabilities with potential to enhance naval capabilities.

Companies interested should email three-page white papers no later than 2 June 2022 to the Navy at NAWCAD_OFFICEWID.fct@navy.mil, with N00421-21-S-0001 in the subject line. More information is online at https://sam.gov/opp/3a0e0f16bedb42db830347d-2c18fc9e9/view.

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The Navy has tested at least two different railgun designs since 2005, one from BAE Systems and one from General Atomics, with the former being the primary prototype the service has used in its previous research and development efforts. Both of these weapons functioned in the same way, launching solid projectiles at hypersonic speeds using powerful electrically generated magnetic fields.

Air Force asks Viasat for encryption in experimental Link 16 satellite

A new Link 16-capable satellite under development by Viasat Inc. in Carlsbad, Calif., will feature military-grade encryption, company officials say. The Link 16 datalink is the U.S. military's primary tactical data exchange network that enables warfighters to share information on the location of friendly and enemy forces to build a common operating picture of the battlefield. Still, Link 16 can't be used to connect warfighters and sensors that are beyond line of sight of each other. Scientists at the Air Force Research Laboratory wanted to change that. In 2019, the lab issued a $10 million contract to Viasat to build a Link 16-capable satellite. By tying directly into the Link 16 tactical network from low Earth orbit, the satellite could connect beyond-line-of-sight forces. Viasat officials say the satellite will integrate the company's In-Line Network Encryptor to give the system radiation-tolerant network encryption that can support more than 100 megabits of data throughput per second. That level of encryption will ensure that classified data can move securely through the otherwise unclassified satellite.

Royal Navy uses AI to counter live missiles in hypersonic rehearsal

The United Kingdom Royal Navy has used artificial intelligence (AI) to help counter live-fire supersonic missile attacks in sea trials for the first time. Part of the Formidable Shield NATO exercise involving 10 nations, 15 ships, dozens of aircraft, and about 3,300 personnel, off the coasts of Scotland and Norway, the test seeks to detect, track, and intercept sea-skimming supersonic missiles as well as ballistic missiles faster with less human intervention. Supersonic missiles are among the most formidable weapons in modern naval arsenals. With their ability to fly faster than the speed of sound close to the water, these weapons are difficult to counter; intercepting them requires instant calculation and decision-making, sometimes involving destroying an incoming threat when it comes within 5,000 feet of its target. With the emergence of hypersonic weapons, there is the danger of air defense operators, even with the aid of computers, being overwhelmed with analyzing massive amounts of data, identifying threats, and launching the correct countermeasures.

Navy scraps 500-ship fleet in 2021 budget; asks for only one new destroyer

The U.S. Navy's modest shipbuilding request 2022 DOD budget shows the Pentagon has walked away from the 500-ship Navy, a senior defense analyst says. The 2022 shipbuilding request in the DOD budget is seeking $22.6 billion — a 3 percent drop from the 2021 shipbuilding total. The move shows the Pentagon has abandoned the Trump administration's plan for an expanded Navy, says retired Army Maj. Gen. John Ferrari, a visiting fellow at the American Enterprise Institute (AEI) in Washington. Ferrari was referring to the Battle Force 2045 plan that proposed to expand the fleet beyond the Navy's 355-ship goal set in 2016. The plan envisioned an aggressive shipbuilding program and added a range of unmanned vessels to the fleet's size. Todd Harrison, a budget specialist at the Center for Strategic and International Studies, says Battle Force 2045 was not fundable because it never considered the budget impact on the other services. Some expect Congress to restore funding for a second Arleigh Burke-class destroyer and a Capitol Hill battle over divesting legacy systems.

Army uniforms with embedded sensors soon could track soldier body's signals

U.S. Army Researchers have taken the first steps in building fiber-embedded clothing for Army uniforms that works like a fiber computer on the body to collect and communicate a soldier's physiological, environmental, and location data for near-instant feedback. Future military uniforms with this technology could power sensors, store and analyze collected data, and transmit that data to outside sources, Army officials say. The project is part of work done at the Army's Institute for Soldier Nanotechnologies at the Massachusetts Institute of Technology (MIT) in Cambridge, Mass., and through the Combat Capabilities Development Command's Army Research Laboratory in Research Triangle Park, N.C.

Raytheon will provide airborne counter-mine capability for the Navy Littoral Combat Ship against bottom and moored sea mines.

Raytheon to build airborne counter-mine and data processing capability for LCS

BY **John Keller**

WASHINGTON — Undersea warfare experts at Raytheon Technologies Corp. are continuing production of an advanced airborne counter-mine system designed to locate and neutralize bottom and moored ocean mines to help U.S. and allied naval forces operate in littoral zones, confined straits, choke points, and invasion beaches.

Officials of the Naval Sea Systems Command in Washington announced a $16.8 million order to the Raytheon Missiles & Defense segment in Portsmouth, R.I., to build Airborne Mine Neutralization Systems (AMNS). With options, this order eventually could be worth $68.6 million.

The Airborne Mine Neutralization System will provide littoral combat ship (LCS) commanders with a rapid, organic counter-mine capability against bottom and moored sea mines. Navy forces will deploy the AMNS from the MH-60 helicopter as part of the LCS mine countermeasures mission module, Navy officials say.

The AMNS deploys explosive mine-destroying ocean vehicles from a launch and handling system (LHS) on the Navy MH-60S helicopter. The mine-destroying unmanned underwater vehicle (UUV) takes its control from the helicopter's common console; it identifies mines before controllers on the helicopter command it to explode and destroy the mine nearby.

The AN/ASQ-235 AMNS consists of two major subsystems: the LHS and the neutralizer. The LHS performs data processing during an AMNS mission, while the LHS manages the neutralizers, and enables the helicopter's common console to communicate with the neutralizers.

The LHS connects with the carriage stream tow and recovery system (CSTRS) and can carry as many as four neutralizers on each mission. Each of the four neutralizers can launch one at a time without recovering the LHS.

The neutralizer communicates with the common console via a fiber-optic data link and provides sonar and video data to operators using the common console. The neutralizer contains a sonar, video camera, and light to find, identify, and attack enemy sea mines.

The neutralizer has six degrees of motion, can maintain a hover position, and can be operated either in automatic or manual mode. The neutralizer also can monitor depth and relative distance from the bottom and can avoid bottom plowing. The operators determine the neutralizer's position with an Integrated Track Point II acoustic tracking system in the LHS.

On this contract modification Raytheon will do the work in Portsmouth, R.I., and should be finished by March 204. For more information contact Raytheon Missiles & Defense online at www.raytheonmissilesanddefense.com, or Naval Sea Systems Command at www.navsea.navy.mil.

Among the most promising applications of early versions of today's deployable laser weapons involves destroying or disabling enemy unmanned aerial vehicle (UAVs).

High-energy laser weapons move quickly from prototype to deployment

U.S. military forces are installing deployable laser weapons on Navy destroyers, Army armored combat vehicles, and even on all-terrain vehicles.

BY **Megan Crouse**

When it comes to defending against oncoming missiles, laser weapons could provide a precise way to target and destroy from aboard a vehicle or ship. Laser weapons can defend against a mortar, which does not have a guidance system, or against a sophisticated drone. They travel at the speed of light and can be tuned to produce as little or as much damage deemed appropriate for the situation. In addition, they have a low capacity for collateral damage, since the size of the beam is so small and precise.

With all these capabilities, however, sometimes it seems that news of laser weapons has been played out. Since the 1960s, engineers and science fiction writers have debated the capabilities and uses of directed light. How many articles say something new is coming in the next five years — the same as they did five years ago? While we can't say for sure whether laser

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The U.S. Navy is set to complete installation of the High Energy Laser and Integrated Optical-dazzler and Surveillance (HELIOS) system aboard the destroyer USS Preble sometime this year.

weapons will change the game, the U.S. military — especially the Navy and Army — has poured time and money into lasers in the last year. So what's the truth? Are laser weapons possible, or will they be forever just on the cusp of practical adoption?

U.S. Navy leaders today are beginning to deploy working lasers and figure out how to integrate them into existing military weapon systems. In November 2020 Rob Afzal, Lockheed Martin Corp. senior fellow of laser and sensor systems explained why, despite being around almost as long as rocketry itself, it has taken so long for today's militaries to deploy laser weapons. "The issue, though, was that those systems were basically just too big, literally. They were physically too big to really be deployed in the tactical environment, on a truck or on an airplane, even on a ship, without taking up large portions of the ship."

Now, that's changing. In a test around this time last year the Navy used a solid state laser — technology maturation (SSL-TM) laser weapons system demonstrator (LWSD) MK 2 MOD 0 from the amphibious transport dock ship USS Portland (LPD 27) to shoot down an unmanned aerial vehicle (UAV) during tests.

So, what is the state of laser technology today? And has science fiction truly become reality, or is it still all talk and hopes? Where and by who are they currently deployed?

The U.S. Army, Air Force, and Navy all have applications and equipment for laser systems today. In 2020 Army leaders announced they will be testing 50-kilowatt lasers mounted on Stryker wheeled combat vehicles. Built by two subcontractors, Northrop Grumman Corp. and Raytheon Technologies Corp., and prime contractor Kord Technologies, these Directed Energy Maneuver Short-Range Air Defense systems, or DE M-SHORAD, will begin testing this summer.

The Navy's littoral combat ship USS Little Rock has a 150-kilowatt laser weapon, likely Lockheed Martin's $150 million High Energy Laser and Integrated Optical-dazzler and Surveillance (HELIOS), or the Surface Navy Laser Weapon System (SNLWS) Increment 1, making it the fourth Navy ship with such a system. This was a relatively easy meeting of ship and system, since both were made by Lockheed Martin.

While some of these laser weapons are offensive, others are dazzlers, made to confuse and blind sensors on other ships, aircraft, or flying missiles. These can burn out a vehicle's cameras without pursuing an aggressive

Raytheon has installed the prototype High Energy Laser Weapon System (HELWS) aboard a Polaris MRZR all-terrain vehicle to defend military forces from enemy unmanned aircraft.

action. The guided missile destroyer USS Dewey, for example, has been fitted with a weapon that is known as ODIN, or Optical Dazzling Interdictor. This essentially blinds drones and causes them to crash. HELIOS can do both, combining dazzler capabilities with actual destruction.

There are some limitations as to what system can go on what ship, naturally. Not all ships can support the 150-kilowatt class systems. This is just one of the areas in which implementing laser weapons is a process in flux, as the Navy and other branches and manufacturers work on making integration with existing vehicles practical.

In a 2021 report, the Congressional Research Service named one of the use cases for lasers on ships as "potential combat situations against adversaries, such as China, that are armed with large numbers of missiles, including advanced models, and large numbers of UAVs."

Lasers could solve two problems of combatting missiles and unmanned aircraft: restricted amounts of ammunition for surface-to-air missiles and Gatling guns, or unfavorable costs.

Since solid state lasers are powered by electricity, they could be fired indefinitely as long as the ship and the laser are operating properly. They also cost less and can defend against small boats and UAVs that might otherwise take from the pool of limited ammunition. Solid-state lasers ideally can counter fast-moving targets with precision, and offer the variability to be used for different responses from simply monitoring targets to causing major damage.

A brief history of high-energy lasers

The U.S. military has had electromagnetic spectrum weapons in mind since the 1960s. Throughout the 1980s, industry and military laid the groundwork for figuring out how to reach practical power levels, beam control and adaptive optics. The Department of Defense officially recognized lasers as a plausible future weapon in 1999, marking the beginning of formal research and development.

However, researchers did demonstrate limited-use lasers earlier than that, with the U.S. Defense Advanced Research Projects Agency (DARPA) firing a 100-kilowatt laser in 1968 and the Navy-ARPA Chemical Laser producing 250 kilowatts in 1975.

Of course, to know what today's lasers need when it comes to their

The U.S. Air Force has ordered High Energy Laser Weapon Systems (HELWS) for field testing to determine if the system can adequately defend against enemy drones.

onboard electronics, we need to know how a laser works in the first place. Technically a little-known acronym for "light amplification by stimulated emission of radiation," lasers emit directed coherent light of a single wavelength.

When we refer to a solid-state laser, we're specifying the source of power used to excite the photons that make up the beam. In a solid-state laser the tasing mechanism is a rod made up of a solid medium, such as glass, crystal or a gem, and an active material such as chromium, titanium or others. Alongside being weapons themselves, these are often the type of lasers used on range finders and target designators, since they can be made to fit in small spaces, are relatively inexpensive, and can run on batteries.

Today's optical fiber lasers also are technically solid state, using optical fibers as the gain medium. They're more rugged than older solid-state lasers, and don't require a clean room to operate or be maintained.

The Navy's first use of a prototype solid-state laser was in 2009, a laser weapon system which was tested against drones and had a reported beam power of 30 kilowatts. The amphibious transport dock ship USS Ponce carried an AN/SEQ-3 Laser Weapon System (LaWS) in August 2014 to test the system against swarming boats and swarming UAVs. At that time, it was considered "operational." From there it was replaced with another ship and the LaWS removed to be refurbished as a test asset for the HELIOS system.

New Threats

New and different threats also make high-energy lasers more practical than they were before.

"High-energy laser systems are a better match to the threats we now face versus the threats 10 or 20 years ago," says Iain McKinnie, director for science and technology at the Raytheon Intelligence & Space segment in McKinney, Texas. "A lot of low-end threats have become much more widely available, more proliferated and widely available. I'm thinking of class 1 or 2 drones that can be armed or used as targeting assets, but also rockets, artillery or mortars. Lasers are really well-suited to deal with threats not particularly hardened, not particularly difficult to kill from a laser standpoint. Also depending on how they're operated they have a very large or infinite magazine."

In the past. lasers have been considered to be a way to defend against ballistic missiles, McKinnie says. However, that's still a difficult application and doesn't take advantage of the large magazine.

SWAP problems and solutions

"What is ironic about the recent attempts is that although I think the technology demonstrators were successful, meaning the system could be put together, and could track, engage and put lethal influence on a target to negate it, the systems themselves are

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

not of a tactically relevant size, weight and power," says Lockheed Martin's Afzal. Those systems couldn't be packaged or integrated.

But three things have changed. First, he says, the development of fiber laser technology has enabled the systems to be "the most efficient at converting electric power into a high-power beam, which means your electrical power systems and waste heat systems are minimized because efficiency is high." Second, the beam is of high-quality. Third, the commercial industrial base now can provide many of the core components.

Lockheed Martin developed the ability to combine the output of a large number of individual fiber lasers instead of trying to build a bigger single beam, says Lockheed Martin's Afzal.

Commercial influence

There are several ways that commercial laser technologies have influenced military laser weapons. Fiber-optics became widely used in communications, and fiber-laser cutters allowed for industrial cutting, welding, and drilling more cost-effectively. Building smart phones and other small electronic devices required very high beam quality from fiber laser cutters, meaning the beam could be focused very specifically.

The Congressional report says significant advancements in industrial solid-state lasers and military research have been critical to making advancements in this area. From there, defense use requires combining mutual individual fiber lasers using spectral beam combination. It reflects those fiber-laser channels off a gating that combines them into a single-output beam.

Along with the ability to focus the beam, a laser weapon needs to propagate at long distances for the different laser strands to remain tight. The beam director needs to stand up to the usual effects of a shipboard environment, where moisture and salt can damage equipment.

"One factor in driving down SWAP has been the development in the commercial domain of fiber lasers," says Raytheon's McKinnie. "First is the communications industry. Low-power fiber optics transmitting signals very often with a high data rates, the things that transmit all of our communications over the internet, a lot of our voice communication etc. since it was first brought about in the '80s perhaps

Army leaders would like to install a high-energy laser weapon on the Stryker eight-wheeled armored combat vehicle as part of the Initial Maneuver Short Range Air Defense (IM-SHORAD) program.

— that's continued to advance. There's a very deep supplier base and a deep global industry in that area."

The kind of signals required in communications are five or six orders of magnitude lower than those in defense uses. However, it's still at the core an enabling technology.

Lockheed Martin's Afzal says he agrees that fiber development in communications made a difference, as did industrial cutting, welding and drilling. The way the fiber is made, the purity of the material, the technique for doping fibers with rare earth elements, creating wave guides, and being able to pull fibers at large sizes and high quality all came from industry. Technology to make semiconductor diode lasers for telecom also comes into play in militarized lasers.

"The last piece is all the micro-optics, even in the low power domain, being able to make hardened components that are kind of the optical equivalent to electronic components like add/drop filters and MUXes and deMUXes," Afzal says.

From the industrial welding side, directed-energy laser applications use technology including high efficiency electrical circuits, power switching circuits and the fiber itself which can hold up under such high-density power.

When it comes to tracking targets with a laser weapon, that requires processing of video from several high-speed cameras. The technology that enables this fast processing draws on developments in the video gaming industry.

"Using all these high-speed video game processors that can process that kind of data and that can do the visualization ... We can run our algorithms against those, and those are truly enabling," says Lockheed Martin's Afzal.

When asked about this element, Raytheon's McKinnie had a slightly different take, saying faster processing is not necessarily a priority. Instead, he says he's watching the artificial intelligence (AI) and machine learning sectors, which in the future could help with target selection and aiming.

Afzal says he also is watching the electrification industries; he says high-energy lasers are to bullets as high-capacity batteries are to internal-combustion engines. Some of the challenges the electric vehicle market faces, he says, ultimately could benefit high-energy laser weapons. Common to laser weapons and electrification are energy storage at high power, thermal management, the ability to deliver power efficiently, cables, power transmission, switching circuits, and other power-distribution technologies.

What's next?

As Afzal says, "everybody likes to talk about scaling laser power." Still, the challenge involves ensuring that long-range laser weapons can remain focused and at full power for short defeat times.

Raytheon tries to solve this with a product it already makes, called the multi spectral targeting system (MTS). It's a turret used for targeting in a wide range of manned and unmanned aircraft today, and is already in volume production and thoroughly tested.

"The MTS's real strength is very low jitter — an ability to point over a long range with very high precision," says Raytheon's McKinnie. "That's very important for targeting and surveillance missions when you don't have a laser involved, you just want to be able to keep looking at the same object but it's also important for high-energy laser systems.

"High-energy laser systems don't kill targets immediately; it's essentially a heating effect, so it takes several seconds to kill a target, McKinnie continues. "During that several seconds it's critical to hold the beam on the target. The beam spot might be centimeters in diameter, but if that is kilometers away its very easy for it to jitter around due to the motion of the target or the platform or the effects of the atmosphere."

If the laser points precisely enough, it actually needs lower power levels to kill each target, McKinnie points out.

However, this still won't solve the problem of weather. Adapting to different weather conditions, such as heat distortion, might be a problem. It's the same phenomenon that in the heat can make cars in the distance look like they're wavering on the wind or floating on water. Adaptive optics, or atmospheric compensation, is the next frontier for technology that can prevent these effects from dissipating some of the laser's focus on the way to the target.

"Even the best beam in the world will jitter around due to scatter in the atmosphere," Raytheon's McKinnie says. "The way to address that challenge fully is what's called adaptive optics, and that's something that's on our roadmap at Raytheon, but it's also quite expensive and has never been made as robust as we need for deployment. So there's some years ahead of us in adaptive optics to focus on those longer ranges. So we focus on shorter-range missions."

The Congressional Research Service report outlined a few more problems that might make solid-state lasers a 'fair-weather' weapon: they work only over line of sight, can be adversely affected by atmospheric turbulence and an effect known as thermal blooming, which risks unintentional damage to aircraft, satellites, and surface ships. Cloud cover can render laser weapons inoperable.

The Navy reportedly plans to pursue 300-kilowatt weapons to interdict and destroy enemy cruise missiles. That requires lasers that can concentrate enough power with enough accuracy on the long side of an incoming missile, since the nose cones are already designed to survive very high heat.

Next, the Navy will attempt to reach the stepping stone of a 150-kilowatt laser beam. Companies such as BAE Systems, Northrop Grumman, Raytheon, and others competed for a 2015 spot eventually won by Northrop Grumman.

This system was fitted aboard the amphibious transport dock ship USS Portland in fall 2019. Fitting it required first choosing a vessel with the right space, weight, and power-generation capacity. The USS Portland was already had the right electrical cables for the laser.

Next, Navy experts will install HELIOS on a Burke-class destroyer USS Preble by sometime this year. Fleet testing and sustainment is scheduled through at least the end of 2025.

As with anything else, size, weight, and power consumption (SWaP) considerations are important. SWaP also is one of the barriers to installing laser systems at all, not even getting into the details of how electronics are packed inside the system itself. The U.S. military remains a far way from hand-held laser guns.

"If I'm going to burn the boats, I'm going to replace something that I have on ship today doing that mission with those weapons," said Rear Adm. Ron Boxall, director of Navy Surface Warfare, in a March 2019 press report. "And if I do that, I've got to be confident that it's going to work and it's going to cover those missions."

In particular he was talking about a directed-energy system on a Burke-class Flight IIA destroyer, and about how that weapon would integrate with other systems on the ship. He points out that it needs to coexist with the Aegis weapon system and its powerful radar, battle management, and anti-air missiles. Lockheed delivered the HELIOS to the Navy last January.

Lockheed Martin's Afzal points to the HELIOS as a mark of how lasers are no longer theoretical. "It's not going out as a prototype on a range; it's going on a real ship. That should give you the indication that we're at a very important tipping point and change point where it's not about proving that the pieces can be put together and can work, it's about building a weapon and integrating it onto a ship and tying it into the combat systems so it can be an effector like any other effector and not just a demonstration ... That's why it's not just going to go back to the lab."

Raytheon's McKinnie cautions that the cost of laser weapons still need to come down before they can be used in large numbers. But he points to the Air Force and Army Stryker applications as leaps toward actually putting this in the field.

"We'll learn so much from the way they use them and don't use them versus working in the lab for the next three or five years," says McKinnie.

WHO'S WHO IN HIGH-ENERGY LASER WEAPONS

Kord Technologies
Huntsville, Ala.
https://kordtechnologies.com

Lockheed Martin Corp.
Bethesda, Md.
https://www.lockheedmartin.com

Northrop Grumman Corp.
Falls Church, Va.
https://www.northropgrumman.com

Raytheon Technologies Corp.
Waltham, Mass.
https://www.rtx.com

Real-time software boosts mission- and life-critical credibility

High-reliability aspects of real-time operating systems also are improving their capabilities in trusted computing and information security

BY **Jamie Whitney**

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

"The first trend is that system security is being taken more seriously," explains Richard Jaenicke, director of marketing for Green Hills Software in Santa Barbara, Calif. "The number of breaches continues to grow each year. One part of the solution is a zero-trust approach where each user and device is verified against approved action in a security policy. That approach contrasts to relying on perimeter defenses such as an initial login.

An executive order issued on 12 May 2021 requires the adoption of a zero-trust architecture by all federal agencies," Jaenicke points out. "In an embedded system, serious software security starts with a separation kernel, a very small piece of software that is the only software running in privileged kernel mode, and its only function is to enforce the fundamental security policies of data isolation, fault isolation, and resource sanitation between applications. The best separation kernels are formally verified to provide that separation so that higher-level applications can count on the kernel to be non-bypassable, always invoked, and tamper-proof."

DDC-I has released its Future Airborne Capability Environment (FACE) 3.0 software conformance for the company's Deos safety-critical DO-178 real-time operating system (RTOS) and OpenArbor development tools running on ARM and x86 processors.

Seeking security

Jaenicke provides the Green Hills INTEGRITY-178 RTOS as a prime example of a secure zero-trust software solution. In late 2020, the U.S. Army selected the INTEGRITY-178 Time-Variant Unified Multi-Processing (tuMP) RTOS as part of the operating system upgrade to the Improved Data Modem (IDM-401) program.

The IDM-401 digitizes Army aviation and is fielded on every modernized Army helicopter, including the CH-47 Chinook, AH-64 Apache, and UH-60 Black Hawk. The IDM helps connect several different helicopter radios and the Blue Force Tracker transceiver,

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

and enables rapid data transfer. The program supports Open Systems Architecture (OSA), Future Airborne Capability Environment (FACE), and Common Operating Environment (COE) interoperability standards.

"For almost a decade, we have been talking about the problem of shared resource contention and multicore interference, the resulting lack of determinism, and its impact on safety," Jaenicke says. "An RTOS-level solution has existed for the past five years, and finally we have two multicore avionics systems that have received technical standard order (TSO) authorization after having meet DO-178C for airborne safety and CAST-32A for addressing multicore issues.

Among the avionics companies with TSO authorization is CMC Electronics in Saint-Laurent, Quebec, which has TSO authorization for the company's PU-3000 avionics computer that can act as a flight director and the MFD-3068 multicore smart display that can be the primary flight display, Jaenicke points out.

"Both systems are authorized to the highest safety rating (DAL A), and both systems depend on the robust multicore partitioning provided by the INTEGRITY-178 tuMP RTOS. Such multicore avionics systems enable greater functionality and further consolidation of flight functions to reduce the number of boxes and the overall size, weight, and power (SWaP)," Jaenicke says.

The Green Hill INTEGRITY-178 tuMP multicore RTOS addresses the interference challenges discussed in CAST-32A with its Bandwidth Allocation and Monitoring (BAM) capability. BAM was developed to DO-178C DAL A objectives to mitigate the interference risks for the IDM. The INTEGRITY-178 tuMP BAM monitors and enforces the bandwidth allocation of the chip-level interconnect to each of the cores, guaranteeing a particular allocation of shared resources. The supported bandwidth management technique emulates a high-rate hardware-based approach to ensure continuous allocation enforcement.

Embracing current tech

Michel Chabroux, the senior director of product management at Wind River Systems Inc. in Alameda, Calif., says another real-time software trend is to leverage developments that are coming out of the information technology (IT) sector.

"This includes the use of, for example, Rust or WebAssembly beyond traditional C and C++, containers as a software deployment/management aid," Chabroux explains. "The primary reason is to accelerate development and reduce time to market. Containers for example enables the use of existing IT technologies and infrastructure to deploy and manage software."

Chabroux also says that the "use of multi-core [processing] is now there for good - many used multi-core hardware in single-core mode."

Open standards

Wind River's Chabroux and Green Hills's Jaenicke say that there is a need for standards like FACE, ARINC, and others. "This trend has been slowly gaining momentum to the point now where most military electronics systems are being specified to follow a Modular Opens Systems Approach (MOSA) as directed by the tri-services memo from [7 Jan. 2019]," Jaenicke says.

"MOSA works its way down to the RTOS in the form of standards such as the FACE technical standard," Jaenicke continues. "The FACE Technical Standard is an open specification that leverages other open standards. In the operating system segment, that includes ARINC 653 and POSIX. But MOSA requires more than just open standards. It also requires modularity and certification of conformance. The FACE Technical Standard defines a systems architecture that breaks the

software into five segments, including the operating system segment, to create the modularity of being able to modify or replace the solution for any segment without affecting the other segments."

The differences between open-systems standards don't end there. "Unlike most standards, the FACE Technical standard has a companion conformance test suite and a requirement for independent verification for conformance," Jaenicke says. "The INTEGRITY-178 tuMP RTOS was the first operating system segment certified conformant to the FACE Technical Standard, edition 3.0, including C, C++, and Ada runtimes on Arm, Intel, and Power Architectures."

Earlier this year, DDC-I Inc. in Phoenix introduced FACE 3.0 software conformance for the company's Deos safety-critical DO-1`78 RTOS and Open Arbor development tools running on ARM and x86 processors. The certification covers the FACE Technical Standard Edition 3.0 Safety Base and Security Profiles for the Operating System Segment (OSS).

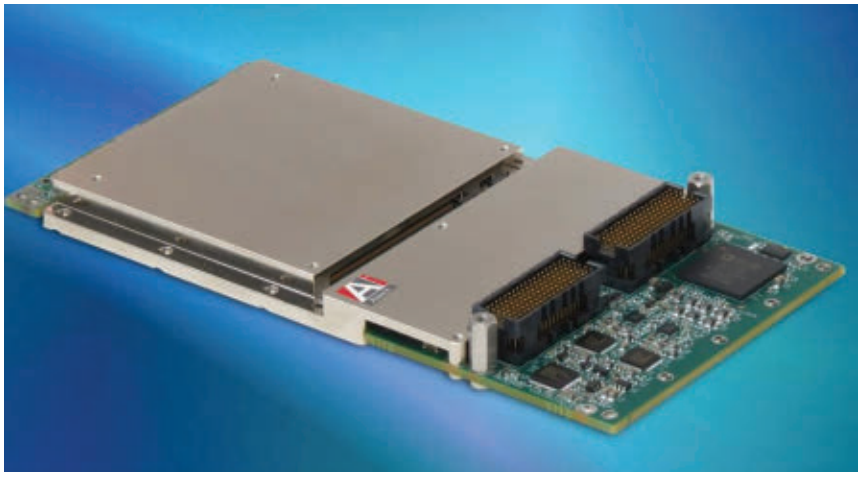
The Deos RTOS Platform for FACE Technical Standard 3.0 combines the time- and space-partitioned Deos RTOS and SafeMC multi-core technology with RTEMS (Real Time Executive for Multiprocessor Systems), a mature, deterministic, open systems, hard-real-time POSIX executive.

In 2020, Collins Aerospace selected real-time software from Green Hills for trusted computing in Navy combat jet training systems.

Deos provides ARINC 653 APEX interfaces and multi-core scheduling. A para-virtualized implementation of RTEMS, which runs in a secure Deos partition, provides POSIX interfaces and scheduling.

The integrated software platform combines the strengths and pedigree of ARINC 653 and POSIX RTOSs, providing industry-standard interfaces and feature set for conformance with the FACE Technical Standard Safety Base and Security and Operating System Profiles in a time and space partitioned, hard-real-time, multi-core execution model.

Deos is a safety-critical embedded RTOS with cache partitioning, memory pools, and safe scheduling to deliver high CPU use. First certified to DO-178 DAL A in 1998, Deos provides a FACE Safety Base Profile that features hard real-time response, time and space partitioning, and both ARINC-653 and POSIX interfaces.



The Aitech M599 graphics embedded computing switched mezzanine card (XMC) is for mission-critical applications that call for real-time operating systems (RTOS).

Virtualization

Real-time experts note that hypervisors — a system made of software or hardware that runs virtual machines — are making a mark in this sector. Ian Ferguson, vice president of marketing and strategic alliances at Lynx Software Technologies in San Jose, Calif., told Military & Aerospace Electronics in 2020 that hypervisors are seeing increased usage in mixed-criticality systems.

The Green Hills INTEGRITY-178 Time-Variant Unified Multi-Processing (tuMP) RTOS was selected by the U.S. Army for the operating system upgrade to the Improved Data Modem (IDM-401) program.

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

Green Hills's Jaenicke says that virtualization is tailored to real-time requirements. "Virtualization became popular in servers, and many of the virtualization solutions for real-time systems are based on similar technology instead of being tailored for lower latency and determinism required for real-time systems," explains Jaenicke. "For example, a Type 1 hypervisor (or even a so-called Type 0 hypervisor) runs directly on the hardware and uses hardware features like a memory management unit (MMU) to enforce isolation of applications in different memory address ranges. That sounds like it should be the highest performance given that it runs directly on the hardware. However, it also means that each and every OS has to run on top of the hypervisor, no matter whether it is an RTOS or a general-purpose OS like Linux or Windows."

There have been improvements, Jaenicke says. "A better approach for real-time systems is to have the RTOS running on the hardware and then layer virtualization on top of the RTOS only where it is needed to run Linux or a legacy OS. In that way, only the non-real-time applications have to pay the latency and determinism penalty of running on the hypervisor. Note that such an approach actually is more secure because it gets the huge virtualization code base out of the kernel running in privilege mode while still using the MMU and other hardware features to provide application isolation."

In 2019, Wind River introduced the Helix Virtualization Platform, and was recognized as a Platinum recipient of the Military & Aerospace Electronics Innovators Awards. The Wind River Helix Virtualization Platform, which combines the company's commercial RTOS and embedded Linux distribution into a software-development system for deployed systems that involve edge computing.

Updating legacy software

This enables other operating systems to run unmodified within the same framework, providing a software development environment across the Wind River portfolio. Wind River Helix means legacy software can remain unchanged while running alongside applications, and it provides a consistent, scalable and agile platform for edge devices.

Helix addresses critical infrastructure development needs, from dynamic environments without certification requirements, to regulated

How a separation kernel works with the Green Hills zero trust software.

static applications such as in avionics and industrial, as well as systems requiring the mixing of safety-certified applications with non-certified ones, such as in automotive.

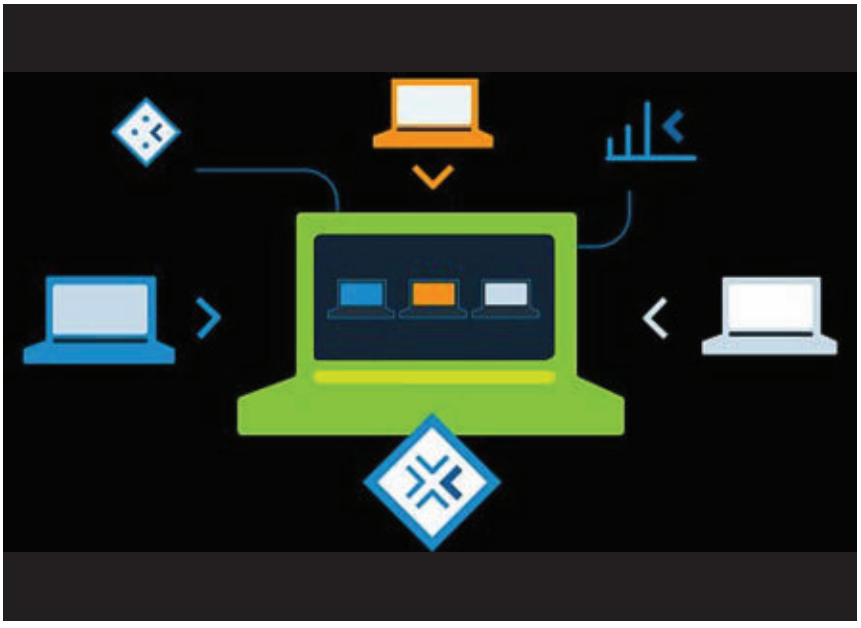
The offering comprises VxWorks along with its virtualization technology, integrated with Wind River Linux and Wind River Simics for system simulation. It meets DO-178C, IEC 61508, and ISO 26262 safety standards, and is operating system-agnostic for deployed systems.

"There are some signal processing applications that have very low latency requirements," says Wind River's Chabroux. "It is important that an RTOS ensures latency is kept to a strict minimal. Looking at Time Sensitive Networking (TSN) born in the industrial market, we are seeing cases where end-users are asking single-digit nanosecond latency for network traffic."

Helix also provides multi-core hardware support and availability on Arm, Intel, NXP, and Xilinx silicon platforms that enable 32- and 64-bit guest operating systems.

Lynx Software Technologies's Ferguson noted in 2020 that certifying multi-core processors for cockpit avionics is difficult because the systems weren't designed with that task in mind.

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



The Helix Virtualization Platform from Wind River Systems is a software-development tool based on a certifiable Type-1 hypervisor that enables applications with different levels of criticality to run simultaneously on one multi-core system.

WHO'S WHO IN REAL-TIME SYSTEMS

Abaco Systems
Huntsville, Ala.
www.abaco.com

BlackBerry Ltd.
Waterloo, Ontario
www.qnx.com

CMX Systems
Sunnyvale, Calif.
www.cmx.com

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

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

ENEA
Stockholm, Sweden
www.enea.com

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

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

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

Mercury Systems
Andover, Mass.
www.mrcy.com

Micrium
Weston, Fla.
www.micrium.com

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

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

TimeSys
Pittsburgh, Pa.
www.timesys.com

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

AH-64E Apache Guardian attack helicopter offers advanced digital communications to enable real-time, secure transfer of battlefield information to air and ground forces.

Boeing to build more AH-64E Guardian attack helicopters for U.S. Army

BY **John Keller**

REDSTONE ARSENAL, Ala. — Military helicopter experts at the Boeing Co. will build new AH-64E Apache Guardian attack helicopters for the U.S. Army under terms of a $39.7 million order.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., are asking the Boeing Defense, Space & Security segment in Mesa, Ariz., to provide new-build Apache AH-64E aircraft.

The AH-64 Apache is a multirole combat helicopter with integrated avionics and weapons, as well as advanced digital communications to enable real-time, secure transfer of battlefield information to air and ground forces.

The AH-64E Apache Guardian features enhanced performance, joint digital operability, improved survivability and cognitive decision aiding, and reduced operating and support costs, Boeing officials say. The AH-64E Apache, is being delivered to the U.S. Army and has been selected by several international defense forces.

The AH-64E Longbow manufacturing effort involves the Longbow Limited Liability Co. (LBL) joint venture between Northrop Grumman Corp. and Lockheed Martin. Lockheed Martin provides the Modernized-Radar Frequency Interferometers (MRFI) and the Hellfire missile, which provides fire and forget capabilities. Northrop Grumman provides the AN/APG-78 millimeter wave fire-control radar.

The combination of the attack fire-control radar, frequency interferometer, and the advanced navigation and communications avionics provides increased situational awareness, lethality, and survivability, Army officials say.

This program also installs the Lockheed Martin Apache Arrowhead Modernized Target Acquisition Designation Sight (M-TADS) and Pilot Night Vision Sensors (PNVS) systems aboard new AH-64E helicopters.

Formerly known as AH-64D Block III, the AH-64E Guardian has improved digital connectivity, the joint tactical radio system (JTRS), more powerful T700-GE-701D engines with upgraded transmission to accommodate more power, capability to control unmanned aerial vehicles (UAVs), new composite rotor blades, instrument flight rules (IFR) capability, and improved landing gear.

The AH-64E is designed for armed reconnaissance, close combat, mobile strike, and vertical maneuver missions in day, night, obscured-battlefield, and adverse-weather conditions. The helicopter has self-diagnostic abilities, Link-16 data linking, and updated Longbow radar with oversea capacity that could enable naval strikes.

Versions of the AH-64 Apache attack helicopter have been in service with the U.S. Army since 1986. It is a four-blade, twin-engine attack helicopter with a tandem cockpit for a two-man crew.

It has a nose-mounted sensor suite for target acquisition and night vision systems. It is armed with a 30-millimeter M230 Chain Gun carried between the main landing gear, under the aircraft's forward fuselage.

The attack helicopter has four hardpoints mounted on stub-wing pylons, typically carrying a mixture of AGM-114 Hellfire missiles and rockets. The helicopter was designed to replace the Bell AH-1 Cobra as the Army's primary attack helicopter. The U.S. Marine Corps still operates late-model versions of the AH-1 Cobra.

Boeing began deliveries of the AH-64E model in October 2011. Seven customers outside the U.S. have ordered this variant. The U.S. and 15 other countries have used the Apache during the past three decades.

On this order Boeing will do the work in Mesa, Ariz., and should be finished by October 2025. For more information contact Boeing Defense, Space & Security online at www.boeing.com/defense/ah-64-apache , or the Army Contracting Command-Redstone at https://acc.army.mil/contractingcenters/acc-rsa/.

Boeing to provide upgrades to ASW sonar system aboard Navy's P-8A Poseidon

BY **John Keller**

PATUXENT RIVER NAS, Md. — Military avionics experts at the Boeing Co. will provide upgrades to a long-range anti-submarine warfare (ASW) system aboard the U.S. Navy P-8A Poseidon maritime patrol aircraft under terms of a $24 million order announced in late May.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking the Boeing Defense, Space & Security segment in Huntington Beach, Calif., to provide additional software builds for the Multi-static Active Coherent Enhancements (MAC-E) program.

The MAC-E project involves upgrades and technology insertion for the Navy's Multistatic Active Coherent Capability (MAC), a sonar subsystem that uses the SSQ-125 sonobuoy to generate loud sounds electronically rather than with small explosive charges.

These sounds travel long distances through ocean waters and reflect off large objects like submarines or other submerged structures to help Navy ASW specialists detect and track potentially hostile submarines.

This contract modification exercises an option to procure additional software builds to provide correction of deficiencies, to include software enhancements or improvements, engineering analyses and evaluations, and integration and test in support of the P-8A Increment 3 C-MAC program.

The SSQ-125 sonobuoy intercepts long-range echoes from submarine contacts and relays them to the P-8A's airborne sensor system. Navy officials say that electronic sound sources generate fewer false returns than do explosive charges.

MAC-E is intended to hasten enemy submarine detection and engagement, and to enable the P-8A to search large areas of the ocean quickly with enhanced precision. Planned MAC-E capabilities will include increased search rate, clutter reduction, and operator-machine interface improvements.

On this order Boeing will do the work in Huntington Beach, Calif.; Patuxent River, Md.,; and California, Md., and should be finished by February 2024. For more information contact Boeing Defense, Space & Security online at www.boeing.com/company/about-bds.

The MAC-E project involves technology insertion for the Navy's Multistatic Active Coherent Capability (MAC) sonobuoy that generates loud sounds that reflect off large objects like submarines.

Defense Science Board warns that quantum radar will not be a big improvement

One of the U.S. Department of Defense (DOD), top independent scientific advisory boards has thrown cold water on the many recent predictions that quantum radar will enable new levels of detection far beyond that of traditional radar systems. Most damning, the Defense Science Board concluded that quantum radar technologies "will not provide upgraded capability to DOD." The news isn't all bad for quantum sciences that still offer promise, which include quantum sensing, quantum computers, and quantum communications. Quantum sciences define the way the physical universe works at the subatomic level. Essentially, it's a way of describing how the particles that compose atoms work and interact with one another. Quantum radar differs from other radar systems because it uses entangled photons to detect objects rather than reflected radio waves. This appears to be true regardless of distance, which may allow for very fast interaction between entangled particles even if the distance between them is very large.

50-Ohm inner DC block to reduce power interference introduced by BroadWave

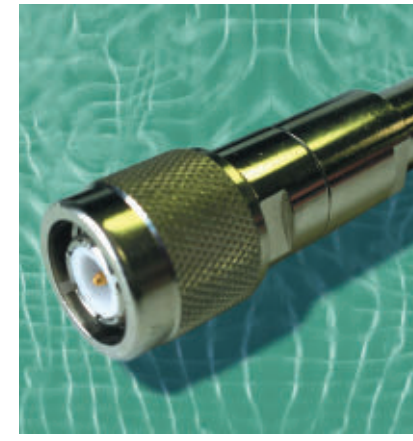
GREENWOOD, Ind. — BroadWave Technologies Inc. in Greenwood, Ind., is introducing the model 851-139-BLK 50-Ohm inner DC block for aerospace and defense power electronics applications.

The inner DC block has a 10-to-3000-MHz operating frequency range, and a maximum voltage standing wave ratio (VSWR) of 1.35:1, maximum power voltage of 50 volts DC, and RF connectors are TNC male and SMA female.

Inner DC blocks happen by placing a capacitor of varying capacitance in-series with the center conductor. The required frequency range, voltage breakdown and desired insertion loss determines the capacitance value selected.

These power devices enable RF and microwave energy to pass through a circuit with minimal interference while preventing DC to pass through the circuit. Solutions in 50- and 75-Ohm impedances with a variety of RF connector combinations are standard.

Custom impedances are available upon request. For more information contact BroadWave Technologies online at www.broadwavetechnologies.com.



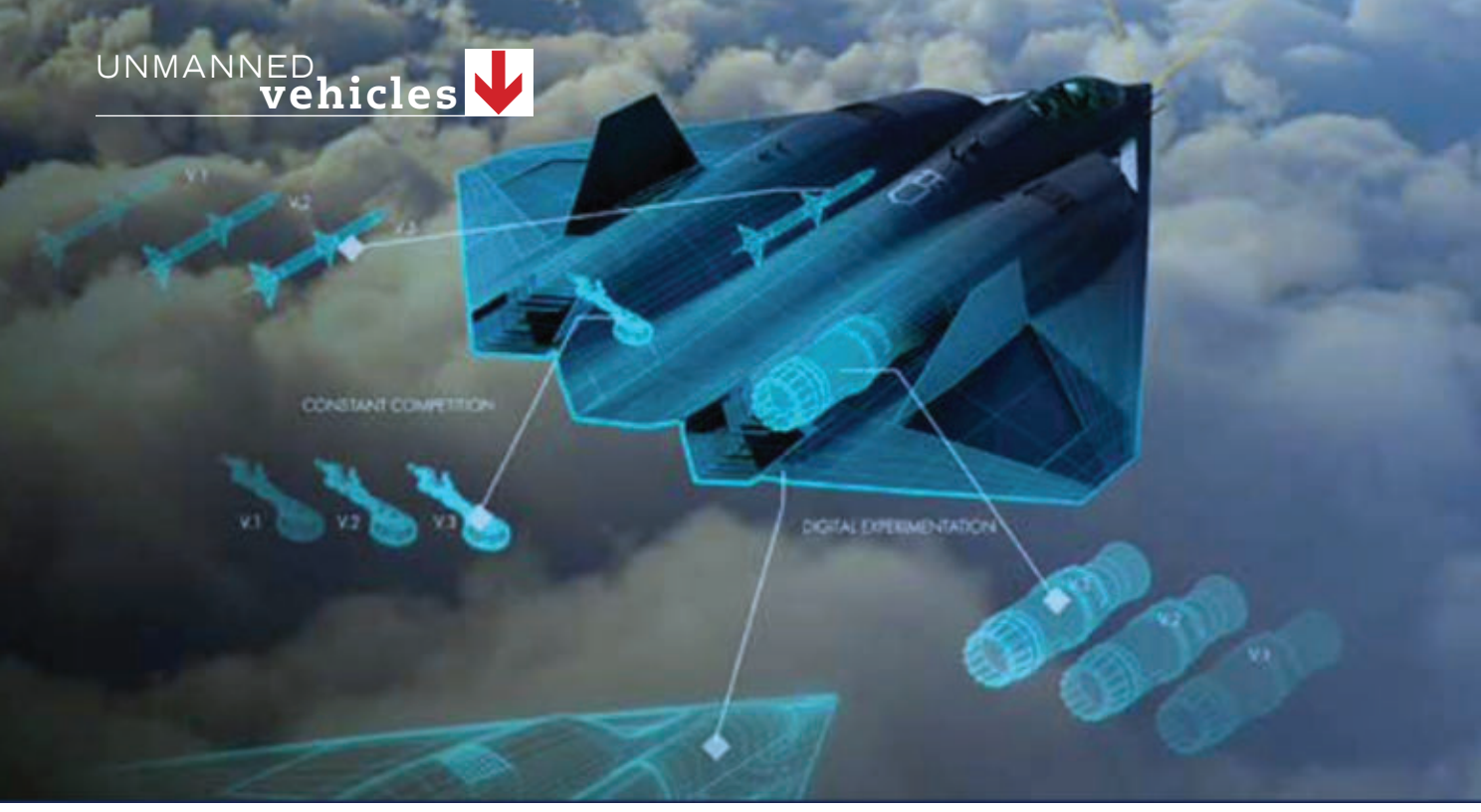
The BroadWave inner DC block has a 10-to-3000-MHz operating frequency range, and a maximum voltage standing wave ratio (VSWR) of 1.35:1.

Electronic protection (EP) takes high priority vs. top adversaries

The U.S. Department of Defense (DOD) risks failing to achieving electromagnetic superiority against top adversaries because military leaders silo different aspects of electronic warfare (EW) across various portfolios. Dave Tremper, director of electronic warfare for the Office of the Secretary of Defense, was referring to electronic protection (EP), which involves shielding systems from spoofing or jamming. He has made electronic protection one of his top priorities since getting into the job — even though he does not have direct responsibility for protecting systems from EW of top adversaries. Electronic protection falls under intelligence, surveillance and reconnaissance (ISR); position, navigation and timing (PNT); and communications communities because this discipline refers to features and not systems. "Very often EP gets cut from budgets because they have cost constraints, they have schedule constraints, they have performance constraints. EP is the first thing to go," Tremper said late last month at the Cyber Electromagnetic Activity conference hosted by the Association of Old Crows.

Army looks to commercial satellites to augment tactical networking

The U.S. Army is beginning to use advanced satellite communications (SATCOM) technology to increase network resiliency. Adding low- and medium-Earth orbit commercial satellite constellations into the service's tactical networking is part of the service's effort to shift to dispersed battlefields, instead of the fixed fiber communications and forward operating bases that defined the last two decades of war in the Middle East. The service's next delivery of tactical network tools will use existing satellites to support the new battlefield communications, says Rich Hoffman, lead electronics engineer for SATCOM at the C5ISR Center at Aberdeen Proving Ground, Md. To support the dispersed and joint warfighting operations of future wars in places such as the Indo-Pacific, the Army needs several options, including commercial SATCOM, to route communications in case an enemy interferes with one option.



Researchers ask industry for artificial intelligence (AI) and unmanned aircraft technologies

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are asking the defense industry to develop revolutionary enabling technologies for land, sea, air, and space applications that would put U.S. forces far ahead of any potential adversaries.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a broad agency announcement (HR001121S0029) for the Redefining Possible project.

Potential U.S. adversaries such as Russia and China have developed ways to counter today's U.S. military systems that are built around exquisite, monolithic integrated systems. Instead, DARPA researchers want to develop revolutionary system architectures that are separate, dispersed, disruptive, and that instill doubt in U.S. adversaries.

DARPA experts want to identify promising technologies and move them quickly to the next phase of research and development. Technologies should improve resilience, responsiveness, range, lethality, access, endurance, and affordability to enable new joint force warfighting concepts.

For aircraft, researchers point out that stealth and low-observability technologies simply do not offer the advantages they used to. Adversaries have come up with generations of countermeasures since stealth was invented, and today the ability to make platforms survivable is approaching physical limits, which makes continuing the traditional path of stealth technologies impractical.

At the same time, unmanned combat air vehicles (UCAVs) have been used widely, and adversaries have developed countermeasures that have compromised the effectiveness of UCAVs and stealth technologies.

Photo (above): U.S. military researchers are asking industry for new technologies that would help protect future unmanned aerial vehicles from sophisticated enemy air defenses and anti-air missiles.

DARPA is interested in systems to counter the proliferation of advanced integrated air defense system (IADS) technologies like extremely capable surface-to-air and air-to-air missiles.

As a result, DARPA researchers are interested in new enabling technologies that provide survivability for next-generation unmanned aerial systems; use distributed and disaggregated systems to reduce reliance on small numbers of exquisite platforms; enable timely delivery of targeting

data; advance aircraft propulsion capabilities; machine autonomy to minimize the risk to human warfighters; and design and development tools to develop and field systems quickly, such as model-based systems engineering, multi-dimensional optimization, and additive manufacturing.

For ground systems, researchers are interested in technologies to improve the integration of unmanned ground systems with one another and with troops to enable both groups to operate together effectively.

DARPA also wants technologies to provide small-unit and individual warfighter mobility and lethality; that can expand combined arms maneuver into the air, into interiors of buildings, and underground. For these technologies DARPA is interested in artificial intelligence (AI) for integrated manned-unmanned ground force operations, ground robots, and ground robotic combat systems to operate at the speed of battle to keep up with human warfighters.

For manned and unmanned surface ships and submarines, DARPA researchers are interested in technologies to reduce reliance on aircraft carriers that require layered air defenses.

For this, researchers want to develop technologies to counter advanced enemy submarines and torpedoes; provide a persistent presence in harsh environments such as the arctic; and small, inexpensive, networked vessels with AI and machine autonomy.

For space, DARPA researchers are interested in technologies to reduce reliance on large and expensive satellites; AI and deep learning technologies for data evaluation; and counter emerging threats in contested space.

For these kinds of technologies, DARPA researchers want to develop new materials, manufacturing, and computational imaging to reduce the size, weight, cost, and timeliness necessary to field game-changing capabilities.

Initial contracts will be worth less than $1 million each, and several contracts are expected. Companies interested have one year to respond, and should submit proposals no later than 10 June 2022 to the DARPA BAA Website at https://baa.darpa.mil. Email questions or concerns to DARPA at HR001121S0029@darpa.mil. More information is online at https://sam.gov/opp/7728a31252544c-5da3083c3533c8d50b/view.

Pentagon leaders eye AI and cyber security in JADC2 command and control system

The goal of the Joint All-Domain Command and Control (JADC2) is to link networks and sensors to warfighters with shared data in all domains — cyber, land, sea, air and space — quickly and securely. Eurasia Review reports. The JADC2's helps enable rapid integration of artificial intelligence (AI), machine learning, predictive analytics, and other emerging technologies. Each of the services is involved in JADC2 experimentation, and the best solutions will be implemented as long as there is no vendor lock or proprietary limitation. "We want this to be open source," says Marine Corps Lt. Gen. Dennis A. Crall, the Joint Staff's director of command, control, communications and computers. JADC2 depends on an enterprise cloud-based computing solution, software development that is sharable, network enhancements, a zero-trust cyber security environment, data sharing, and solutions that work on the tactical edge.

Maritime authorities consider future modes of wide-area ocean persistent surveillance

Persistent surveillance is a term from a Navy, Marine Corps, and Coast Guard military strategy document exploring new dimensions of maritime warfare. It describes an insatiable appetite for intelligence, surveillance, and reconnaissance. The new strategy discusses possibilities for armed unmanned aerial vehicles (UAVs), undersea sensing and attack, and overhead wide-area ocean surveillance from manned and unmanned aircraft. It could involve massive numbers of unmanned undersea vehicles (UUVs), unmanned surface vessels (USVs), and manned and unmanned aircraft. One important player is the P-8 Poseidon maritime patrol jet. The document explains that surveillance technologies will help combine information into a common, actionable operational picture to enable U.S. forces to act more quickly than their adversaries. This wide-area ocean surveillance approach relies on advanced command and control, dispersed networked forces, artificial intelligence (AI), and virtually every kind of unmanned system. The Navy MQ-4C Triton long-range UAV, for example, has high-altitude sensors. New data AI-enabled analysis might make platforms like the MQ-4C Triton as capable as the much larger manned P-8 Poseidon.

Continued on page 37

Navy eyes autonomous capability for Expeditionary Fast Transport vessel

BY **John Keller**

WASHINGTON — U.S. Navy shipboard electronics experts are introducing autonomous capability in the expeditionary fast transport ship, which is designed for rapid intratheater transport of medium-sized cargo payloads.

Officials of the Naval Sea Systems Command in Washington have announced a $44 million order to Austal USA in Mobile, Ala., to design, install, and demonstrate autonomous capability in the Expeditionary Fast Transport USNS Apalachicola (T-EPF-13), which is under construction in Mobile, Ala.

The EPF provides high speed, shallow-draft transport capability to move as much as 600 tons of personnel, supplies, and equipment as far as 1,200 nautical miles within military theaters at top speeds between 35 and 45 knots.

Bridging the gap between slow ships and fast aircraft, the EPF can move loads quickly from ships far offshore to austere, minor, and damaged ports to support the intra-theater maneuver for the Navy, Marine Corps, and Army. Apalachicola will be the thirteenth Spearhead-class expeditionary fast transport.

The EPF normally has a crew of 22 in normal operations, and introducing shipboard electronics autonomy such as unmanned operation or follow capability could enable naval commanders to reduce the number of crew necessary to operate these kinds of vessels. The EPF previously was called the joint high speed vessel (JHSV), but was redesignated in 2015.

The ship will include a perception and autonomy control suite, as well as several automation enhancements to reduce the number of personnel necessary for operations and maintenance at sea, Austal officials say. The ship even could be operated entirely remotely as an unmanned surface vessel.

Navy leaders may consider using the EPF for the Large Unmanned Surface Vessel (LUSV) by adding vertical missile launch cells to convert the ship to a robotic guided-missile cruiser. The flat-topped EPF also is designed to support helicopter operations, so it has potential to support unmanned helicopters for autonomous flight operations.

The EPF is a shallow-draft, all-aluminum, commercial-based catamaran capable of operating in shallow-draft ports and waterways together with roll-on/roll-off facilities. It can move a combat-loaded M1A2 Abrams main battle tank.

The EPF includes a flight deck for helicopters and an off-load ramp that enables vehicles to drive quickly off the ship. The ramp is suitable for the types of austere piers and quay walls common in developing countries.

The ship's draft is less than 15 feet to give it access to many different kinds of ports and offload areas. It has airline style seating for more than 312 warfighters and fixed berthing for an additional 104. The Navy has accepted 10 EPFs with USNS Burlington (T-EPF 10) the most recent in November 2018.

The U.S. Navy expeditionary fast transport ship USNS Apalachicola is being built with machine autonomy to enable the vessel to operate manned or unmanned.

On this order Austal USA will do the work in Mobile, Ala.; Reston, and Fairfax, Va., and should be finished by July 2022. For more information contact Austal USA online at https://usa.austal.com, or Naval Sea Systems Command at www.navsea.navy.mil.

Continued from page 35

Nontraditional businesses to tackle challenges of sustainment of robotic combat vehicles

The U.S. Army is tapping nontraditional businesses to tackle the challenge of future robotic combat vehicle (RCV) sustainment, say officials of the Army Applications Laboratory (AAL) in Austin, Texas. The AAL is choosing companies that can develop hardware and software around sensors to gather, fuse, and interpret robotic combat vehicle sustainment requirements to deliver actionable information to decision makers, Army officials say. The Army has a history of neglecting sustainment when developing programs; experts instead try to solve how to manage systems after they are fielded. Army leaders are helping modernize the service by considering the entire life cycle into account to save cost and time. The Army Applications Lab works with businesses that may not have much experience in the defense world but have technology with useful military applications like sustainment of robotic combat vehicles.

Pentagon leaders may be buying too much into artificial intelligence (AI) hype

A pair of military experts recently penned an article with a simple warning to the Pentagon: winter is coming. In this case, said winter is an artificial intelligence (AI) winter, and said AI winter is an artificial AI winter. The authors of the article are Marc Losito and John Anderson, who believe that the U.S. military leaders are guilty of believing too much hype when it comes to AI. The big idea here is that the Pentagon always has invested in military technology research and development. These experts aren't asking the government to stop, they're warning the government against treating AI like any other technology. The writers warn that the U.S. has been here before when it comes to AI. After World War II, for example, U.S. military leaders were pretty high on the idea of replacing soldiers with machines that could fight for themselves. The calculus, however, has changed. The Pentagon is no longer viewing AI in narrow, project-specific terms. it is going all-in on AI as a method to revolutionize the way we fight wars.

Illegal export to China enables theft of underwater warfare capability

In late April, Massachusetts-based businessman Qin Shuren became the latest person to plead guilty in the Justice Department's crackdown on the illegal export of strategic technologies. Qin's company, LinkOcean Technologies, falsified documentation to send a Chinese military-affiliated university some $100,000 worth of equipment built with military technologies, including hydrophones, sonobuoys, side-scan sonars, and even an autonomous underwater vehicle (AUV). The case is just one part of a long trail of open-source evidence that illustrates a larger issue: U.S. technology being used to advance Chinese military ends. The trail begins with the Justice Department's press release, which says that Mr. Qin was working at the direction of Northwestern Polytechnical University in the northwest Chinese city of Xi'an. NWPU is one of the "Seven Sons of National Defense," a group of universities known for particularly close ties to the People's Liberation Army and which contribute a high proportion of the defense workforce and research in China. For two decades, NWPU has been on the U.S. Department of Commerce Entity List, the group of foreign organizations and individuals to which the export of certain U.S. strategic technologies is restricted.

Pentagon to spend $874 million on artificial intelligence (AI) and machine learning

BY **John Keller**

WASHINGTON — U.S. Department of Defense (DOD) leaders plan to invest $874 million next year in artificial intelligence (AI)-related technologies to boost deterrence against potential adversaries like China, as well as to enhance efficiencies in computing, command and control, and logistics.

Pentagon experts are asking Congress for AI funding in several projects, as revealed in the federal fiscal year 2022 DOD budget, which was released in June. Federal fiscal year 2022 begins next 1 Oct. The Pentagon's AI efforts now number more than 600, which is up about 50 percent over current-year levels, DOD officials say.

In efforts to keep technological pace with China and other adversaries, DOD is leveraging technological advantages and investing in cutting-edge technologies like AI, hypersonic technology, cyber, and quantum computing, among others, according to DOD budget documents.

New technologies like AI, autonomy, and robotics will change the character of warfare, resulting in a faster, more lethal, and more distributed battlefield, experts say.

The Pentagon's efforts in AI primarily are part of the military's $2.3 billion science and technology research budget, and revolve around the military Joint Artificial Intelligence Center's (JAIC) in Washington.

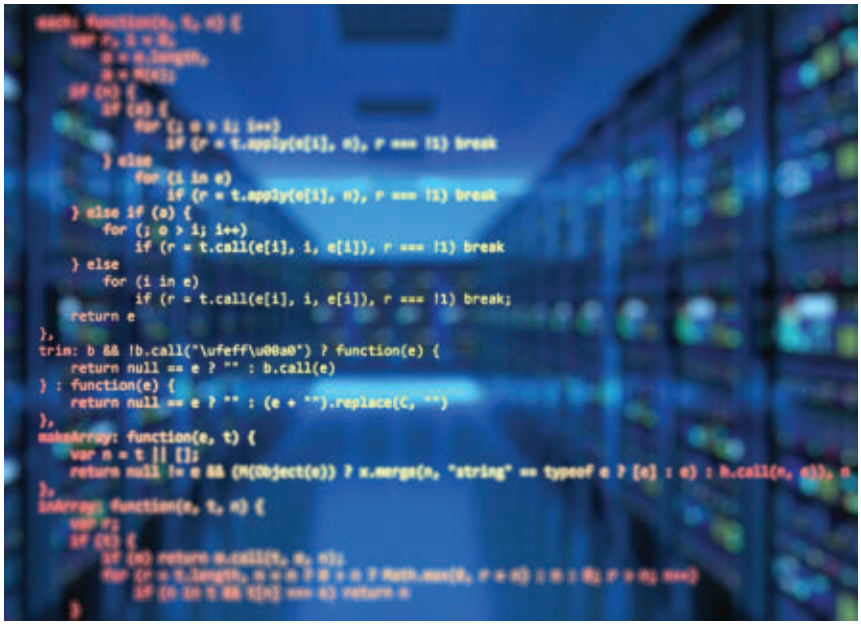
Pentagon science and technology efforts focus on high payoff basic research projects in physical science, life science, and applied mathematics that probe the limits of today's technologies. Emerging technologies include AI and machine learning; quantum science; neuroscience; novel engineered materials; understanding human and social behavior; engineered biology; and manufacturing sciences.

Much of the AI funding from the separate military services filters through the JAIC, which primarily is part of the U.S. Defense Information Systems Agency (DISA), which is located at Fort Meade, Md. The U.S. Army, for example, allocates money from the service's 2022 budget request to the JAIC for efforts in small unit maneuver.

U.S. Navy leaders say they plan to capitalize on emergent, game-changing technologies through targeted investments in AI, cyber weapons, unmanned technologies, directed energy, and hypersonics.

U.S. Special Operations Command also is investing in AI to increase the speed of processing, exploitation, and dissemination for intelligence, surveillance, and reconnaissance.

In the Pentagon's 2022 research and development budget request, the Army is asking for $10.2 million for AI and machine learning basic research; for $15 million for AI and machine learning applied research; and for $909,000 for AI and machine learning advanced technologies.



Artificial intelligence and machine learning — particularly for next-generation unmanned vehicles — are among the U.S. military's highest priorities for technological development.

The 2022 DISA research budget request asks for $10 million for JAIC operational systems development; and for $186.6 million for JAIC software and digital pilot programs.

Lockheed Martin will provide U.S. ballistic missile submarines with precise inertial navigation systems to navigate for long periods without using GPS signals.

Lockheed Martin to build submarine inertial navigation with new laser gyro technology

BY **John Keller**

WASHINGTON — U.S. Navy navigation and guidance experts are asking Lockheed Martin Corp. to build precise inertial navigation systems for U.S. Navy Ohio- and future Columbia-class ballistic missile submarines under terms of a $191.2 million contract.

Officials of the Strategic Systems Programs office in Washington are asking the Lockheed Martin Rotary and Mission Systems segment in Uniondale, N.Y., to build Trident SSI Increment 8 inertial navigation systems and inertial spare parts for the Ohio and Columbia ballistic missile submarine shallow water submersible platforms for the fleet ballistic missile program.

For more than 20 years the U.S. Ohio-class ballistic missile submarines have used the Electrostatically Supported Gyro Navigator (ESGN) as the vessel's inertial navigation system. The ESGN uses a precise laser gyro for precision undersea navigation and positioning that operates independently of GPS or celestial navigation.

An inertial navigation system uses a computer, motion sensors, accelerometers and gyroscopes to calculate continuously by dead reckoning the position, the direction and speed of movement of a moving object without the need for external references. Precise inertial navigation for submarines typically uses ring laser gyros or laser-based fiber-optic gyros.

The SSI Increment 8 program seeks to replace the 30-year-old ESGN which needs a refresh of inertial technology components. This program also seeks to replace the Ohio-class submarine's electronic equipment consoles and update navigation subsystem software.

The Ohio-class submarine's ESGN is from the Boeing Co. Defense, Space & Security segment in Huntington Beach, Calif. The ESGN originally was designed by the former Rockwell Autonetics business unit in Anaheim, Calif., which Boeing acquired in 1996.

The ESGN enables ballistic missile submarines to navigate precisely underwater for long distances and long durations, and is accurate enough to launch intercontinental missiles with pinpoint accuracy. The new submarine inertial navigation system is expected to be even better.

It was Rockwell Autonetics that designed the inertial navigation system that enabled the U.S. Navy's first operational nuclear-powered submarine USS Nautilus to navigate safely while traversing underneath Earth's polar ice cap in 1958.

On this contract Lockheed Martin and company partners will do the work in Heath, Ohio; Huntington Beach, Calif.; Uniondale, N.Y.; and Manassas, Va., and should be finished by February 2028.

For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com, Boeing Defense, Space & Security at www.boeing.com/company/about-bds, or the Strategic Systems Programs office at www.ssp.navy.mil.

Danbury Mission Technologies to develop electro-optical payload for DARPA Blackjack

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers needed a company to develop bus and electro-optical payload for a two satellite on-orbit demonstration of small, secure, and affordable military satellites. They found their solution from Danbury Mission Technologies LLC in Danbury, Conn.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced $42.9 million contract to Danbury for phase two of the Blackjack program that seeks to orbit a constellation of small, secure, and affordable military satellites that capitalize on modern commercial satellite technologies.

Blackjack seeks to develop low-cost space payloads and commoditized satellite buses with low size, weight, power, and cost (SWaP-C) with similar capabilities to today's military communications that operate at geosynchronous orbit (GEO), but at a fraction of the cost.

Danbury Mission Technologies specializes in tactical intelligence, surveillance, and reconnaissance satellites; electro-optical satellite payloads, optical subsystems; and launch vehicle and satellite electronics.

Danbury joins other companies working with DARPA on Blackjack phase two that include Systems & Technology Research LLC in Woburn Mass.; SA Photonics Inc. in Los Gatos, Calif.; the Northrop Grumman Corp. Mission Systems segment in Linthicum, Md.; and Blue Canyon Technologies Inc. in Boulder Colo.

Future Blackjack reconnaissance and communications satellites will have electro-optical sensor payloads from Danbury Mission Technologies.

Military satellites are critical to U.S. warfighting capabilities. Traditionally they are placed in GEO to deliver persistent overhead access to any point on the globe.

Yet in the increasingly contested space environment, these costly and monolithic systems are vulnerable targets that would take years to replace if degraded or destroyed. Moreover, their long development schedules make it difficult or impossible to respond quickly to new threats.

The Blackjack program seeks to develop enabling technologies for a global high-speed network backbone in LEO that enables networked, resilient, and persistent military payloads that provide infinite over-the-horizon sensing, signals, and communications capabilities.

Historically, U.S. Department of Defense (DOD) satellites have been custom-designed, with lengthy and expensive design and upgrade cycles. The evolution of commercial space,

however, has led to LEO broadband Internet communications satellites that could offer attractive economies of scale.

The Blackjack program emphasizes a commoditized bus and low-cost interchangeable payloads with short design cycles and frequent technology upgrades, based on a 'good enough' payloads optimized for more than one type of bus.

Commoditized satellite buses based on open-architecture electrical, software, and mesh network interface control could provide a way for dozens or hundreds of different types of military satellite payloads to operate in low-Earth orbit, DARPA officials say.

The Blackjack program has three primary objectives:

- develop payload and mission-level autonomy software with on-orbit distributed decision processors that can operate autonomously with on-orbit data processing, and perform shared tasks on-orbit;
- use advanced commercial manufacturing for military payloads and the spacecraft bus, including high-rate manufacturing using commercial off-the-shelf (COTS)-like parts, reduced screening and acceptance testing for individual spacecraft, and reduced expectations for spacecraft life; and
- demonstrating satellite payloads in LEO that operate on par with current GEO systems with the spacecraft at costs of less than $6 million per satellite.

To reduce integration risk, Blackjack is developing an avionics unit called Pit Boss for each spacecraft with high-speed processor and encryption devices that will function as a common network and electrical interface. In charge of Pit Boss design is SEAKR Engineering Inc. in Centennial, Colo.

Not only will Pit Boss provide a common electrical interface to each payload, but it also will provide mission level autonomy functions, enable on-orbit edge computing, manage communication between Blackjack satellites and ground users, provide a command and telemetry link to the bus, and encrypt payload data.

Every Blackjack satellite will consist of one commoditized bus capable of broadband rate global communications to other nodes, one Pit Boss control unit, and one or more military payloads that can operate autonomously for more than 24 hours.

The goal is to develop a 60-to-200-satellite constellation operating at altitudes of between 310.7 miles and 807.8 miles above the Earth's surface. One operations center will cover all government satellites and payloads, and the constellation will be able to operate without the operations center for 30 days. Blackjack payload data processing will be performed on-orbit without the assistance of ground data processing.

The program's three phases are: defining bus and payload requirements; developing bus and payloads for a two satellite on-orbit demonstration; and demonstrating a two-plane system in low-Earth orbit for six months. A future Blackjack demonstration constellation will involve 20 spacecraft in two planes with one or more payloads on each satellite.

For more information contact Danbury Mission Technologies online at www.dmtllc.org, or DARPA at www.darpa.mil.

Navy eyes free-space laser communications for fast wireless data

BY **John Keller**

NORTH CHARLESTON, S.C. — U.S. Navy communications experts are reaching out to industry to find companies able to develop laser communications systems that can maintain communications links from stationary or moving laser transmitters and receivers.

Officials of the Naval Information Warfare Center-Atlantic (NIWC-Atlantic) in North Charleston, S.C., have issued a request for information (N65236_SNOTE_00746AD9) for the Free Space Optics Communications project.

Free-space optical communications uses a light source — typically a laser — propagating in free space to transmit wireless data for telecommunications or computer networking. Free space means air, outer space, vacuum, or something similar, and does not use solids such as optical fiber cable.

From industry, Navy researchers want information about tactical free-space optical communications technologies that at least are at Technology Readiness Level 4, which describes components assembled in a laboratory that are tested together.

Technologies of interest include active pointing and tracking systems for maintaining links in dynamic environments. Tactical free-space optical communications systems that are of interest included fixed-site point to point transmitters and receivers that could be adapted to active pointing and tracking systems.

Navy researchers are looking for free-space optical communications solutions that can support multi-access from distributed end-users with automated network management, and that support multi-in, multi-out tactical free-space optical communications or non-line-of-sight tactical free-space optical communications through relay or re-transmission.

U.S. Navy researchers are asking industry for laser communications technologies that can maintain communications links from stationary or moving laser transmitters and receivers.

Responses will be selected for a technical exchange with NIWC Atlantic engineers. Information provided to the government will be part of a commercial survey of tactical free-space optical communications solutions with potential for future demonstrations.

Tactical free-space optical communications systems should be able to establish a non-line-of-sight link through relay or retransmission; include active pointing and tracking systems and automated network management, and have been demonstrated in the laboratory.

Responses should include brief descriptions of the technology, with simple drawings depicting operation of the technology with generic components, and that specify link budgets for 1-, 5-, and 10-kilometer optical data links.

Descriptions should include approximate data rate and bit error rate at each range in a standard atmosphere, but may include link budgets that include scattering effects. All information delivered must be unclassified.

Companies interested were asked to email responses by 16 July 2021 to ssc_lant_t2@navy.mil. Email questions or concerns to the Navy's Samuel Mellon at samuel.n.mellon1@navy.mil. More information is online at https://sam.gov/opp/222149756f724963ae6a03d-d5679e3ef/view.

Boeing Insitu to provide small reconnaissance unmanned aircraft and sensor payloads

BY **John Keller**

PATUXENT RIVER NAS, Md. — U.S. Navy unmanned aerial vehicle (UAV) experts needed small reconnaissance UAVs for the Navy and U.S. allies. They found their solution from Boeing Insitu in Bingen, Wash.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $12.5 million order to Boeing Insitu to provide RQ-21A Blackjack UAVs and ScanEagle UAVs, spart parts, and support for the Navy and U.S. foreign military sales (FMS) customers.

The Boeing Insitu RQ-21 is a twin-boom, single-engine, monoplane UAV for surveillance and reconnaissance. It can be launched and recovered on land or at sea without runways, using a pneumatic launcher and net-type recovery system.

The 81-pound Blackjack is eight feet long with a 16-foot wingspan designed to carry multi-sensor payloads in large pod below its nose. The UAV can fly as quickly as 104 miles per hour, cruises at 63 miles per hour, can fly as long as 24 hours, and can fly as high as 19,500 feet. It is a version of the Insitu Integrator UAV.

The multi-mission RQ-21A Blackjack's open-architecture payload bays can be customized with visible-light and infrared cameras, communications, and other tools to give warfighters on the forward edge of battle situational awareness information.

It can integrate new payloads quickly, offers roll-on, roll-off capability to move the system quickly from ship to shore, and aboard cargo aircraft. The UAV can carry sensor payloads as heavy as 39 pounds.

The Blackjack's standard sensor payload consists of a visible-light imager, mid-wave infrared imager, laser rangefinder, infrared marker, communications, and automatic identification system.

The RQ-21A is for persistent maritime and land-based tactical reconnaissance, surveillance, and target acquisition (RSTA) data collection and dissemination capabilities to the warfighter.

The Boeing Insitu ScanEagle UAV, meanwhile, is 5.1 feet long with a 5.6-foot wingspan. It weighs as much as 48.5 pounds and can carry a 7.5-pound sensor payload. The UAV can fly for more than 24 hours at altitudes as high as 19.500 feet, and at speeds to 80 knots.

The ScanEagle UAV can fly on gasoline or heavy fuels like jet fuel, diesel, or kerosine. It provides persistent surveillance and reconnaissance imagery on land or at sea at lower costs than other surveillance methods for military and agriculture missions.

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

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

On this order Boeing Insitu will do the work in Bingen, Wash., as well as at locations outside and inside the continental U.S., and should be finished by June 2022. For more information contact Boeing Insitu online at www.insitu.com, or Naval Air Systems Command at www.navair.navy.mil.

The multi-mission RQ-21A Blackjack's open-architecture payload bays can be customized with visible-light and infrared cameras, communications, and other tools.

ELECTRONIC WARFARE

Persistent Systems to provide electronic warfare (EW) resistance for unmanned aircraft

Unmanned aerial vehicle (UAV) experts at Martin UAV LLC in Plano, Texas, needed radio networking for the company's V-BAT unmanned aircraft that will part of the U.S. Navy's vertical take-off and landing (VTOL) replacement. They found their solution from Persistent Systems LLC in New York City.

Martin UAV officials have selected pending a final award the Persistent Systems MPU5 Wave Relay and embedded module networking devices over the coming years for an advanced modified version of the V-BAT-128 UAV that is part of the Navy Mi2 project, which seeks to develop UAVs able to operate at sea and in other austere environments with little support.

Navy officials chose Martin UAV's V-BAT unmanned aircraft version as this next-generation Vertical Take-Off and Landing (VTOL) replacement following an Mi2 live demonstration last November and December at Yuma Proving Ground, Ariz.

"In keeping with the program's expeditionary focus, our technology will help warfighters operate the V-BAT in the most austere environments, without the need for satellite links," says Eric Waldo, an unmanned aerial systems program manager at Persistent Systems.

The Persistent Systems MPU5 offers long-range operations and also is resilient against electronic warfare (EW) threats without sacrificing performance or scalability, Waldo says. The MPU5 mobile ad hoc network (MANET) solution also is validated by the U.S. Army's Electronic Warfare Laboratory.

The Martin UAV V-BAT is a ducted fan VTOL unmanned aircraft system that takes off like a helicopter and flies as a fixed-winged aircraft for long-endurance intelligence surveillance and reconnaissance (ISR) missions.

Martin UAV is a longstanding member of the Persistent Systems Wave Relay Ecosystem, a coalition of sensors and unmanned system companies that all use the Wave Relay MANET.

For more information contact Persistent Systems online at www.persistentsystems.com, Martin UAV at https://martin-uav.com, or the Naval Air Warfare Center Aircraft Division (NAWCAD) at www.navair.navy.mil/nawcad.

SMART MUNITIONS

Alliant Techsystems to help convert 155-millimeter artillery shells to smart munitions

U.S. Army explosives experts are looking to Alliant Techsystems Operations LLC in Plymouth, Minn., to provide precision-guidance kits to transform conventional 155-millimeter artillery shells into GPS-guided smart munitions.

Officials of the Army Contracting Command at Picatinny Arsenal, N.J., announced a $167.8 million order to Alliant Techsystems Operations LLC, a wholly owned subsidiary of Northrop Grumman Corp., for M1156 precision guidance kits for the Army.

Alliant Techsystems's precision guidance kit (PGK) transforms existing 155-millimeter high-explosive artillery projectiles into affordable satellite-guided precision weapons.

The PGK uses signals from the Global Positioning System (GPS) to guide artillery shells to their targets with accuracy of less than 10 meters.

The low-cost reliable, fuze-sized guidance kit installs in the artillery shell's fuze well and also provides traditional fuze functions for height-of-burst and point detonation.

PGK provides maneuver forces with an organic precision capability that works in all weather conditions, and fills a gap between conventional artillery and smart munitions capabilities.

On this contract modification Alliant Techsystems will do the work in Plymouth, Minn., and should be finished by May 2024. For

more information contact Northrop Grumman online at www.northropgrumman.com, or the Army Contracting Command New Jersey at https://acc.army.mil/contractingcenters/acc-nj.

SENSOR PAYLOADS

Air Force orders Global 6000 jets for voice and data communications payloads

Military communications experts needed business jet-sized aircraft to host persistent voice and data communications payloads that receives, bridges, and distributes communications among all participants in a battle. They found their solution from Learjet Inc. in Wichita, Kan.

Officials of the U.S. Air Force Life Cycle Management Center at Hanscom Air Force Base, Mass., announced a $464.9 million contract to Learjet to deliver as many as six Bombardier Global 6000 aircraft and completion work to host the Battlefield Airborne Communications Node (BACN).

The BACN — from the Northrop Grumman Corp. Aeronautics Systems segment in San Diego — is an electronic payload aboard the E-11A manned aircraft and Air Force RQ-4 Global Hawk large unmanned aerial vehicle (UAV). The E-11A is based on the Bombardier Global Express business jet.

The Bombardier Global 6000 is a large-cabin business jet with a range of 6,000 nautical miles that has been updated and modified for military missions. the aircraft is 99.5 feet long, has a wingspan of 94 feet, and can fly at speeds of 600 knots.

The BACN uses the Airborne Executive Processor (AEP) to enable a persistent voice and data gateway in the sky that receives, bridges, and distributes communications among all participants in a battle.

The BACN payload aboard the E-11A and Global Hawk helps enable diverse battlefield weapon systems to communicate with each other during in-theater operations where mountainous terrain, large buildings, or other obstructions inhibit line-of-sight communications.

Military leaders found that such obstructions could limit operating units to see only a limited set of the complete picture of the battlefield. The BACN command and control network is designed to provide situational awareness from small ground units in contact up to the highest command levels, Northrop Grumman officials say.

BACN's AEP provides translator and gateway interfaces among all supported communications systems, and forwards intelligence information to the Global Information Grid. By controlling the AEP via a ground station, BACN is radio- and platform-agnostic, Northrop Grumman officials say.

On this contract Northrop Grumman will do the work in San Diego and at overseas locations, and should be finished by January 2026. For more information contact Northrop Grumman Aeronautics online at www.northropgrumman.com, or the U.S. Air Force Life Cycle Management Center at www.aflcmc.af.mil.

VIDEO TRANSMISSION

Textron video systems to enable Army vehicles to receive video from unmanned aircraft

U.S. Army reconnaissance experts needed modular video and data systems for Army land vehicles and infantry warfighters that enables users to downlink live surveillance images and geospatial data remotely from manned and unmanned aircraft. They found their solution from Textron Systems Corp. in Hunt Valley, Md.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., announced a $92.5 million contract to Textron for One System Remote Video Terminal (OSRVT) and Soldier Portable OSRVT (SPOT) production with contractor logistics support.

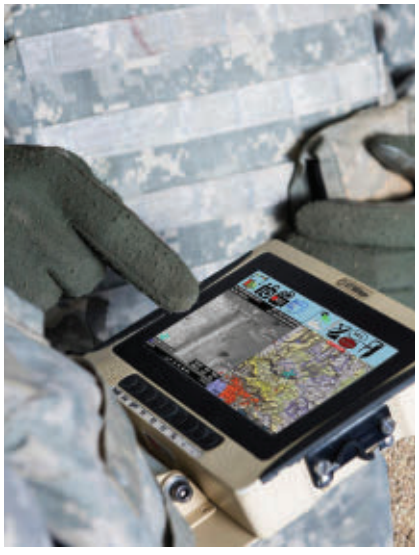
The Textron OSRVT is a modular video and data system for reconnaissance that enables warfighters to downlink live surveillance images and critical geospatial data remotely from joint operations tactical UAVs and manned aircraft.

SPOT systems are smaller version of the OSRVT, and are for the individual warfighter to provide near-real-time surveillance imagery for immediate reaction to threats or to assist in identifying friendly units. Army officials say they will buy as many as 100 new OSRVTs and as many as 100 SPOT systems from Textron.

The Army awarded the contract to Textron sole-source because the skills necessary to build these systems only is available from Textron, Army officials say.

OSRVT provides data and telemetry from UAVs like the Textron Shadow drone, yet its common software also can integrate with tracked and wheeled ground vehicles to enhance warfighter situational awareness on the battlefield.

The OSRVT's graphical user interface delivers battlespace information in live video or annotated map views, and enables users to save, export, and analyze data.



The OSRVT delivers real-time situational awareness with a modular hardware design that can be configured for manpack, mounted, stationary, airborne, and maritime applications.

Upgrades to the OSRVT with bi-directional capabilities also will enable users to control the electro-optical and infrared sensor payloads on a variety of UAVs.

On this contract Textron will do the work at locations to be determined with each order, and should be finished by February 2024. For more information contact Textron Systems online at www.textronsystems.com, or the Army Contracting Command-Redstone at https://acc.army.mil/contractingcenters/acc-rsa/.

RADAR

Raytheon to build AESA airborne radar for modern versions of the F-15 jet fighter

Airborne radar experts at Raytheon Technologies Corp. will build upgraded radar systems for advanced versions of the Boeing F-15 Eagle jet fighter under terms of a $3.1 billion U.S. Air Force contract.

Officials of the F-15 Division Contracts Branch at Wright-Patterson Air Force Base, Ohio, are asking the Raytheon Intelligence & Space segment in El Segundo, Calif., to build, modernize, and support the AN/APG-82 active electronically scanned array (AESA) radar system to align rapidly with the F-15 weapons system program. The awarded is part of the F-15 Radar Eagle Vision project.

The latest version of the F-15 combat jet is the F-15EX, which is based on the F-15 Advanced Eagle that Boeing is building for the air forces of Qatar and Saudi Arabia. The Advanced Eagle has a fly-by-wire flight control system, digital electronic warfare (EW) suite, an infrared search and track (IRST) system, and the Raytheon APG-63(v)3 AESA radar.

The latest version of the Raytheon APG-82(V)1 AESA radar optimizes the F-15Es multirole mission capability, Raytheon officials say. In addition to its extended range and improved multi-target track and precision engagement capabilities, the APG-82(V)1 improves F-15 system reliability over the APG-70 radar in the legacy two-seat F-15E jet fighter-bomber.

Raytheon capitalizes on enabling technologies in the company's the APG-79 and APG-63(V)3 AESA radars flying on the Navy F/A-18E/F jet fighter-bomber, the EA-18G electronic warfare (EW) jet, and the single-seat F-15C air-superiority jet fighter. The APG-82(V)1 is intended to boost situational awareness and attack capability in the F-15E.

Aircraft equipped with the APG-82(V)1 AESA radar can detect, identify, and track several different air and surface targets simultaneously at long ranges. With this week's contract, Raytheon now will make additional upgrades to the APG-82 radar for aircraft such as the F-15EX and its descendants.

The F-15EX carries more weapons than similar fighter aircraft, and will be able to launch hypersonic weapons that are as large as 22 feet long and weigh as much as 7,000 pounds, Boeing officials say. The F-15EX also is following the U.S. Department of Defense (DOD) DevSecOps initiative to develop secure, flexible, and agile software and an open-systems avionics architecture.

The F-15EX will be a large, powerful, non-stealthy, twin-engine jet fighter able to carry a large air-superiority weapons payload. The plane will be able to carry as many as 22 AIM-9X Sidewinder and AMRAAM medium range air-to-air missiles.

It also will have a substantially more powerful mission computer than all existing versions of the F-15, new cockpit displays, a digital backbone, infrared search and track (IRST) system, the Raytheon APG-63(v)3 active electronically scanned array (AESA) radar, and the Eagle Passive Active Warning Survivability System (EPAWSS) — an electronic warfare and threat identification system.

The F-15EX also will have terrain-following radar to enable the pilot to fly at a very low altitude following cues displayed on a heads up display. The targeting pod contains a laser designator and a tracking system with a 10-mile range. The plane also will have as many as 11 underwing weapons stations and digital Joint Helmet-Mounted Cueing Systems. The original F-15 jet fighter began development in 1967, and entered service with the U.S. Air Force in 1976.

On this contract Raytheon will do the work in El Segundo, Calif., and should be finished by June 2036. For more information contact Raytheon Intelligence & Space online at www.raytheonintelligenceandspace.com, or the Air Force Life Cycle Management Center at www.aflcmc.af.mil.

WEAPONS LAUNCHERS

Fulcrum Concepts to build combination missile, rocket, and unmanned launcher for helicopters

U.S. Army helicopter aviation experts needed a weapons launcher able to shoot missiles, rockets, and small unmanned aerial vehicles (UAVs) equipped with sensors and explosives. They found their solution from Fulcrum Concepts LLC in Mattaponi, Va.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., announced a $9.5 million contract to Fulcrum to develop, integrate, and test the Modular Effects Launcher (MEL).

The MEL will be for the future Army Future Attack Reconnaissance Aircraft (FARA), a high-speed light scout to replace the retired OH-58 Kiowa helicopter. FARA is under development by Bell Textron in Fort Worth, Texas, and Sikorsky, a Lockheed Martin company in Stratford, Conn.

Both versions of the FARA will carry an MEL, which Fulcrum is developing to launch missiles, rockets, and multi-purpose mini-drones called air-launched effects (ALE), which is in development.

ALE consists of an unmanned aircraft, sensor and weapons payloads, mission system applications, and support equipment. The ALE should be able to identify and attack threats from beyond weapons range of the aircraft hosting the modular effects launcher.

The ALE should be able to deliver kinetic and non-kinetic, lethal and non-lethal mission effects against several different kinds of threats, as well as provide battle damage assessment video.

The intent of ALE is to provide scalable effects to detect, locate, disrupt, decoy, deliver lethal effects against enemy forces. The relatively low-cost ALE will be attritable or optionally recoverable, and uses a modular open systems design for modularity and rapid integration of new technologies.

The modular effects launcher should be able to launch ALE aircraft, as well as rockets and missiles. Fulcrum also builds the GLB-4 Griffin B Block II launcher for helicopters and small fixed-wing aircraft. It carriers four Griffin missiles, accommodates several electronics modules, connectors and GPS antennas. The GLB-4 launcher weighs 43 pounds empty.

On the MEL contract, Fulcrum will do the work in Mattaponi, Va., and should be finished by June 2023. For more information contact fulcrum Concepts online at https://fulcrumconceptsllc.com, or the Army Contracting Command-Redstone at acc.army.mil/contractingcenters/acc-rsa.

SMART SENSORS

Raytheon to develop smart sensors and machine learning for military targeting

Sensors experts at Raytheon Technologies Corp. will develop a new kind of camera and digital signal processing to enable electro-optical smart sensors for tactical military applications.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced an $8.8 million contract to the Raytheon Intelligence & Space segment in El Segundo, Calif., for the Fast Event-based Neuromorphic Camera and Electronics (FENCE) project.

FENCE seeks to develop and demonstrate a low-latency, low-power, event-based camera and a new class of digital signal processing and machine learning algorithms that use combined spatial and temporal information to enable intelligent sensors for tactical military applications.

Neuromorphic describes silicon circuits that mimic brain operation; it exhibits low latency, sparse output, and extreme energy efficiency. Neuromorphic cameras offer sparse output, and respond only to changes in the scene, with accompanying low latency and low power for small-format cameras in sparse scenes.

Event-based imaging sensors operate asynchronously, and only transmit data from pixels that have changed, so they produce 100 times less data in sparse scenes than traditional focal plane arrays (FPAs). This leads to 100x lower latency at 100x lower power.

Despite their inherent advantages, existing event-based cameras are not compatible with military applications because military images are cluttered and dynamic. The FENCE program seeks to develop an integrated event-based infrared focal plan array with embedded digital signal processing to overcome these challenges.

The FENCE program's primary focus is on developing an asynchronous read-out integrated circuit (ROIC) capable of very low latency and power operation, and a new, low-latency event-based infrared sensor with in-pixel processing.

The project also will develop a low-power processing layer that integrates with the ROIC to identify relevant spatial and temporal signals. The ROIC and the processing layer together will enable an integrated FENCE sensor that can operate on less power than 1.5 Watts.

The FENCE program will last for four years, and DARPA researchers issued their broad agency announcement for the project last October. Raytheon may not be the only FENCE contractor, as DARPA officials say they plan to award contracts to several companies.

On this contract Raytheon will do the work in Goleta and El Segundo, Calif.; Cambridge and Tewksbury, Mass.; McKinney, Texas; Tempe, Ariz.; and New York City, and should be finished by May 2025.

For more information contact Raytheon Intelligence & Space online at www.rtx.com/our-company/our-businesses/ris, or DARPA at www.darpa.mil.

To submit new products for consideration, contact John Keller at jkeller@endeavorb2b.com.

RF AND MICROWAVE

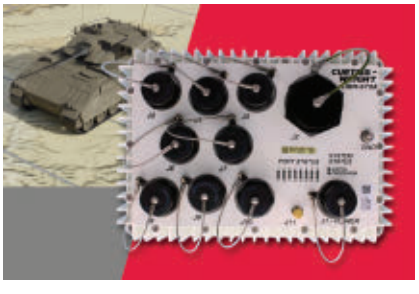
Military multiplexers for RF and microwave applications introduced by Pickering

Pickering Interfaces in Clacton-On-Sea, England, is introducing microwave multiplexers with a maximum frequency of 67 GHz in SP4T and SP6T form factors for aerospace and defense RF and microwave applications. The model 40/42-785C PXI and PXI Express multiplexers and models 60-800 and 60-803 LXI multiplexers maintain the same physical dimensions as existing lower frequency products, enabling users to upgrade to 67 GHz products while maintaining the same slot count and rack height within their test systems. The introduction of the PXI Express format to the microwave multiplexers includes the range from 3 GHz to 67 GHz. The 40/42-785C and 60-800 & 60-803 67 GHz multiplexers are available in unterminated SP4T & SP6T forms using the SMA-1.85 connector interface. The components exhibit virtually identical performance to 50 GHz when compared to existing 50 GHz switches. This helps to maintain performance characteristics for legacy test systems that were previously based on 50 GHz components. In addition, the relays used in Pickering's 67 GHz multiplexers have the same life expectancy, 2M operations, as lower frequency products from the company and twice that of competitors. The 67 GHz SP4T & SP6T relays also can be specified in Pickering's Turnkey LXI microwave switch and signal routing subsystems. For more information contact Pickering Interfaces online at www.pickeringtest.com.

VETRONICS

Embedded computer, PNT, and Gigabit Ethernet switch introduced by Curtiss-Wright

The Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va., is introducing the DBH-670A A-PNT Digital Beachhead A-PNT vehicle computer for assured-positioning, navigation and timing (A-PNT) applications in military ground vehicles. The VPX3-673 also is for radial clock distribution applications and can provide a server for various low-power timing services. The new DBH-670A is a computer and Gigabit Ethernet switch that integrates A-PNT functionality from complementary PNT sources into a compact and rugged line replaceable unit (LRU) that also hosts a Vehicular Integration for C4ISR/EW Interoperability (VICTORY network switch and vehicle management computer. The DBH-670A securely distributes A-PNT data across the vehicle in a trusted manner. Because it hosts the Defense Advanced GPS Receiver (DAGR) functionality within the VICTORY switch, the DBH-670A eliminates the need for a legacy DAGR LRU from the vehicle. The DBH-670A integrates a multi-functional vehicle computer, Gigabit Ethernet switch, and a Arm computer in one rugged box. This Modular Open Systems Approach (MOSA)-based unit provides a chip scale atomic clock (CSAC) and an on-board 10-degree-of-freedom inertial measurement unit (IMU). For more information contact Curtiss-Wright Defense Solutions online at www.curtisswrightds.com.



POWER ELECTRONICS

High-voltage DC-DC converters for noise-sensitive uses offered by TDK Lambda

TDK-Lambda Americas Inc. in San Diego is introducing the CHVM series of high-voltage DC-DC converters for noise-sensitive applications like photomultiplier tubes, photodiodes, scanning electron microscopes, X-ray fluorescence spectrometers, mass spectrometers, and ultrasonic probes. These non-isolated power supplies can operate from a nominal 12-volt input, and deliver output voltages ranging from 180 to 2,000 volts. The power electronics devices achieve low-output ripple and noise with a metallic case that provides five-sided shielding to reduce radiated emissions. The series comprises 20 parts, with positive or negative polarity output voltages of 180, 300, 350, 470, 1,000, 1,500, and 2,000 volts. The maximum output ripple and noise level is 150 millivolts and typical measurements are between 5 and 50 millivolts. The output voltage of these DC-DC converters can be adjusted over a 0.5-to-100 percent range with an external voltage or resistor or inhibited using the remote on/off function. The input voltage is 11 to 13-volts for the 1.4- and

1.5-Watt models, 10.8 to 16.5-volt for the 2 Watts and 10.8 to 13.2-volt for those rated 2.5 Watts or higher. The compact converters are available in three case sizes. The CHVM1R5 (1.4 Watts and 1.5 Watts) measures 44 by 16 by 30 millimeters (WxLxH), the CHVM2 and CHVM2R6 (2 Watts and 2.6 Watts) 110 by 12 by 19.75 millimeters, and the CHVM2R5, CHVM2R7 and CHVM3 (2.5 Watts, 2.7 Watts and 3 Watts) 80 by 12 by 19.75 millimeters. For more information contact TDK Lambda online at www.us.lambda.tdk.com.

ELECTRONIC WARFARE

Low-noise amplifiers for electronic warfare (EW) uses introduced by Pasternack

Pasternack, an Infinite Electronics brand in Irvine, Calif., is introducing a series of low-noise amplifiers for electronic warfare (EW), microwave radio, satellite communications (SATCOM), test and measurement, and radar applications. The input protected low-noise amplifiers feature gallium nitride (GaN) semiconductor technology that provides input power protection. GaN semiconductors provide a power-to volume ratio for broadband high power applications. These amplifiers offer thermal properties and high breakdown voltage that results in tolerating high RF input power signal levels while maintaining low noise figure performance. These amplifiers cover broadband RF and microwave frequencies ranging from 1 to 23 GHz, gain to 46 decibels typical, noise figures as low as 1.5 decibels typical, and high RF input power handling to 10 Watts continuous wave. These LNAs offer a rugged, mil-grade compact coaxial designs and SMA connectors. For more information contact Pasternack online at www.pasternack.com.

AVIONICS

MIL-STD-1553B in-line bus couplers for confined-space applications introduced by MilesTek

MilesTek, an Infinite Electronics company in Lewisville, Texas, is introducing RoHS-compliant MIL-STD-1553B in-line bus couplers for confined-space applications in avionics, the military, and laboratories. The MIL-STD-1553B inline bus couplers a space-saving, small-form-factor design, and one through four stub options: blunt with no connectors with 0.3 meter leads; M17/176-00002 78 Ohm Twinax cable; and combinations of left and right stub leads. The couplers have a transformer ratio of 1:1.41 with stub resistor values of 78.7 Ohms, 2 Watts, 1 percent. The couplers are for use in aircraft avionics, land vehicles, ships, submarines, other applications that require MIL-STD-1553 connectivity. For more information contact MilesTek online at www.milestek.com.

POWER ELECTRONICS

Upgraded ceramic MOSFETs for energy storage and inverters introduced by Infineon

Infineon Technologies AG in Munich is introducing upgraded FF11MR12W1M1_B70 and

FF6MR12W2M1_B70 EasyDUAL CoolSiC high-performance MOSFET ceramic modules with an aluminum nitride (AIN) ceramic for power electronics in solar systems, uninterruptible power supplies, auxiliary inverters, energy storage systems and electric vehicle chargers. The 1200-volt power devices come in half-bridge configuration with an on-state resistance (R DS(on)) of 11 mO in an EasyDUAL 1B package and 6 mO in an EasyDUAL 2B package. The EasyDUAL modules have CoolSiC metal oxide silicon field-effect transistor (MOSFET) technology that features superior gate-oxide reliability. With the improved thermal conductivity of the DCB material, the thermal resistance to the heat sink (R thJH) can be lowered by as much as 40 percent. Combined with the CoolSiC Easy modules, the AIN ceramic enables an increase of the output power or reduces the junction temperatures, which can improve the lifespan of the system. More information is online at www.infineon.com/easy.

CONNECTORS

Adapters able to operate at millimeter wave frequencies introduced by Cinch Connectivity

Cinch Connectivity Solutions in Wesaca, Minn., is introducing 1.85 to 2.92 millimeters between series adapters in rugged stainless-steel construction for product design, test, and manufacturing applications. These RF and microwave adapters provide repeatable

high-frequency performance, and are popular with test and research laboratories to support frequencies as high as 46.5 GHz. Cinch offers same series and between series high-frequency adapters that cover configurations of 1.85, 2.4, and 2.92 millimeters, as well as SMPM, SMP, and SMA. These adapters support 5G and IoT applications operating at millimeter wave frequencies. For more information contact Cinch Connectivity Solutions online at https://belfuse.com/cinch.

TEST AND MEASUREMENT

Millimeter wave semiconductor test and measurement system introduced by Marvin

Marvin Test Solutions Inc. in Irvine, Calif., is announcing that the company's TS-900e-5G production test system for 5G millimeter wave semiconductor devices is in use by several semiconductor manufacturers. Rapid industry adoption signals the significance of these test solutions, enabling manufacturers to meet high-throughput production demands for millimeter wave semiconductor devices. Part of the Marvin Test Solutions GENASYS Semi suite of configurable semiconductor test solutions, the TS-900e-5G is for wafer probing and package test with support for production automation and handling tools. GENASYS Semi 5G millimeter wave solutions deliver repeatable production VNA / S- parameter measurements, and can support as many as 20 independent VNA ports of 44 GHz signal delivery to the device under test (DUT). Additionally, the modular architecture of the test system can address the evolving needs of millimeter wave test, with expanded performance to 53 GHz scheduled for this summer. The TS-900e-5G test and measurement core system includes the Keysight high-throughput VNAs and ATEasy, the MTS suite of software tools that enable users to develop and maintain test applications, as well as ICEasy, which facilitates device test development and characterization. For more information contact Marvin Text Solutions online at www.marvintest.com/5G.

SPACE ELECTRONICS

Rad-hard microprocessor and microcontroller for space introduced by Microchip

Microchip Technology Inc. in Chandler, Ariz., is introducing the SAMRH71 Arm-based microprocessor and SAMRH707 microcontroller with Arm Cortex-M7 system-on-chip (SoC) radiation-hardened technology for space applications. Microchip developed the SAMRH71 and SAMRH707 devices with the support of the European Space Agency (ESA) and Centre National D'Etudes Spatiales (CNES), the French space agency. Relying on the standard Arm Cortex-M7 architecture and the same peripherals as automotive and industrial processors, the SAMRH71 and SAMRH707 help optimize development costs and schedule by using standard software and hardware tools. The SAMRH71, a radiation-hardened variant of Microchip's COTS automotive SoC technology, provides a combination of space connectivity interfaces along with high-performance architecture with more than 200 Dhrystone MIPS (DMIPS). Designed for high-level radiation performance and extreme temperatures, the SAMRH71 Arm Cortex-M7 microprocessor core is coupled with high-bandwidth communication interfaces such as SpaceWire, MIL-STD-1553, CAN FD, and Ethernet with IEEE 1588 Generalized Precision Time Protocol (gPTP) capabilities. The device is ESCC qualified with support from CNES and compliant with MIL standard Class V and Q high-reliability grades. For more information contact Microchip Technology online at www.microchip.com.

BOARD PRODUCTS

Embedded computing module for harsh-environment applications introduced by WinSystems

WinSystems Inc. in Grand Prairie, Texas, is introducing the COMeT10-3900 industrial COM Express Type 10 Mini embedded computing for industrial and other harsh-environment applications. This low-power industrial small-form-factor module was designed and manufactured in the U.S., and is designed as a processor mezzanine that can be plugged onto a carrier board that contains user-specific I/O requirements. Suitable for industrial internet of things (IoT) applications, the COMeT10-3900 has an Intel Atom E3900 processor, formally Apollo Lake-I. It has as much as eight gigabytes LPDDR4 2400 MT/s system memory; Intel low-power Gen9 graphics engine; and full-HD and 3D graphics acceleration. For trusted computing the module has on-board discrete TPM 2.0 hardware security. It operates in temperatures from -40 85 degrees Celsius, offers power input from 4.75 to volts to 20 volts DC. Expansion includes four PCI Express lanes configurable as 4×1, 2×1 + 1×2, or 1×4; two USB 3.1 Gen 1, 6x USB 2.0; one MIPI-CSI-2 (4-Lanes); one

i210 1-gigabit-per-second Ethernet RGMII with IEEE 1588 support; HD audio; two SATA III (6 -gigabit-per-second); two UART; and four GPI, four GPO (SDIO option for MicroSD socket). The board for harsh-environment applications has on-board eMMC 5.x (eight to 128 gigabytes of on-board data storage; one dual-mode display (DisplayPort, HDMI, DVI); and one eDP (optional single-channel LVDS). For more information contact WinSystems online at www.winsystems.com.

DATA RECORDERS

Rugged rackmount data recorder for radar and spectrum-monitoring introduced by Pentek

Pentek Inc. in Upper Saddle River, N.J., is introducing the Talon model RTR 2628 8-channel phase coherent 4U 19-inch rackmount data recorder for spectrum-monitoring applications that need to interpret synchronized signals. The Talon model RTR 2628 8-channel phase coherent 4U 19-inch rackmount data recorder offers integrated RF tuners and A/D converters, and is designed to operate under conditions of vibration and extended operating temperatures. The Talon RTR 2628 accepts signals from eight antennas to provide eight channels of phase-coherent RF signal recording. Each channel is tunable to 6 GHz and captures as much as 80 MHz of instantaneous bandwidth. Applications include beamforming, direction finding, phased-array radar and multi-antenna diversity receivers. Each input channel includes a 250 MHz 16-bit A/D and a field-programmable gate array (FPGA)-based digital downconverter with programmable decimations from 2 to 65536 for instantaneous bandwidths from 80 MHz down to 3 kHz. Users can tune, sample, digitally downconvert, and stream RF signals to 6 GHz in frequency to disk in real-time at sustained aggregate recording rates to 3.2 gigabytes per second. RF tuning frequencies, A/D sampling rates, DDC decimations. and trigger settings are among the selectable system parameters, providing a system that is flexible, yet simple to configure and operate. For more information contact Pentek online at www.pentek.com.

EMBEDDED SYSTEMS

6U OpenVPX development backplane for embedded computing introduced by Pixus

Pixus Technologies in Waterloo, Ontario, is introducing a three-slot 6U OpenVPX development backplane and chassis for embedded computing development projects. The open-frame development chassis features the 6U OpenVPX power and ground only backplane with 1 VPX slot and dual VITA 67.3c slots with cutouts in the P3 and P6 sections of the board. The design enables systems designers to plug VITA 65 and VITA 67 boards into the same backplane. The development backplane also can combine with a second unit for more slots or other standard VITA 65 or SOSA profiles. The open-frame 6U OpenVPX chassis features card guide options for air-cooled or conduction-cooled modules, or a mix of the two. The Pixus chassis platform also offers modular power supplies, an optional fan speed control dial, and a carry handle. Pixus offers OpenVPX backplanes and chassis systems in commercial, development, and military rugged formats. The company also provides IEEE and Eurocard components for the embedded computer market. For more information contact Pixus Technologies online at https://pixustechnologies.com.

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