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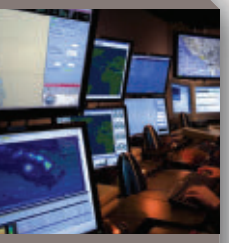

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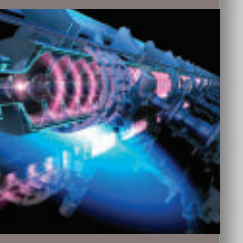

BY **JOHN KELLER**, EDITOR IN CHIEF

Rad-hard industry faces challenges of adapting to Space 2.0

The radiation-hardened electronics industry is in the midst of yet-another major transition — the second in the last quarter-century — that once again is likely to redefine the space market, boost new industry players, and shake out some of the old ones.

The latest round of disruptive technology in the rad-hard electronics industry involves the emerging market for small satellites (SmallSats) with limited life cycles. The aerospace industry calls this market New Space or Space 2.0. Rad-hard electronics component suppliers are doing their best to gear-up for the anticipated new era.

Getting ready for Space 2.0, however, may be easier said than done — particularly for the traditional longtime suppliers of radiation-hardened electronics parts. The transition involves not just technology, but also a whole new way of doing business.

"You can't just adapt the technology; you have to adapt the flexible business model," says Chris Clardy, general manager of semiconductor solutions at rad-hard specialist Cobham Advanced Electronic Solutions in Plainview, N.Y.

Making the pivot to Space 2.0 involves offering rad-hard product lines that are more affordable than ever before, and that have a wide range of radiation hardness. This is one way that the next generation of SmallSats and so-called CubeSats that will define Space 2.0 can meet system requirements while keeping costs to a minimum.

In other words, the gold-plating is all gone. Spacecraft designers involved in Space 2.0 no longer want reliability at any cost; they want reliability that's just good enough. They're looking to shave costs at the rad-hard component level, which is something they've rarely — if ever — done before.

Traditional rad-hard suppliers like Cobham, BAE Systems, IBM, Northrop Grumman, and others grew up in another era when reliability was everything, and cost was not nearly the concern it is becoming today. The legacy of traditional rad-hard suppliers, in fact, extends back 25 years and more to the Cold War when fears of nuclear weapons explosions in space drove requirements to enable electronics to operate through nuclear events with little, if any, disruption.

From a business standpoint, those electronic parts designed to operate through nuclear explosions didn't come cheap; they were some of the most expensive, rugged, and reliable components available anywhere, and satellite designers of that era were more than willing to pay their prices. Legacy satellite communications (SATCOM) systems like the Military Strategic and Tactical Relay (MILSTAR) satellites were examples of this.

With a history of reliability virtually at any cost, some of the traditional rad-hard electronic suppliers might find it difficult to make the switch to Space 2.0. That's difficult, but probably not impossible.

"There will be a traditional space market that will remain, driven by the military, with 20-year life cycles," says Anthony Jordan, vice president for product marketing and applications engineering at the Cobham semiconductor segment in Colorado Springs, Colo. He points out that there isn't a lot of duplication now in the rad-hard electronics business, and says he doesn't expect a major industry shakeout.

Still, there's much change in the wind for the rad-hard parts industry, not only because of the technology disruptions brought about by the end of the Cold War, and later with Space 2.0. New generations of technology employees also are expected to drive change.

"We have to look at the new Millennial talent and let them do their thing, rather than impose what we've done for the past 20 years," Cobham's Clardy says.

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DARPA to develop real-time intelligence processor to uncover patterns in vast data

BY JOHN KELLER

ARLINGTON, Va. — U.S. military researchers are asking for industry's help in developing a new data processor to help intelligence analysts understand relationships in vast data streams from cameras, social media, sensor feeds, and scientific data.

Military researchers are trying to capitalize on the best of industry's high-performance computing technologies to uncover patterns in vast amounts of data.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a presolicitation (DARPA-BAA-16-52) for the Hierarchical Identify Verify Exploit (HIVE) project. The HIVE program seeks to develop a generic and scalable graph processor that specializes in processing sparse graph primitives, and achieves 1000-times improvement in processing efficiency over standard processors.

This capability will help intelligence analysts discover the relationships between events as they unfold in the field, rather than relying on forensic analysis in data centers, DARPA officials say.

The program will develop chip prototypes and software tools to support programming the new hardware, as well as design a system architecture to support efficient multi-node scaling.

Today large amounts of data come from sources like social media, cameras, other kinds of sensor feeds, and scientific data. Graph analytics has emerged as a way to understand the relationships between these heterogeneous types of data to enable analysts to draw conclusions from the patterns in the data and to answer previously unthinkable questions, DARPA experts explain.

Yet analysts might be able to understand a more complete picture of the problem by understanding the complex relationships between different data feeds.

Today most graph analytics happens in large data centers on large cached or static data sets. This requires massive amounts of processing power — particularly for "needle-in-the-haystack" types of problems. Moreover, the nature of the graph can be very

IN BRIEF

Lockheed Martin to design F-35 simulation and training at Lemoore NAS

U.S. Navy air combat experts are expanding simulation and training activities for the F-35C carrier-based joint strike fighter to help give F-35 pilots and flight crews a realistic training experience at the most economical cost possible. Over the next three years, Navy Pacific Fleet F-35C pilots will gain access to a state-of-the-art flight simulation facility at Lemoore Naval Air Station in Central California that will involve training tasks ranging from basic flight skills to team-based mission rehearsal that will mimic challenging combat conditions. Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $20.8 million order to the Lockheed Martin Corp. Aeronautics segment in Fort Worth, Texas, to build a sophisticated F-35C simulation and training facility at Lemoore. Through early 2019, Lockheed Martin engineers will deliver, install, configure, and stand up an F-35C Training Infrastructure System (TIS) and Pilot Fitting Facility at Lemoore.

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sparse, as analysts are not clear on the number of relationships between entities.

Analysts also need to make decisions in real time. To do this, they must understand how relationships in the graph evolve over time. The graph must update at the speed of incoming data, not as an offline process, because the graph must develop and change in real time.

Trying to analyze the graph with standard processors is extremely inefficient because sparse data must be processed in real time, DARPA officials say.

Graph analytics shifts the processing workload to locating the information and moving the data; only 4 percent of processing time and power goes to the overall effort.

Such inefficiency either limits the size of the graph to what the chip can hold, or requires an extremely large cluster of computers. Instead, the HIVE program seeks to create a special processor that works on graph analytics 1000 times faster than can today's standard processors.

The program will focus on improving the efficiency of random access memory transactions to limit data movement, efficient parallelism to improve scalability, and new accelerators designed specifically for graph computation.

The HIVE program has three phases. First, an architectural phase will develop new memory controllers, new accelerators based on graph primitives, new data flow models, new data mapping tools, and new middleware to enable seamless transition of existing graph algorithms onto the new hardware.

Second, a prototyping phase will demonstrate these new technologies on military applications. Third, a fabrication phase will demonstrate the scalable performance of a 16-node system of custom graph processors for accelerating the most demanding military analytics applications.

The project has three technical areas: graph analytics processor, graph analytics tool kits, and system evaluator. The graph analytics processor (technical area one) will design a new chip architecture from scratch, focusing on the mem-

ory wall and on parallelization of multinode systems. The memory wall will create new memory architectures that allow for non-uniform memory access (NUMA).

Parallelization, meanwhile, will enable machines to work closely together, rather than working in parallel but running independently. Technical area one, in essence, has to move from today's single instruction multi-data (SIMD) world to one that allows for multiple instruction multi-data (MIMD) execution, DARPA officials say.

This component of the HIVE program will create an accelerator architecture and processor pipeline that processes graph primitives in a native sparse matrix format; develop a chip architecture that moves data quickly and efficiently from memory or I/Os to the accelerators; and develop an external memory controller that uses data mapping tools to handle random and sequential memory accesses on memory transfers as small as 8 to 32 bytes.

The prototype phase will develop the new chip architecture on a printed circuit board and low-level software that will emulate the future chip.

Graph analytics toolkits (technical area two) aims to develop the fundamental software technologies to translate existing graph algorithms into the new hardware by developing micro-code to match the microarchitecture of the new chips. Micro-code must support the data format and graph primitives of existing graph algorithms and not force them to re-write their algorithms.

System evaluator (technical area three) aims to identify and develop static and streaming graph analytics to solve five types of problem areas: anomaly detection, domain specific search, dependency mapping, N-x contingency analysis, and causal modeling of events.

Companies interested should submit proposals no later than 19 Oct. 2016 to the DARPA website at https://baa.darpa.mil. E-mail questions or concerns to DARPA's Trung Tran, the HIVE program manager, at DARPA-BAA-16-52@darpa.mil.

MORE INFORMATION IS online at *https://www.fbo.gov/spg/ODA/DARPA/CMO/DARPA-BAA-16-52/listing.html*.

Wearable electronics adapt to the infantry

Reliable power, information overload, size and weight, and interpreting old-fashioned infantry hand signals top research priorities for digitizing the warfighter.

BY **J.R. Wilson**

The first recorded war took place between Sumer and Elam in Mesopotamia in 2700 BC, but archaeological evidence shows a history of violent mass conflict for more than 12,000 years, about the time humans began changing from hunter-gatherers to farmers and builders.

For that entire history, the brunt of war has fallen on the foot soldier, with little change in the basics of individual ground combat other than personal weapons, organization, and training. For all but the last few decades, these warriors generally were the least educated, most disposable members of society — sometimes dismissed as "cannon fodder".

That began to change with the U.S. military in the 20th Century, with the development of a cadre of well-trained noncommissioned officers providing leadership in the moment-to-moment

Researchers at Draper Laboratory are trying to capitalize on commercial wearable electronics technologies to create wearables for the future warfighter.

actions on the battlefield. Little else changed, however, until the 21st Century, when infantry began receiving individual communications, navigation-and-location equipment, computing capability, sensors, personal armor, and precision-guided munitions.

These were the result of explosive advances in technology, especially miniaturization and faster, more powerful computing. As a result, the American warfighter in 2015 bears little resemblance to those of 2001 — and far less to any previous generation. Yet despite these advances, little really has changed in how top commanders use the foot soldier in battle.

That is about to change — indeed, already is changing — building on what was done in the past 15 years in the evolution of warfare. Still, this new level could be considered more revolutionary than evolutionary as the next 20 years brings about more change in warfare — and especially in the equipping, capabilities, and use of dismounted infantry — than in the preceding 12,000 years.

Providing power for wearable electronics is a big concern for military designers. Conformal batteries that can be slipped into body armor are under development.

That change will be based on wearable electronic devices — sometimes known as wearable devices.

"Wearable computing is part of ubiquitous or pervasive computing," explains Stephen Russell, branch chief of battlefield information processing at the U.S. Army Research Laboratory in Adelphi, Md. Wearable electronics, he says, describes the common availability of computer equipment and sensors that provide information about the environment, the soldier's medical state, and similar information of value to infantry warfighters and commanders.

The prospect of many infantry warfighters with wearable electronics, however, presents a challenge that involves huge volumes of data that somehow must be processed quickly enough to benefit a fast-maneuvering ground fighting force. "Some of the challenges are being able to understand that volume of information and make it available not only to [the individual] soldiers but to command and control in ways that make sense while tailoring it to improve decision-making," Russell says.

"Imagine a soldier on the battlefield communicating with other soldiers — some non-verbal, some passive — and outfitted with a completely instrumented system, such as an arm band that collects and sends medical data," Russell continues. "How do we deal with all that information available not only about the soldier but also his environment and equipment, all of which will be operating interactively?"

Army researchers are exploring the use of a wearable arm band sensor to convey the meaning of standard infantry hand signals to intelligent communication software and facilitate information dissemination and retrieval.

Influences on the battlespace

To date, with a few comparatively minor exceptions, wearable computing and electronics for frontline warfighters have been limited to military forecasters, theoreticians, and future tech-development engineers. Problems involve limitations in sufficient capability and broadcast range, and in the size, weight, and longevity of batteries the soldier must wear.

The military is asking for a great deal from future tech, acknowledges Chris Boger, group leader for system integration at the Charles Stark Draper Laboratory in Cambridge, Mass. "The state-of-the-art, specifically with respect to frontline warfighters, really is pretty limited," Boger says. "Most wearable devices are more likely found in training environments or development centers. So the warfighter probably is behind what you would see on a normal consumer at this point. We need to consider the overall system in which the soldier is a part and how the equipment will react to a given environment or activity and interact with other equipment. We have to develop an integrated solution that puts it all together for the best result and stop hanging things on the soldier like a Christmas tree."

Such an approach may be easier said than done, since the infantry warfighter's needs are so broad. What the military is asking for "really runs the gamut, from real-time force health status to different means of human augmentation, from exoskeletons to robotics, physiological monitoring, position and navigation, and vibration monitoring," Boger says. "We're also starting to see requests for more system-level answers, and we're trying to break into the brain. How do we monitor cognitive activity."

The challenges of antennas

Some Army researchers are starting to work on a wearables area that has been overlooked for far too long if the concept is ever to succeed: antennas.

"Antennas tend to be the last thought about part of the system. They can be expensive, but when dealing with a mobile or body-wearable antenna, they're not the big expense item in the system," says Mitchell Mayer, a radio electronics engineer at the Army Communications-Electronics Research, Development and Engineering Center (CERDEC) at Aberdeen Proving Ground, Md.

"Usually they develop a new technology, then see what antenna they have on the shelf they can use with it," says Mayer, a retired Army lieutenant colonel now working in the

radio-frequency communications division of CERDEC's space and terrestrial communications directorate.

Systems integrators developing wearable radios and helmet- and uniform-mounted sensors usually take the antennas that manufacturers give them; they can't always afford to develop new antennas custom-designed for the application.

"When you look at all the sophisticated systems we have out there, you see soldiers operating it with antennas that have been around for 50 years, such as an 8-foot collapsible stick or a 3-foot metal whip, that are the only approved antennas operating in that frequency by the Army for VHF," Mayer notes. "If they are concerned about visibility to the enemy or operating in a dense forest or jungle, they will collapse the antenna or try some other means to get around it and that limits the range and quality of their communications."

There are different types of wearable antennas — including fabric that uses conductive threads — but so far they don't work very well, and definitely not in the frequencies of U.S. military communications

The MILTECH 308 is one of the industry's lightest Ethernet switches that saves weight in man-packable systems that may include radios, heads-up displays, navigation systems, and computers.

systems like the single-channel ground and airborne radio system (SINCGARS).

Fabric-worn antennas are "a nice experimental thing, but not practical for the Army," Mayer says. "Even if you could put an antenna into the fabric of a uniform, you still would need a connector to the radio, which can be bulky. And any time you make a conductive fabric or something else on the uniform, it has to be laundered — and that is a considerable concern."

Making the antenna part of a warfighter's uniform, moreover, can complicate efforts to relocate the antenna for best reception, or to increase its range, such as on a hilltop or in a tree, Mayer explains.

To overcome some of these problems, researchers are considering RF repeaters mounted on unmanned aerial vehicles (UAVs). "One of the things we are looking at is the ability for expeditionary forces to operate and that means longer ranges," Mayer says. His team has developed a communications relay that fits on an RQ-7 Shadow UAV, which improves the range by about five-fold compared to the existing Shadow antenna.

CERDEC engineers are trying to design wearable antennas based on the antennas' RF transmit and receive propagation patterns — or how much RF energy gets transmitted, how much is reflected back. Unfortunately this approach has its drawbacks. "The problem is when you design an antenna that way and put it in close proximity to the human body, the results you get are sometimes bizarre," Mayer says. "Patterns don't look the way they should because the body absorbs a lot of radiation and blocks some of the rest."

Using his own military experience and speaking with soldiers in the field, Mayer identified what frontline warfighters need most. "In a squad, there is a certain distance between soldiers and they want to communicate while in a prone position. So I designed an antenna to deal with that and told the manufacturer I was more interested in operational, rather than technical, performance."

"Wearable technology provides instant access to critical information, improves quality, helps increase collaboration, [and] enhances existing workflows." — John Schmidt, managing director, North American aerospace & defense, Accenture

Problem solved

The effort took some doing, but ultimately found a solution. "We went through a number of false starts doing this, but ultimately came up with a single-channel unit that met the RFI for SINCGARS," Mayer says. That was a start, but created problems of its own. "The radios we use — the Harris PRC-152 and Thales PRC-148, which are the two largest fieldings right now — are software-defined radios, so they are more than just SINCGARS and can operate in other bands up to 540 MHz," he says.

The problem is that wearable antennas can be confining — not only to the warfighter's comfort in the field, but also to the RF com-

Today's tactical air control parties, which help guild precision-controlled weapons to their targets, are making some use of wearable electronics, but technology developers are looking for a more integrated approach.

munications bandwidth the warfighter can use. "There are no multiband wearable antennas, so a soldier needing to interface with multiple units has to take multiple antennas to handle each of those," Mayer says.

Solving that challenge may be possible, but it's taking a long time. "An advantage would be a single multi-channel antenna," Mayer says. "I've already issued a new contract solicitation, with two contracts awarded, but that is a three-year effort. There is a second requirement that it also must function if remoted into a tree. The requirement when on the body still must meet the range requirement between two soldiers in a prone position, with that range higher when remoted."

As with the wearable devices themselves, the future of wearable antennas depends on the super-miniaturization of circuitry and a mixture of filters, shielding, and other components. "There are a lot of buzzwords out there such as metamaterials and nanotech that sound good, but the problem is they are not very effective in low frequencies and those that do are extremely expensive," Mayer points out.

Attaching the antenna to the uniform — rather than sewing it in — always is an option. "Today's uniforms use a lot of Velcro and some of these wearable technologies could be Velcroed onto the uniform, which would allow you to change the antenna patch for different uses," Mayer says. "In the future, we may use something like Bluetooth, so you don't have to use a lot of wires. CERDEC's Command, Power and Integration Directorate also is doing a lot of work on batteries, such as miniaturization and capturing the body's kinetic energy."

The safety of the individual warfighter also is a concern, as antennas radiate a radio's RF energy. Depending on the power output and where the antenna sits on the body, it could generate potentially dangerous levels of RF radiation. To that end, CERDEC's Specific Absorption Rate Testing Lab is working with the IEEE standard to test any new antenna design.

"Wearable electronics will be on a battlefield that looks vastly different from today, so the needs of the warfighters also will be different," says Zak Sucher, business development manager at Techaya in Pardes Hana, Israel. "Within 10 years, it all will look different. Bandwidth will grow — both availability and requirements — because you have more and more devices transmitting information in that battlespace. The general direction is higher speed, lower weight, new protocols, and integrating different devices into a single device."

Leveraging COTS

Commercial off-the-shelf (COTS) electronics undoubtedly will play a big role in the future of military wearable electronics, but the way forward isn't always clear. "We've been looking at next-generation systems that leverage commercial developments, but extend and apply these specifically to warfighter concepts of operations," says Jana Schwartz, an information and cognitions engineer in Draper Lab's software & algorithms directorate.

The military environment is far more demanding — and potentially deadly — than the commercial

environment, and presents challenges that designers can't ignore. "There are current defense programs that leverage today's COTS technologies, but whether it's military systems or broader applications, wearables tend to rely on you to look at them," Schwartz says. "Your watch may tap to tell you someone is calling, but you still have to look at it. The problem with that in combat is if you are looking at your wrist, you're not looking around. Some technologies have tried to solve that, but are still very new and struggling."

Future wars won't be fought by infantry staring at tiny screens. "They must be able to fight without having eyes on a screen all the time," agrees Techaya's Sucher. "The programs are looking for the right balance to provide information, but be self-activated."

Information overload

Another concern, already manifesting, is information overload. "We're at the point, outside the military, where wearables already have outpaced our ability to deal with all the information they can provide," says Draper Lab's Boger. "For the military, we need to get ahead of that curve so we do more good than harm. That means developing algorithms and systems that can process and store data and determine how and to whom to distribute that information and present it to the user in the best way possible."

The Crystal Group TAC-V integrated military communications system for mobile computing capability is small and lightweight for infantry and vetronics applications.

The trick is to give warfighters exactly the information they need, when they need it — no more, and no less. "Just as we are able to make better decisions about what route to take by leveraging real-time data in civilian life, the same future applies to warfighters," points out Draper Lab's Schwartz.

"We aren't going to drown them with data, just give them the insights and info they need to be more effective and safer. So it is a transition from a radio station with traffic tracking and weather to Google maps only interrupting me when there is something I should see on the battlefield," Schwartz says. "We will ride on the commercial world's shoulders for a ways, but the stresses and uses in military life are very different and we will have to surpass what a commercial vendor might be interested in developing."

Researchers are starting to consider using a wider variety of the warfighter's senses than viewing text, images, and video on a screen. "The way our brains have evolved, we're not just visual creatures but take in data from all our senses," Schwartz says. "Our brains react differently to seeing something, hearing something, or seeing and hearing at the same time. We need to duplicate that for our warfighters on the battlefield so they can make good decisions as quickly as possible."

Perhaps researchers should take a fresh look at how people absorb complex information quickly, Schwartz suggests. "Presenting data in as intuitive a manner as we can is the path to accomplishing that. There is more recognition of aligning to the user so it is not rejected by the warfighter because it is more distracting than helpful."

Digitizing hand signals

A major effort at the Army Research Lab involves reconciling the silent infantry hand signals with digital technologies like wearable computers and software-defined radio (SDR). Army researchers are trying to move the hand signals that warfighters have used for centuries to convey information and orders without speaking into a digital electronic environment.

Researchers addressed this issue in a "Wearables Notification via Dissemination Service in a Pervasive Computing Environment" study based on the NATO signals developed for silent communications among warfighters who do not speak a common language.

"We conducted an experiment with arm bands on individuals and had them execute several NATO gestures, then ran an experiment to see how we could classify those signals into an accurate determination of their meaning," explains the Army Research Lab's Russell.

"We got as high as 80 to 90 percent accuracy in many cases," Russell continues. "We looked at personalized models, customized to the individual, such as commercial speech-to-text software you have to train to understand your voice, but you need a generalized model, such as Siri. We got a high degree of accuracy with our personalized model and now are extending that to a generalized model."

That same area of research also is leading to one of the most dramatic changes that will be seen on battlefields 10 or 20 years into the future — robotic warfighters that work alongside and communicate with actively pursuing autonomous systems and human/machine interfaces for the future battlespace.

Robotic warfighters

To accomplish it requires 100 percent accuracy and precision in recognizing signaling and communications like the Army Research Lab has been developing.

"Twenty years from now, not all combatants will be human, so without ears or sight, how do we take a wearable signal by a human warfighter and translate that into an appropriate action, for both human and robotic squad members?" Russell asks. "We're researching the fundamental issues, with that as our goal. One element is precision and accuracy, which is what we're working today for human warfighters. A humanoid robot will have arms and legs and could signal to other humans, but not all robots will be humanoid."

Russell says he advocates the expansion of intelligent systems for infantry warfighters. "We're also monitoring a human warfighter's medical state so we can detect not only his message but also if he is dehydrated. A robot — humanoid or otherwise — could receive that message and take water to the human soldier. We are leveraging and integrating our work to couple with what is being done by those building robots and intelligent automations with which we will integrate."

The future goes beyond human warfighters with wearable devices, agrees Draper Lab's Schwartz. "I can imagine a future where robots can do a lot of the things people do today. In that future, we will have to make a moral determination about having them on the battlefield. In the short term, the best way to combine human and machine intelligence is not to rely solely on either human or robot, but let automation and data fusion and our brains work together to get to the right course of action."

Military leaders and technology developers are hesitant to integrate robots into the fighting force in a big way because machines are not very innovative and don't understand when context changes. "Those are the sort of special functions at which humans excel," Schwartz says.

Whether looking at the short-term efforts being pursued by CERDEC, Draper Lab, and Techaya or the far long-term developments central to Army research, it is clear the foot soldier is becoming a platform for sensors and weapons unlike anything ever seen in 12,000 years of warfare.

"The battlefield is changing and we have to be ready for it. As it once was who has the better aircraft or tank, now it is who has the better soldier, more adaptable, better protected," says Techaya's Sucher. "This is a reality and the reason for moving forward is to increase the ability and efficiency of the soldier to identify and eliminate the target faster." ←

Data in demand: answering the call for communications

Modern electronics hardware and software combine in compact communications systems to meet ever-increasing demands for real-time, high-speed information sharing.

BY **Courtney E. Howard**

PacStar technologies support WIN-T Increment 1, the Army's tactical communications network backbone, to help solve complex battlefield communications challenges.

Aerospace and defense missions, including day-to-day activities, increasingly rely on information. Especially important is one's ability to share much-needed data — whether by voice, images, or video — and do so reliably, securely, and in real time. The efficient exchange of safety- and mission-critical information is no mean feat, especially in remote and harsh environments, and requires a combination of robust and reliable electronics hardware and software.

Information is a critical component in virtually all military and aerospace missions today; yet, communications bandwidth limitations often plague mil/aero applications and end users. Bandwidth challenges can be costly, and cause gaps in intelligence gathering and dissemination that could put missions and lives in jeopardy.

Much is being done in an effort to remedy such challenges: Industry technology firms continue to advance data communications and networking technologies, while mil/aero organizations work to deliver more modern, efficient tools in the hands of deployed assets — mil/aero personnel and platforms.

Networking needs

"Today, information sharing is absolutely critical as a core means to ensure mission success," explains Charlie Kawasaki, chief technology officer at Pacific Star Communications Inc. (PacStar), a Portland, Ore.-based provider of tactical and deployable communications equipment. "Nearly every operation is highly dependent on information systems to ensure mission command availability, to achieve and maintain situational awareness, to ensure that the needs of soldiers are met, and to coordinate with coalition partners."

Applications such as mission planning and coordination, intelligence, fire support, combat support, and logistics all rely heavily on Internet Protocol (IP) networks, Kawasaki continues. "Large amounts of

Communications devices help improve combat readiness and interoperability. (Army photo.)

communications bandwidth are required throughout the globe, even in locations with austere, missing, or damaged infrastructure. Information sharing is so important, the question is not 'if' but 'how'."

Aerospace and defense organizations, including militaries worldwide, are opting to adopt hardware and software products from the commercial market. By fielding commercial off-the-shelf (COTS) technologies in lieu of purpose-built, one-off, and proprietary products, they aim to benefit from the commercial world's rapid pace of technology advancement and cost-saving economies of scale. COTS adoption is not without its caveats, however, especially when it comes to communications.

"More and more data and networking capabilities are being pushed out to the edge of the field with the help of virtualization," Kawasaki says. Gigantic enterprise-class software and hardware capabilities are virtualized on very small-form-factor (SFF) servers and networking equipment to increase availability. Yet, this trend results in two side effects: more requirements and an ease-of-use problem.

Rugged requirements

Not too many years ago, a large program fielded satellite terminals to provide warfighters access to the Secret Internet Protocol Router Network (SIPRNet) and Non-classified Internet Protocol Router Network (NIPRNet) in the field, Kawasaki says. "Hundreds of them, out in dusty field. Half of them were offline most of the time, and there was not enough military communications expertise to operate them out in the field.

"Most systems you buy from traditional systems developers go from the factory to the air-conditioned space where they are to be used," Kawasaki says. In contrast, COTS equipment used in aerospace and defense applications are bounced around, are relocated again and again, endure temperature extremes, are exposed to the elements, and so on. "COTS technologies from large OEMs aren't necessarily qualified to run in those environments."

In addition to providing effective communications, solutions for aerospace and defense must meet high standards of environmental testing for shock, vibration, and temperature. Compliance with and third-party testing to MIL-STD-810G and MIL-STD-461F are critical to assure reliably in real operations in remote or mission-critical settings, Kawasaki says. "While these types of standards have been around for quite some time, they have been infrequently applied to COTS equipment. Systems designed and independently tested to standards provide a strong level of assurance to organizations and programs that require reliability in mission-critical systems."

Third-party validation can be a crucial part of rugged military systems design. "We have seen some organizations design to meet military standards, and we go the extra step and have a third party evaluate and qualify. If I was a program manager, I wouldn't settle for anything less. This is mission-critical stuff and it can be incredibly difficult to get replacements out in the field; if a critical parameter is reducing size, weight, and power (SWaP), it defeats the purpose to bring back-ups."

SWaP

"As part of its modernization efforts, the Army continues to improve current and future SATCOM systems to reduce size, weight, and power (SWaP) requirements, as well as increase throughput, network extension, and operational versatility," say officials of the U.S. Army Program Executive Office Command Control Communications — Tactical (PEO C3T) division at Aberdeen Proving Ground, Md.

PacStar 400-series small communications modules enable engineers to customize systems.

"SWaP is an evergreen challenge for warfighter communications," Kawasaki says. "Communications equipment can never be too small, too light, or too power efficient — all else being equal. As new capabilities for information sharing and cyber security push to the edge of the network, requiring more bandwidth and computing power, this only adds to SWaP challenges.

"In the past, tactical/deployed organizations had two main methods to deploy communications technologies," Kawasaki continues. "Option one was to use standard commercial off-the-shelf, 19-inch, rack-mount networking equipment installed in transit cases — which is large, heavy, power hungry, and not designed or ruggedized for transport.

"Option two was to use government-designed or specialized rugged equipment that is extraordinarily expensive, and thus was restricted for use in only the most critical and demanding environments," Kawasaki says.

Today, however, organizations can benefit from:

1. COTS embeddable, small-form-factor circuit boards based on commercial technology, which can be packaged into ruggedized systems at a fraction of the cost of developing purpose-built systems. Using these systems, organizations gain the benefit of commercial sector technology economics, while also benefiting from the right level of ruggedization required to meet mission objectives.
2. Virtualized versions of networking appliances. In the past, networking technologies such as routers, switches, firewalls, Wi-Fi controllers were only available in 19-inch, rack-mount solutions. Today, well-known networking technology vendors are rushing to create software versions of these technologies, making their deployment on COTS, small-form-factor, single-board computers possible. In addition to reducing the SWaP of a single host, a single host can often run multiple services, collapsing a number of network appliances into a single SFF server running multiple virtualized machines.

Ease of use and training

To leverage COTS technologies, many warfighter programs create

systems from hardware and software components that are readily available and in use or derived from enterprise information technology (IT) or network systems, Kawasaki says. "This approach is unquestionably the right one — every day tens of thousands of engineers go to work adding many new features and capabilities that our warfighters can benefit from. However, this blended hardware/software approach has also introduced an unintended negative side effect for the operators — comms specialists and signal officers — in the field: a usability nightmare and an intractable learning curve."

The general move to COTS by the U.S. government prompted enterprise companies to repurpose enterprise-class electronics for use in the field. "It is the equivalent of taking a phone system the magnitude of a major communications company, putting it in a small box, and foisting on operators incredibly complex capabilities and features, many of which are not appropriate for in the field," Kawasaki says. "Approximately 80 percent of features added to COTS software/hardware systems are seldom or never used, particularly in deployed operations."

Usability is a challenge; it's a human factors issue and tricky in the communications arena, Kawasaki explains. "Now you are deploying accelerated mission command capabilities, including video teleconferencing, out in the field, and the U.S. Department of Defense (DOD) is constrained in its ability to send trained operators with all that technology."

Complexity is a big challenge. Soldiers typically are trained in just a few weeks, which is not the same as an IT professional that has studied the technology for years, Kawasaki says. "Plus, they are operating under pressure and in harsh environments, setting up [complex communications and networking equipment] in theater with people asking why comms aren't up yet."

PacStar engineers have encountered this usability conundrum firsthand: In one instance, an integrated communications system included a firewall, wireless access point and encryption gateway, a router and switch, voice gateway, server with a PBX, e-mail and user directory sys-

tem, and a digitally monitored uninterruptible power supply (UPS).

"Each system component [was] designed and manufactured by a different COTS vendor, and each with its own user interface and set of commands," Kawasaki says. "The firewall component alone came with 5,000 pages of documentation, and required the operations staff to undertake multiple training programs. Moreover, this was just one of a set of eight devices integrated into a single system.

It can be impossible to make this approach work for rapidly changing conditions in the military. "While integrated systems can be pre-configured to provide significant baseline capabilities, adapting such systems to rapidly changing situations in the field requires extensively trained signal officers," Kawasaki explains. "In addition to the downward budgetary pressure on today's armed forces, future network plans envision a dramatic expansion of the number of soldiers equipped with network access. Combined, these trends will widen an already critical gap in the availability/supply of operators capable and trained in operating and managing these advanced systems — a gap that is partially filled through reliance on expensive civilian contractors."

Software approach

An effective solution is to hide systems complexity by using unified management software interfaces that expose only the features needed, Kawasaki says. This can remove 80 percent of unnecessary features. PacStar takes a "single pane of glass" approach, using its IQ-Core communications management software, to present to the operator just those features and capabilities they need to worry about in the field and hide the enterprise features.

"COTS solutions can be deployed with application software that integrates the view of systems from a management perspective and, when restricted to critical use cases, can be delivered in relatively lightweight implementations," Kawasaki says. "By making these types of capabilities available in the field, it enables systems support in the field by operators with little training — closing the gap between the complexity of the systems and the availability of capable operators."

Pentek's Onyx Model 71791 connects to SATCOM or communications system L-band signals.

Officials of the Army Project Manager Warfighter Information Network-Tactical (PM WIN-T) at Aberdeen Proving Ground, Md., have placed several follow-on purchases for additional deployments, and also have worked with PacStar to add capabilities to the company's software. PacStar won a three-year, $6.2 million contract to support WIN-T Increment 1, the Army's current and future tactical communications network backbone and arguably the largest tactical communications program in the world.

WIN-T enables assured, mobile battlefield communications by delivering to the warfighter a range of data, voice, and video communications and network management tools for establishing and managing communications. This new contract effectively extends the use of PacStar's IQ-Core Software by mobile network communications units across the U.S. Army, officials say.

"The U.S. Army — and the military as a whole — requires technology that solves complex battlefield communications challenges and enables soldiers to focus on fighting the battle, not the network," says PacStar CEO Bob Dunn.

Holistic engineering

"Sensors — and by that I mean anything electronically sensing the world, from radar and sonar to electro-optics and high-speed video cameras — are producing more and more data for intelligence, surveillance, and reconnaissance (ISR)," says Paul Davis, director of product management at the Curtiss-Wright Defense Solutions division in Dayton, Ohio. Inefficient bandwidth, between electronics systems and within individual electronics, is a big problem, especially given the rate of information capture today and the critical need for information sharing in aerospace and defense.

"Sensors are sending fire hoses full of data that just does not stop," Davis says. "You can't back them off and wait because there's more data behind that. A system has got to be able to absorb bandwidth on the

front end and have more storage on the back end for data capture from sensors."

Especially challenging are aircraft flying at high speeds and over long distances, gathering data in the process. Designers are pushing toward 10 Gigabit Ethernet on the front end for normal Ethernet networks, Davis says. "We are also seeing special sensors prompting the use of higher-speed interfaces like InfiniBand."

Advanced sensors are capturing detailed, high-resolution data at a rapid rate, requiring the use of InfiniBand in data-handling electronic systems. "You've got to have enough bandwidth to support data capture on the front end, the input. You've got to use bigger pipes to get all the essential data." On the back end, look at storage holistically, Davis advises. "If you have a fire hose of data coming and you want to fly around for set a period of time, you need enough storage to capture all that data — and you want that storage to be rugged to survive tough environments."

Securing data by encrypting it is also a challenge at high speed. Aerospace and defense product engineers are adopting commercial encryption methods to keep pace with high-speed data capture. "On the storage end, we use solid-state drives with encryption built into them in rugged environments. When data flows into the drive, it is encrypted, so it is protected when being transported from the airplane to the ground station."

Curtiss-Wright engineers worked with the Lockheed Martin Corp. Aeronautics segment in Marietta, Ga., to bolster the C-130J military aircraft with Gigabit Ethernet bandwidth and data protection. "A lot of data is coming in and being encrypted with one of our standard COTS products," Davis says.

Curtiss-Wright provided its Compact Network Storage (CNS) subsystems to Lockheed Martin for the Network File Server (NFS) on U.S. Air Force HC/MC-130J Super Hercules special-mission aircraft. Curtiss-Wright delivered the products to Lockheed Martin in 2011.

"Today, the C-130J customer is talking about increased storage," Davis says. Common questions from aerospace and defense clients include: "Could we double our storage?" and "What are you going to do next year because we are going to need more storage?"

Designing for the future

Davis, who recommends designing systems with the future in mind, describes a potential customer

seeking a solution for a high-speed ISR application. "Between when we initially talked to them earlier this year and just recently, roughly six months, their data-rate demand grew by 5X. The data rate went up five times, and it was high to begin with; and now they have to have encryption. They realize that by upping the bandwidth, we are going to have to do something on the storage side and look at different methods for handling encryption."

At the same time, Davis has seen military customers come back after several years and say, "Now we want to handle classified data." It's just one more example of how requirements change, and data demands go up, he says.

"I always tell customers that a data recording and storage solution has three dimensions. Think of 3D cube, with input/output (I/O), storage, and data protection/encryption on the x, y, and z axes. You have to think in terms of these three interrelated dimensions. If I/O triples, you need to account for storage and how you're going to protect the data. How are you going to react when your customer comes back and says, 'I need to increase the bandwidth, double the storage, or more protection'? Think about how you are going to handle that."

Flexibility is key, and built into the company's CNS-4, Davis says. "Always invest in flexibility — the ability to accommodate various I/O, scalable storage, provide advanced encryption. Know that you can change the front end or the back end; don't box yourself in because your program requirements are likely to change."

Advatech Pacific's Tactical Cross-Domain Solution (TACDS) automatically performs deep content inspections on information moving across classified and unclassified domains.

Modularity

A key criteria organizations should consider is modularity, which provides the ability to size equipment based on mission, reducing overall payload by leaving unneeded capabilities at home, and allowing systems to be sized and configured as needed, explains PacStar's Kawasaki.

"Further, with the rapid pace of development of COTS technology, it is unusual for networking and communications equipment to have a life span longer than a few years, limited not by failure, but by obsolescence," Kawasaki adds. With modularity, it is possible to upgrade obsolete components with new modules, as needed, rather than replacing entire systems — and field repair is simplified through small field-replaceable units, he says.

"There's so much innovation in the commercial sector now that a software-based router being deployed now will be obsolete in three years," Kawasaki adds. "Systems deployed for communications, more often than not, use technologies from different vendors and are on different refresh cycles. Consider a modularity approach that allows upgrades at different times without destroying the logistics train and training. It is one of the most important concepts when developing systems: enable in-the-field upgrades on all parts of these systems."

PacStar 400-series small communications modules, the size of a large paperback book, snap together like a Lego set, enabling engineers and end users to customize a modular system, Kawasaki says. "It can run off batteries, which makes it efficient from a power perspective. It equates to fewer trips taken to resupply diesel generators, saving cost and casualties. Fuel resupply is a dangerous mission; more energy-efficient devices in the field is a win for everybody."

Wireless in the works

"In the past, warfighters would plunk down a satellite communications (SATCOM) terminal in the sand somewhere, stand up a networking

router and switch, and plug in all devices (laptops, phones, etc.)," Kawasaki says. "Today, it is evident that they can benefit from wireless access in the field. Instead of shipping thousands of feet and hundreds of pounds of Ethernet cable which takes several hours to set up, they can essentially flip a switch to get a command post running."

Whereas Kawasaki admits he may have oversimplified the process a bit, modern hardware is enabling fast, easy wireless networking in the field — and the pool of electronics available to military/aerospace communications and networking experts is rapidly expanding.

Aerospace and defense will "see significant adoption of wireless in the field," Kawasaki predicts. "Don't bet against the smartphone. Don't bet against wi-fi. There are too many compelling reasons to adopt."

Celliboost has developed secure mobile broadband technology for use in rugged terrain.

Think about how in theater operations and combat missions, push-to-talk radio with voice is still the primary means of communication, Kawasaki says. Now compare that with smartphone technologies delivering video, video conferencing and sharing, high-resolution images and data, detailed maps, and mission command information all the way to the warfighter in the field. "It's a strong bet: letting the warfighter benefit from the fast pace of research and development in the private sector versus trying to have the government re-engineer that technology with government-funded programs, which doesn't make a lot of sense."

GATR, a business within Cubic Mission Solutions, provides inflatable satellite communication (SATCOM) antenna solutions designed to offer portability, low cost of ownership, reliability in extreme environments, and ease of setup.

Security

The U.S. National Security Agency (NSA) at Fort Meade, Md., has launched the Commercial Solutions for Classified (CSfC) program to leverage emerging technologies to deliver more timely information assurance solutions for rapidly evolving customer requirements. With the NSA's new process, officials say, commercial products can be used in layered solutions to protect classified information, enabling end users to securely communicate based on commercial standards in a solution that can be fielded in months, rather than years.

"The CSfC program enables, through a set of specifications and requirements, warfighters to stand up wi-fi or privately managed cell networks and transmit classified information using COTS technology from well-known companies like Cisco and Hewlett-Packard rather than buying expensive, classified military encryptors — and buying one for every device that you attach to wi-fi," Kawasaki says. "It made the reality of deploying classified wireless too expensive for people to consider. COTS configured appropriately to wirelessly communicate classified information can stand up in minutes the equivalent of a Starbucks wireless access point in the middle of remote, unfriendly territory."

Kawasaki says he is seeing interest in the CSfC program for enabling commercial smartphones, when configured correctly, to transmit classified voice and data. "This will bring the benefits of commercial economics, and the power and integrated functions of smartphones to the warfighter," he says. "Combined with networking functions deployed at the edge, warfighters will have high-performance, local services and the mobility of smartphones in a unified solution."

PacStar won a contract to provide its IQ-Software management platform to "a premier wireless tactical program, enabling management of commercial systems transmitting classified information to smartphones and laptops over wi-fi and cellular radios," Kawasaki says. "Our software has been delivered, and is installed on systems currently undergoing NSA/DOD certification. This is by far the largest CSfC program we are aware of."

More aerospace and defense applications are considering the CSfC approach, explains Curtiss-Wright's Davis. The company's product engineers are employing commercial techniques to bring more flexibility to encryption.

"The traditional approach was to achieve NSA Type 1 — that's the high end, the ultimate for security," Davis says. "For some applications, a combination of commercial security techniques can be employed effectively. We are supporting customers with the CSfC approach, using commercial encryption techniques and two-layers of encryption."

Curtis-Wright Defense Solutions offers its DTS1 COTS-based, two-layer encryption device as a low-cost, fast-to-deploy solution for applications that don't require Top Secret Unattended-level security.

"What the NSA has done because so many things need to be protected that aren't because of the expensive, laborious process — costing millions and years to achieve Type 1 approval — is enable a layered security approach with certified COTS products," Davis says. "The cost goes down because a vendor has already made that investment toward approval. More applications are considering that approach, for faster time to deployment and cost."

Data demand

"Everybody wants the highest resolution, [most responsive] sensors available. Consider how fast we went from high definition (HD) to 4K and now to high-dynamic-range (HDR) TVs," says Larry Schaffer, director of business development at Abaco Systems in Huntsville, Ala.

"Small form factors for sensors are also highly desirable and these small sensors are readily available. So as the cameras get smaller and the resolutions and dynamic range get bigger, the bandwidth needed to get hold of all that juicy data gets huge," Schaffer says. "Consider that a single 4K camera running at 60 frames per second will require nearly 10 gigabytes per second of transmission bandwidth.

"Modern computers can easily handle this kind of 'bit-crunching,' but the big issue is that of the sensor electrical interface — getting all that data into the processor," Schaffer continues. "There are lots of options for this: PCI Express, Ethernet, and many others, but supporting protocols for these interfaces are scattered, so the successful interface will be the one that will be the easiest to integrate. That is to say, efficient and with established software and hardware infrastructure — and also, open standards."

Fiber optics

Aerospace and defense engineers are leveraging fiber-optic cabling and connectors to help facilitate high-speed data throughput, both within systems and among them.

"The high-speed capability that fiber optics provide for more integrated computing systems on land, sea, and air platforms, does give fiber-optic systems an edge," says Michael Rachlin, director of product management at electronics parts supplier Pasternack Enterprises in Irvine, Calif. But, he cautions, "coaxial cables will still be required to bridge the gap between photonic and radio-frequency (RF)/microwave electronic technologies."

Curtiss-Wright's VRD1-CC video management system facilitates network distribution.

Mil/aero applications are moving to fiber optics, says Thomas Heller, aerospace and defense account manager at Molex in Walldorf, Germany. "The reasons are weight savings and bigger bandwidths."

Fiber-optic connectors are becoming increasingly common as requirements for faster data rates over longer distances become more prevalent, says Mike Dabrowski, military/aerospace market director at Amphenol Fiber Systems International in Allen, Texas. "Beyond data rate, fiber optics offers the additional benefits of electromagnetic interference (EMI) immunity, lower cable weight, and complete data security; a fiber-optic cable cannot be easily 'tapped.'

"Fiber is successfully used today in the most difficult environments imaginable," Dabrowski says, yet "a world of difference exists between mil/aero fiber-optic connectors and commercial fiber connectors. Commercial fiber-optic connectors are typically used in a controlled environment, like a data center or telecom central office; they have very little chance of survival when exposed to the elements."

Amphenol FSI has supplied military-grade, fiber-optic connectors and cable assemblies used globally in many command, control, communications, computers, and intelligence (C4I) ground system communication programs, missile launchers, radars, electronic warfare systems, ruggedized displays, unmanned aerial vehicles (UAVs) and ground control stations, and SATCOM programs, Dabrowski explains.

Cross-domain communique

"We fight in a connected way now, which requires getting information to the troops about where the blue forces are and where the red forces are — the Force XXI

Battle Command Brigade and Below (FBCB2) concept of Blue Force tracking," explains William Cannon, director of the Electronics & Communications (EC) Business Unit of Advatech Pacific in Dayton, Ohio.

"Being so connected brings a lot of security issues to the table," Cannon continues. "Most warfighters don't have security clearance. Taking information at the secret level down to individual combatants means you have to cross that security communications boundary."

The company's tactical information assurance solutions, including its Tactical Cross-Domain Solution (TACDS), are used by the U.S. military and its allies at the very front of the tactical edge — on the individual soldier, ground vehicle, aircraft, UAV, etc. — to enhance interoperability and secure information sharing.

Cross-domain devices are critical because connecting SIPRNet and NIPRNet is not allowed, says Tara Cannon, program manager of the electronics and communications business unit of Advatech Pacific in Dayton, Ohio. "There needs to be a secure way to get information to the soldiers on the unclassified side."

Not just any cross-domain system will do either, Tara Cannon adds. For communications from commander to commander, command post, or operations center, enterprise cross-domain devices might be fine; but when out on the tactical edge, it's a real problem sharing classified and unclassified information — often requiring two sets of equipment, twice the bandwidth, etc., she says. For this reason, the U.S. and Canadian armies reached out to Advatech to see "what it would take to get a tactical cross-domain solution, an effective guard or protection layer, between one security enclave and another."

PacStar's 400-series modules are designed to maximize communications capabilities in the smallest SWaP possible.

TACDS automatically performs deep content inspections on information moving across classified and unclassified domains; each piece of information being passed is scrutinized to guard against data breaches and cyber threats such as malware, William Cannon says. "What we do is take information in one security domain, inspect it closely, and make sure no classified information is leaking out; going the other way, from unclassified to classified domains, we make sure to get rid of any malware attached to the information," he says. "We don't want classified networks attacked from the unclassified data sources; our devices inspect and recognize data, ensure it meets rigid content and format checks, and checks for malware."

The need for rugged, tactical cross-domain electronics hardware and software solutions will only grow in the future, based on both the growing need for mission-critical information and ever-increasing cyber security threats.

"The impetus to adopt cross-domain appliances is driven by the growing need for secure information sharing across security domains — how to get information to the edge in the face of cyber threats," William Cannon says.

Systems "are getting hacked minute by minute, exposing networks all the way down to the tactical edge, where it is difficult to control entry points. You need something in place detecting what is good information and what has embedded malware — and do so automatically without a human in the loop. Today, we've got to do that not just among homogenous forces (the U.S. Army, Air Force, Navy, and Marine Corps.) but also with coalition partners. We don't go into fight alone anymore and that brings another challenge related to information passing between national networks and individual units; militaries are sensitive about how much information needs to be shared," William Cannon affirms.

Government and military officials are under "a lot of pressure from a security standpoint today given the current cyber-threat environment, which brings to the forefront the need for tactical cross-domain solutions," William Cannon says. When it comes to information sharing among devices and networks, "things they got away with previously… they can't get away with that now; it's so critical to protect that boundary" between domains today.

Companies to research cryogenic superconducting technologies for RF SIGINT

BY **John Keller**

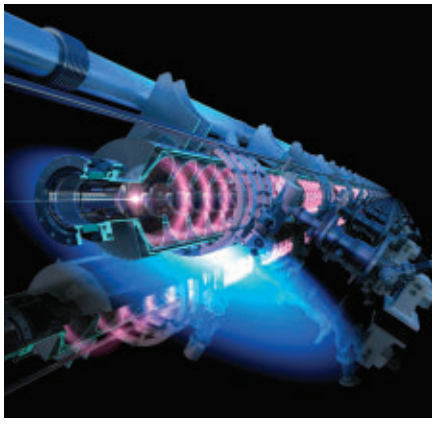
SAN DIEGO — Two research companies are helping the U.S. Navy develop cryogenic super-cooled superconducting RF and microwave technologies for future tactical signals intelligence (SIGINT) systems.

Officials of the Space and Naval Warfare (SPAWAR) Systems Center Pacific in San Diego announced contracts to Out of the Fog Research LLC in Mountain View, Calif., and Hypres Inc. in Elmsford, N.Y., for the Emerging Cryogenic devices, Electronics, and Systems program.

Cryogenics refers to electronics that are super-cooled with liquid helium. Superconducting RF and microwave technologies require this kind of electronics thermal management. Superconducting electronics offer zero electrical resistance and can operate at dangerously high temperatures because of their efficient conduction. Superconducting systems are particularly useful for SIGINT, electronic warfare (EW), and advanced radar systems.

Experts from the two companies will concentrate on cryogenic RF systems, and advanced cryogenic core digital and quantum memory technologies that use superconducting quantum interference device (SQUID) technology, tactical signals intelligence systems, and other military platforms.

Contracts to the two companies are for three years, with two one-year options that could bring the contract durations to five years each.



Researchers are developing ways to super-cool electronics to get the most performance possible out of RF and microwave components for SIGINT applications.

Out of the Fog won a $53.4 million Emerging Cryogenic devices, Electronics, and Systems contract that with options could reach as much as $91.4 million. Hypres won a $40.4 million contract that with options could reach as much as $67.7 million.

During the course of the program, Out of the Fog and Hypres will compete for task orders. The companies will do the work in San Diego, Mountain View, Calif., and Elmsford, N.Y., and should be finished by July 2019. Option periods could extend the contract through July 2021. ←

FOR MORE INFORMATION visit **Out of the Fog Research** online at *www.outofthefogresearch.com*, **Hypres** at *www.hypres.com*, or **SPAWAR Systems Center Pacific** at *www.public.navy.mil/spawar/Pacific*.

Boeing to upgrade networking and communications avionics aboard Poseidon ASW aircraft

Military avionics experts at the Boeing Co. in Seattle are making several improvements to the P-8A Poseidon maritime patrol aircraft avionics to upgrade the plane's ability to detect, track, and attack enemy submarines and surface ships. These improvements, part of a package of electronics enhancements expected to become operational in 2020, will upgrade the Poseidon aircraft's signals intelligence (SIGINT) capabilities, as well as its ability to network both among onboard subsystems and with other military systems. Officials of the U.S. Naval Air Systems Command (NAVAIR) at Patuxent River Naval Air Station, Md., announced a $71.6 million order to the Boeing Defense, Space & Security segment in Seattle to build, integrate, and test several Poseidon Increment 3 Block I capabilities. This order to Boeing is part of the third of three phases of planned improvements to the Poseidon aircraft, a ruggedized version of the Boeing 737 single-aisle jetliner hardened for long-range anti-submarine warfare; anti-surface warfare; and intelligence, surveillance, and reconnaissance missions. ←

DARPA artificial intelligence project aims to help humans and machines get along better

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are launching an artificial intelligence and machine learning program to help humans and machines get along better than ever before. Officials of the U.S Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have released a solicitation (DARPA-BAA-16-53) for the Explainable Artificial Intelligence (XAI) project.

XAI centers on machine learning and human/computer interaction, and seeks to create a suite of machine learning techniques that produce explainable models that, when combined with explanation techniques, enable end users to understand, trust, and manage the emerging generation of artificial intelligence (AI) systems.

Dramatic success in machine learning has led to an explosion of AI capabilities that can produce autonomous systems that perceive, learn, decide, and act on their own. Although these systems offer tremendous benefits, their effectiveness is limited by the machine's inability to explain its decisions and actions to humans. XAI seeks machine-learning and computer/human interaction tools to enable an end user who depends on decisions, recommendations, or actions produced by an AI system to understand the rationale for the system's decisions.

XAI tools will help provide end users with an explanation of individual decisions, enable users to understand the system's overall strengths and weaknesses, convey an understanding of how the system will behave in the future, and perhaps how to correct the system's mistakes.

Military researchers are trying to clear up any misunderstandings that might arise between humans and smart machines.

The XAI project aims at three related research and development challenges: how to produce more models; how to design the explanation interface; and how to understand the psychological requirements for effective explanations.

For the first challenge, XAI seeks to develop machine-learning techniques to produce explainable models. For the second challenge, the program anticipates integrating state-of-the-art human-computer interaction (HCI) techniques with new principles, strategies, and techniques to generate effective explanations. For the third challenge, XAI plans to summarize, extend, and apply current psychological theories of explanation.

The program has two technical areas: one to develop an explainable learning system that contains an explainable model and an explanation interface; and the second that involves psychological theories of explanation. The XAI program will last four years and start in May 2017. Several contractors will be involved, including at least one with expertise in the psychology of explanation.

MORE INFORMATION IS online at *http://bit.ly/2bOCwJg*.

Future NASA space unmanned submarines may help explore the seas of icy moons

One of the most profound breakthroughs in planetary science in the past two decades has been the discovery of liquid methane lakes on the surface of Saturn's largest moon Titan, and liquid oceans under the icy surfaces of many of the giant gas planets' other moons. Some of these space "waters" may actually harbor life, space experts say. An idea being explored is developing submarines to send through space to the moons. Over the next two years, NASA is devoting half a million dollars to researching the prospect of sending such a vehicle to Titan. Other studies target Jupiter's Europa and Ganymede, and Saturn's Enceladus. Are such missions actually within our technological reach? The answer to that question is maybe; it just depends on when these deep-space missions could be staged. Machine autonomy and machine vision technologies are improving all the time. The big challenges would be getting the space submarines to their destinations and communicating with them effectively.

Composite Engineering to develop technologies for low-cost unmanned attack aircraft

BY **John Keller**

WRIGHT-PATTERSON AFB — U.S. Air Force researchers are asking the Composite Engineering Inc. (CEI) Unmanned Systems Division in Sacramento, Calif., to develop low-cost unmanned aerial vehicle (UAV) technology that can lend itself to large-scale aerial attacks in remote regions where forward basing is difficult or impossible.

Air Force Research Laboratory (AFRL) officials at Wright-Patterson Air Force Base, Ohio, announced a $40.8 million cost-share contract to CEI for the Low-Cost Attritable Strike Unmanned Aerial System (UAS) Demonstration project.

The Air Force is asking CEI to develop enabling technologies for affordable UAVs able to carry out long-range and high-speed attacks that are of sufficiently low cost that loss of these aircraft in battle could be tolerated.

CEI experts will design, develop, assemble, and test a technical baseline for a high-speed, long-range, low-cost, limited-life strike UAV, identify key enabling technologies for future low-cost aircraft demonstrations, and provide a test drone for future capability and technology demonstrations.

Tight defense budgets and many kinds of military threats throughout the world are encouraging the Air Force to make dramatic reductions in the costs of attack UAVs to bring mass to the engagement, and increase defensive costs to potential adversaries, officials say.

Composite Engineering Inc., part of Kratos, will help develop enabling technologies for a future low-cost attack unmanned aircraft.

Researchers want to trade the relatively high costs of UAV performance, design life, reliability, and maintainability for low-cost attritable aircraft intended for reuse with limited life and number of sorties.

The goal is to establish a benchmark concluding in a flight demonstration that will test the bounds of what can be accomplished in a short time to establish a baseline system cost against a notional set of strike vehicle requirements.

Air Force researchers want to develop UAV concepts that offer dramatic cost reductions to bring many unmanned aircraft to future engagements. The key will be to drive down the costs of unmanned strike aircraft, and reduce the time it takes to develop them.

On this contract the government share is $7.3 million and CEI's share is $33.5 million.

CEI will do the work in Sacramento, Calif., and should be finished by April 2019. ←

FOR MORE INFORMATION visit **CEI**, part of the **Kratos Unmanned Systems Division**, online at *www.kratosusd.com*, or the **Air Force Research Laboratory** at *www.wpafb.af.mil/AFRL*.

BAE Systems investigates ability to grow tiny drones from vat of chemicals

During this century, small unmanned aerial vehicles (UAVs) could be grown in large-scale labs through chemistry, speeding up evolutionary processes and creating bespoke aircraft in weeks, rather than years. Engineers and scientists at BAE Systems and the University of Glasgow have outlined their current thinking about military aircraft design and manufacturing in the future. A new machine called a Chemputer could enable advanced chemical processes to grow aircraft and some of their complex electronic systems, conceivably from a molecular level upwards. It also could produce multifunctional parts for large manned aircraft.

U.S. military's robotic unmanned submarine hunter completes first tests at sea

An unmanned robotic ship designed to help the U.S. military hunt enemy submarines has completed its first tests at sea. The 132-foot "Sea Hunter" unmanned surface vessel (USV) is still getting its figurative sea legs, but the anti-submarine warfare (ASW) performance tests off the coast of San Diego have steered the project on a course to enter the U.S. Navy's fleet by 2018. The Sea Hunter "surpassed all performance objectives for speed, maneuverability, stability, sea keeping, acceleration/deceleration ,and fuel consumption," say officials at Leidos, the company developing the Sea Hunter. ←

Global photonics market to grow through 2020

The global photonics market will grow from $509.7 billion in 2013 to $765 billion by the end of 2020, at a combined annual growth rate of 5.8 percent, predict analysts at Transparency Market Research in Albany, N.Y. The report "Photonics Market — Global Industry Analysis, Size, Share, Growth, Trends, and Forecast, 2014-2020" says growing demand for efficient electronic products is driving the photonics market. The only restraint on the global photonics market is poor commercialization of photonic devices, analysts say.

32-gigabyte memory for high-speed camera systems introduced by Photron

Photron Inc. in San Diego is introducing the 32-gigabyte memory option for the FASTCAM Mini AX, FASTCAM Mini UX, and FASTCAM Mini WX high-speed camera systems for demanding high-frame-rate imaging applications. The memory option is doubled at 32 gigabytes; other memory options available are 4, 8, and 16 gigabytes for applications like military and aerospace research, biomechanics, material sciences, fluid dynamics, and critical laboratory research. The Mini AX family provides ISO 40,000 (mono) and ISO 16,000 (color), with the IR filter retained as per ISO 12232. The camera systems have high-performance Gigabit Ethernet interfaces, and also are for high-G, high-shock environments, tested to 100 G, 10 ms, 6 axes. ←

Four companies developing technologies for tomorrow's lidar sensors

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are working with four companies to develop enabling technologies for future small, lightweight, and affordable light detection and ranging (lidar) electro-optical sensor systems.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have announced four contracts collectively worth $16.3 million for the Modular Optical Aperture Building Blocks (MOABB) project.

MOABB aims to develop enabling technologies for a small, lightweight electro-optical sensor using free-space optical technology with ultra-low size, weight, and cost with much faster beam scanning speeds than are available today.

Companies involved in the DARPA MOABB project are Lockheed Martin Coherent Technologies in Louisville, Colo.; TREX Enterprises Corp. in San Diego; Analog Photonics LLC in Hingham, Mass.; and Teledyne Scientific & Imaging LLC in Thousand Oaks, Calif.

The project will develop technologies for an integrated photonic device that can generate, amplify, transmit, and receive free-space optical radiation over a wide angle. Researchers eventually would like to demonstrate this technology in a lidar sensor.

DARPA researchers want to build planar, millimeter-scale transmit/receive units with a high fill factor aperture, non-mechanical beam steering, and integrated amplification. Their goal is to tile the unit cells to assemble a large coherent higher-power aperture.

The program ultimately seeks to fabricate a coherent 10-centimeter transmit/receive array with distributed gain built with wafer-scale processing, and demonstrate the coherent array in a packaged lidar system capable of 3D imaging from as far away as 100 meters.

DARPA awarded a $7.1 million contract to Lockheed Martin Coherent Technologies on 9 Aug.; a $4.2 million contract to TREX Enterprises on 4 Aug.; a $3 million contract to Analog Photonics on 3 Aug.; and a $2 million contract to Teledyne Scientific on 27 July.

All the contracts have options that could increase their value substantially. TREX Enterprises could earn as much as $23.6 million; Analog Photonics as much as $19.4 million; and Teledyne Scientific as much as $8.6 million.

Free-space optical systems have potential for sensing, illumination, and communications, DARPA scientists say. The micron-scale wavelength allows for 0.001-degree angu-

lar resolution and antenna gain of more than 100 decibels from a modest 10-centimeter aperture.

The frequency in the hundreds of terahertz range and wide operating bandwidths enable high-speed data transmission and 3D imaging with sub-millimeter range resolution. Optical beams also have wide windows of low atmospheric absorption for long-range propagation over terahertz of open bandwidth.

Applications for these features span the space from 3D mapping, foliage penetrating lidar, navigation, and long-range communications.

While free-space optical systems offer compelling capabilities, they are too big, heavy, and expensive for many applications. Above a 10-centimeter aperture, their size and weight are dominated by the bulky lenses, mirrors, stabilized mechanical components, and large volume of empty space of the telescope or imaging system.

On the other hand, aperture smaller than 10 centimeters still require bulky mechanical gimbals to steer the telescope and the back-end optics like lasers and detectors.

Instead, DARPA scientists want to capitalize on recent developments in integrated photonics that offer the potential for high-speed, non-mechanical beam-steering.

Researchers believe that efficient sources, detectors, amplifiers, and low-loss waveguides can be fabricated on one planar platform for high-power, large scale apertures.

The MOABB program has two technical areas: technologies for a tileable optical array element for operation in the short-wave infrared band, and a packaged lidar system that demonstrates the utility of this kind of technology.

The 21-month first phase of the MOABB program will address the modular transmit and receive unit cells. The second 18-month phase will develop the unit cell efficiency and fill-factor. The 21-month third phase will develop 100-square-inch transmit and receive apertures.

FOR MORE INFORMATION visit **Lockheed Martin** online at *www.lockheedmartin.com*; **TREX Enterprises** at *www.trexenterprises.com*; **Analog Photonics** at *www.analogphotonics.com*; or **Teledyne Scientific & Imaging** at *www.teledyne-si.com*.

Army to kick off industry competition for next-generation, laser-protecting eyewear

BY **John Keller**

NATICK, Mass. — U.S. Army land warfare experts are ready to kick off an industry competition to develop a new generation of laser-protecting goggles and other eyewear that safeguards soldiers' eyes from shrapnel, laser beams, sand and dust, and bright sunlight.

Army officials are looking for the next generation of battlefield eyewear to protect warfighters' eyes from lasers and shrapnel.

Officials of the Army Contracting Command at Natick, Mass., have issued a presolicitation (W911QY-16-R-0043) for the Next Generation Eye Protection (NGEP) project. Army officials say they plan to award one or more one-year contracts to develop prototype protective eyewear.

These eye-protection devices must offer ballistic fragmentation protection per MIL-PRF-32432, high optical quality, configurations for laser eye protection, accommodate varying light conditions, and be compatible with the Universal Prescription Lens Carrier (UPLC) to accommodate vision correction for warfighters.

Army experts are placing heavy emphasis on manufacturing capabilities for production quantities since they envision follow-on production contracts. A formal solicitation is expected soon.

The Army's point of contact for the NGEP program is John Conlin, who can be reached by e-mail at john.conlin3.civ@mail.mil, by phone at 508-233-6164, and via the following postal address: Building 1, Kansas Street, Natick, Mass. 01760-5011. Army officials will not answer questions over the phone, but will offer a question-and-answer period after release of the formal solicitation.

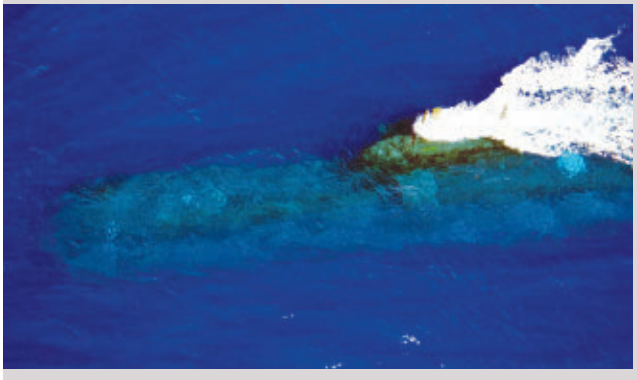
MORE INFORMATION IS online at *https://www.fbo.gov/notices/be634592f80d6a2dd37190adbb88f4a1*.

PRODUCT applications

ELECTROLYZERS

UTC to supply electrolyzers for breathing oxygen aboard submerged submarines

U.S. Navy submarine designers needed low-pressure electrolyzers to produce breathing oxygen aboard submerged submarines. They found their solution from UTC Aerospace Systems in Windsor Locks, Conn.



Officials of the Naval Surface Warfare Center Philadelphia Division in Philadelphia announced a $42.8 million five-year contract to UTC Aerospace (formerly Hamilton Sundstrand) to supply low-pressure electrolyzers.

The low-pressure electrolyzer is a self-contained, electro-chemical, oxygen-generating plant for submarine life support service. UTC Aerospace produces the Integrated Low Pressure Electrolyzer (ILPE) that produces low-pressure oxygen for submarines and requires no high-pressure storage.

It has a capacity of 15 to 225 standard cubic feet per hour of oxygen, with power of 100 kilowatts, three-phase 440 volts AC of control power. The ILPE operates automatically enabling unattended operation, UTC officials say. The operator interface is via a color, touch-sensitive liquid crystal display with back-up operation through a laptop computer.

The heart of the ILPE involves proton exchange membrane (PEM) electrolyzer technology, which uses electricity and distilled water as inputs to create pure breathing oxygen and hydrogen as a byproduct. Proton Energy Systems Inc. in Wallingford, Conn., provides the electrolyzer stacks for the ILPE.

On this contract UTC Aerospace will do the work in Windsor Locks, Conn., and should be finished by July 2021.

FOR MORE INFORMATION visit **UTC Aerospace** online at *http://utcaerospacesystems.com*, or the **Naval Surface Warfare Center-Philadelphia** at *www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Philadelphia*.

ELECTRO-OPTICS

Safran wins Army job to build next-generation Laser Target Locator Module II

U.S. Army land warfare experts are asking electro-optics engineers at Safran Optics 1 Inc. in Bedford, N.H., to build the Army's next-generation laser target locator.

Officials of the Army Contracting Command at Aberdeen Proving Ground, Md., announced a $304.5 million contract to Safran to build the Laser Target Locator Module II (LTLM II). A laser target locator enables foot soldiers to identify target locations in daylight or at night, as well as in obscured-visibility such as fog or smoke.

The LTLM II is a lightweight handheld laser target locator with a color day camera and night sight, and a selective availability anti-spoof module (SAASM) Global Positioning System (GPS) receiver. The LTLM II is to be smaller and more affordable than previous laser targeting systems, such as the lightweight handheld Laser Target Locator Module (LTLM), which is being manufactured by the BAE Systems Electronic Systems segment in Hudson, N.H.

For LTLM II, Army officials say weight is a crucial factor. The goal for this next-generation laser rangefinder is to reduce the system's size, weight, and power consumption while decreasing its cost. Among the laser targeting products from Safran is the company's Handheld Precision Targeting Device (HHPTD) — a

lightweight, multi-functional, integrated sensor that provides accurate target coordinates for precision target engagement.

The multispectral device delivers precision target coordinates by using several north-finding solutions and displays a 90-percent target location error measurement in the bi-ocular eyepiece, Safran officials say. The field-proven HHPTD system provides precision target measurements and long-range observation capability in day or night and under all-weather environments.

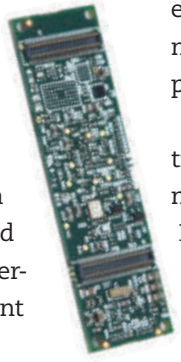
FOR MORE INFORMATION visit **Safran Optics 1** online at *www.optics1.com* or the **Army Contracting Command-Aberdeen** at *http://acc.army.mil/contractingcenters/acc-apg*.

EMBEDDED COMPUTING

Gumstix to provide small-form-factor embedded computing for Army training system

U.S. Army training instrumentation experts needed small-form-factor embedded computing modules for a system that evaluates the performance of soldiers during live training. They found their solution from Gumstix Inc. in Portola Valley, Calif.

Officials of the Army Contracting Command at Tobyhanna Army Depot, Pa., announced their intention to buy 2,964 GUM3703E Overo EarthSTORM computer-on-module embedded computers from Gumstix sole-source. The Army needs the Gumstix small-form-factor computer modules for the Precision Real-Time Location System (PRTLS) radios and data communications interface (DCI) at the Army Joint Multinational Readiness Center (JMRC) in Hohenfels, Germany.



The Gumstix Overo EarthSTORM embedded computing module measures about three inches long and half an inch wide and weighs about a quarter of an ounce. It is based on the ARM Cortex-A8 processor architecture, has 512 megabytes of RAM, and at least 512 megabytes of Flash memory.

PRTLS radios are an integral part of the JMRC instrumentation system (JMRC-IS) that collects, processes, displays, and stores training performance data from soldiers performing live, collective training at the JMRC. PRTLS radios collect training data from vehicles and foot soldiers and relay that information to the JMRC-IS to monitor the training exercise and provide feedback to the Soldiers in training.

The PRTLS radio for JMRC is a unique device only used at JMRC, which uses a terrestrial trunked radio (TETRA) communications infrastructure that uses only radio technology that complies with German spectrum requirements.

FOR MORE INFORMATION visit **Gumstix** online at *www.gumstix.com*.

RADIO COMMUNICATIONS

Two companies to supply electronics spare parts for legacy military radios

Military radio manufacturers Harris Corp. and Rockwell Collins have landed contracts collectively worth $53.6 million to supply electronics spare parts for legacy military radios.

Officials of the Defense Logistics Agency Land and Maritime segment at Aberdeen Proving Ground, Md., announced a $22.5 million contract to the Harris RF Communications segment in Rochester, N.Y., for Single-Channel Ground and Airborne Radio System (SINCGARS) circuit card assembly parts.

The Naval Supply Systems command Weapon Systems Support division in Philadelphia announced a $31.1 million contract to Rockwell Collins in Cedar Rapids, Iowa, for AN/ARC-210 weapon-replaceable assembly and repair.

The AN/ARC-210 Gen V programmable digital aircraft radio from Rockwell Collins provides two-way, multi-mode voice and data communications over frequencies from 30 to 512 MHz, covering UHF and VHF bands with AM, FM, and satellite communications (SATCOM) capabilities. The ARC-210 radio also includes embedded anti-jam waveforms,

including Have Quick and SINCGARS, and other data link and secure communications features for battlefield interoperability and transfer of data, voice, and imagery. The radios communicate with other avionics over a MIL-STD-1553 data bus.

Harris will do the work on its contract in Rochester, N.Y., and should be finished by July 2021. Rockwell Collins will do its work in the U.S. and the United Kingdom, and should be finished by July 2021. The contract has options that could increase its value to $67 million and its duration to July 2026.

FOR MORE INFORMATION visit **Harris RF Communications** online at *www.harris.com* and **Rockwell Collins** at *www.rockwellcollins.com*.

new PRODUCTS

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

SECURE DATA STORAGE

System to gather encrypted data from unmanned vehicles introduced by Curtiss-Wright

The Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va., is introducing the Data Transport System 1-Slot (DTS1) small-form-factor, SWaP-optimized data storage solution for storing large amounts of

data on unmanned aerial vehicles (UAV), unmanned underwater vehicles (UUV), and intelligence, surveillance, and reconnaissance (ISR) aircraft. The single-slot, network-attached storage (NAS) device weighs four pounds and measures 1.5 by 5 by 6.5 inches. It delivers as much as two terabytes of storage and supports advanced encryption to protect critical data-at-rest. The DTS1 functions as a NAS file server, helping system designers reduce SWaP by eliminating the need for independent storage in each of the platform's computer, display, or management devices. It enables network-enabled devices to communicate with other similar devices, to retrieve stored data, or to save captured data. Networked devices using heterogeneous operating systems like Linux, VxWorks, or Windows — or CPUs that support industry-standard protocols like NFS, CIFS, FTP, or HTTP — can share and store data through the DTS1.

FOR MORE INFORMATION visit **Curtiss-Wright Defense Solutions** online at *www.curtisswrightds.com*.

EMBEDDED POWER

6U rugged VPX power for military and aerospace apps introduced by NAI

North Atlantic Industries (NAI) in Bohemia, N.Y., is introducing the VPX56H-6 6U rugged VPX power product for rugged military and aerospace applications. The VPX56H-6 provides as much as 1,000 watts of power (CC4 temperature range, full load) with five outputs and complies with MIL-STD-704F. Other features include current share, remote error sensing, and a built-in MIL-STD-

461F EMI filter — all within a one-slot, 1-inch pitch, 6U package. The VPX56H-6 is designed to meet standard 6U VPX mechanical requirements and has VITA 62-compatible keying, outputs and signaling, user programmability, I2C communication, geographical addressing, programmable over-temperature monitor and a five state, status LED. The VPX56H-6 provides an input that accepts either 3-phase AC or 270-volt DC input within a VITA 62-compatible product.

FOR MORE INFORMATION visit **NAI** online at *www.naii.com*.

DATA RECORDERS

Intelligent signal-scanning SIGINT data recorder for introduced by Pentek

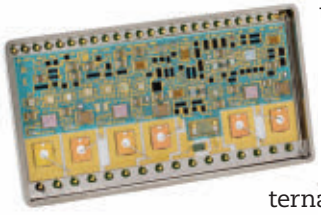
Pentek Inc. in Upper Saddle River, N.J., is introducing the RTS 2620 six-gigahertz RF Sentinel intelligent signal-scanning rackmount data recorder for military, security, and government intelligence (SIGINT, COMINT, and ELINT) applications. The RTS 2620 combines a Pentek Talon recording system with signal scanner, RF tuner, and RF upconverter. A Pentek 78621 Cobalt transceiver module serves as the data acquisition engine of the Talon RTS 2620. Its 200-MHz, 16-bit A/D converter provides 86 dB of dynamic range and 74 dB of SNR. A digital downconverter (DDC) provides frequency zooming for signal bandwidths as low as a few kilohertz. The Model 78621 is coupled to a 6-GHz RF tuner front end with excellent dynamic range across its entire spectrum. The Sentinel recorder provides automated signal monitoring and detection. The user specifies a start and stop frequency for the scan, covering any range between 2 MHz and 6 GHz. The RF tuner and DDC step across the scan range in consecutive bands, each programmable to 40 MHz in width. RF energy in each band is detected to create a waterfall spectrum display of the entire scan.

FOR MORE INFORMATION visit **Pentek** online at *www.pentek.com*.

MOTION CONTROL

Rad-tolerant motor drive hybrid introduced by DDC

Data Device Corp. (DDC) in Bohemia, N.Y., is introducing the PW-82336 radiation-tolerant, three-phase motor drive hybrid for servo-amplifiers and speed controls in high-performance space, aerospace, and military applications. The device provides 100 kilorads total dose protection, advanced circuit and logic protection, and uses a high-efficiency, radiation-tolerant MOSFET output stage with a 100-volt DC rating to deliver 5 amps continuous current (10 amps peak) to the motor. The motor drive hybrid offers flexible I/O; eliminates shoot-through conditions; internal logic controls (from +5 to +15 volts); and constant output performance for switching frequencies from DC to 50 kHz. The device measures 66 by 35.7 by 6.35 millimeters and comes in a small case with internal logic for optimized performance.



FOR MORE INFORMATION visit **DDC** online at *www.ddc-web.com*.

BOARD PINS

Spring-loaded pin for mating with circuit board pads introduced by Mill-Max

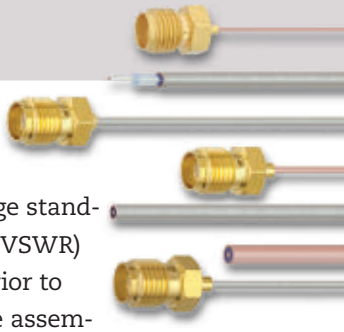
Mill-Max Manufacturing Co. in Oyster Bay, N.Y., is introducing the 0973-0-15-20-77-14-11-0 high-reliability, spring-loaded pin for mating with gold-plated printed circuit board pads or Mill-Max target pins and connectors. The pin offers a solder cup designed to accept wire as large as 20 AWG wire, and has a maximum stroke of .08 inches and can be used at a minimum spacing of 0.1 inches. The shoulder and barb features are located and designed for assembly into connector housings. The terminating wires may be passed through a connector housing and soldered to the cup of the 0973. Once the soldering is complete, the wires can now draw the 0973 spring pins into the housing and the spring pins can be secured with the press-fit. Gold-plated brass components and beryllium copper springs ensure conductivity, corrosion resistance, and durability.

FOR MORE INFORMATION visit **Mill-Max** online at *www.mill-max.com*.

RF AND MICROWAVE

Semi-rigid test probes for microwave circuits introduced by Pasternack

Pasternack Enterprises in Irvine, Calif., is introducing a line of semi-rigid test probes to assist in test and measurement testing microwave circuits. By soldering the outer conductor to the signal ground and the exposed center conductor to the trace carrying the signal of interest, users can make sampling measurements with these probes without creating a separate subassembly circuit board or add a connector to the circuit layout. The test probes come in three different diameters of semi-rigid coax including 0.02 inch, 0.034 inch, and 0.047 inch. All test probe cable assemblies are RF tested to a maximum frequency of 6 GHz, and also to ensure that the SMA connector interface meets the 1.35:1 voltage standing wave ratio (VSWR) specification prior to shipping. These assemblies come in 3-, 6-, 9-, and 12-inch lengths and are designed to fit a variety of trace widths and applications. The probes are also terminated with female SMA connectors.



FOR MORE INFORMATION visit **Pasternack** online *at www.pasternack.com*.

POWER SUPPLIES

Crane qualifies MFK DC-DC converters to MIL-PRF-38534 Class H

Crane Aerospace & Electronics in Redmond, Wash., is introducing mil-spec qualification for the Interpoint MFK series DC-DC converters for military and aerospace power electronics applications. The devices now meet MIL-PRF-38534 Class H. This performance specification for hybrid microcircuits, administered by the U.S. Defense Logistics Agency's Land and Maritime segment in Columbus, Ohio, describes a standard military quality level for use in the U.S. Department of Defense (DOD). This document is a performance specification for hybrid microcircuits, multichip modules (MCM), and similar devices, and provides a manufacturing baseline to support government microcircuit applications. Adhering to MIL-PRF-38535 Class H ensures that these devices meet performance requirements per the U.S. military's qualified manufacturing list (QML). It's an assurance of quality without additional parts tests and screening.

FOR MORE INFORMATION visit **Crane** online at *www.craneae.com*.

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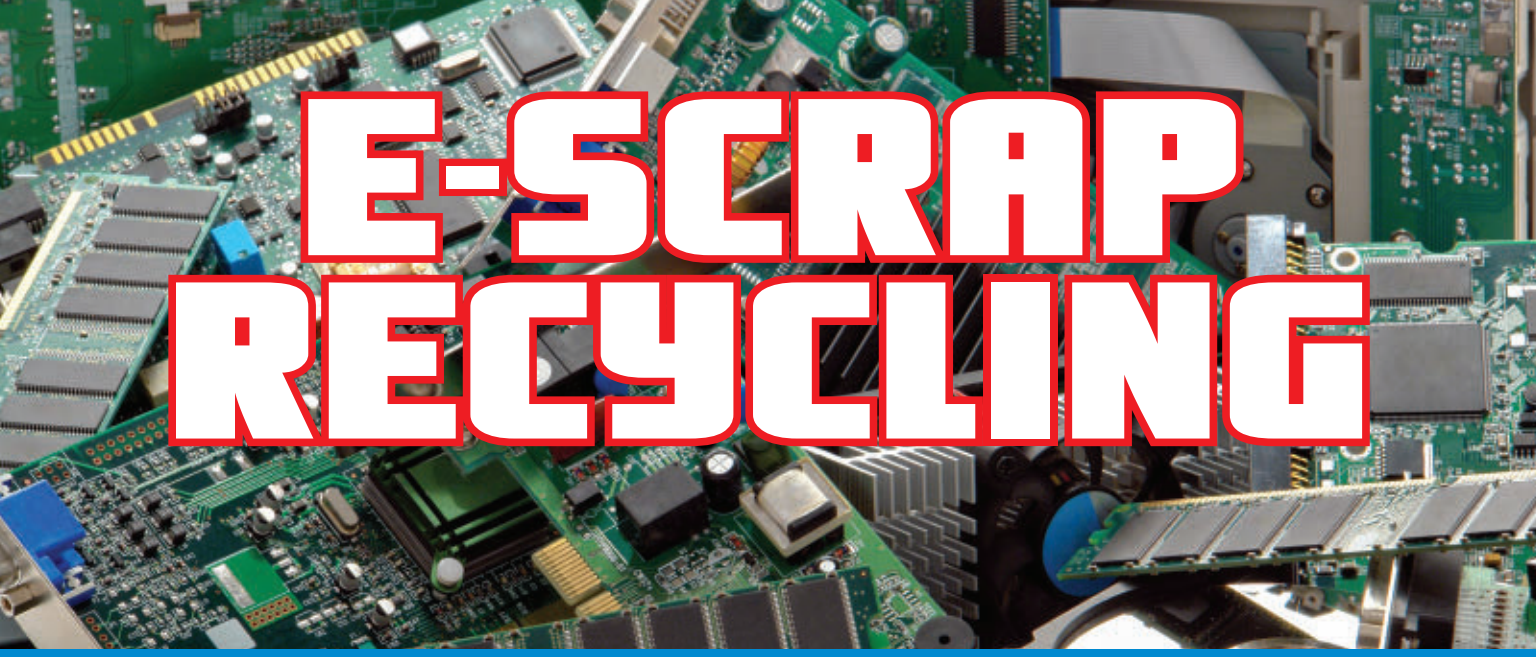

E-SCRAP RECYCLING

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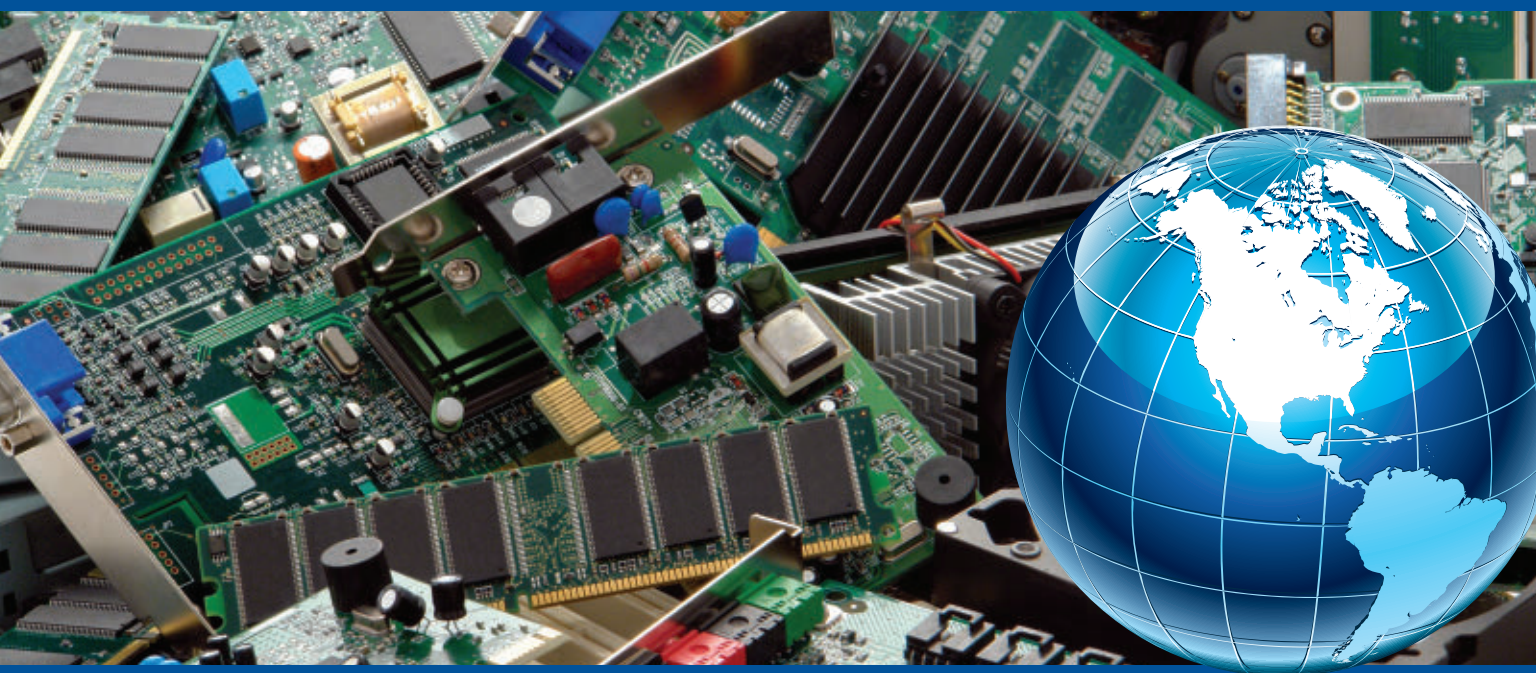

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