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The AOC Electronic Warfare Publication
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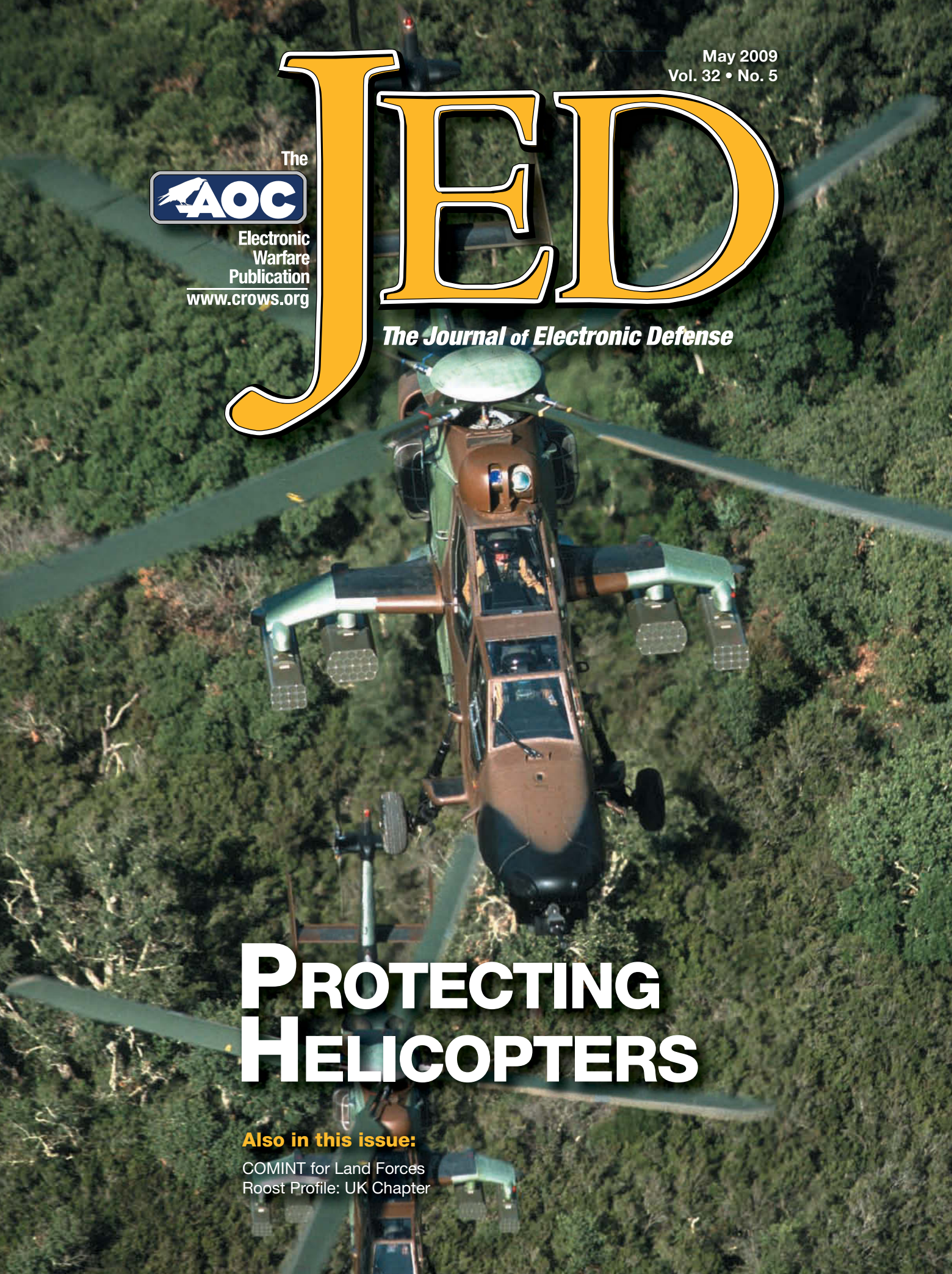
JED

The Journal of Electronic Defense



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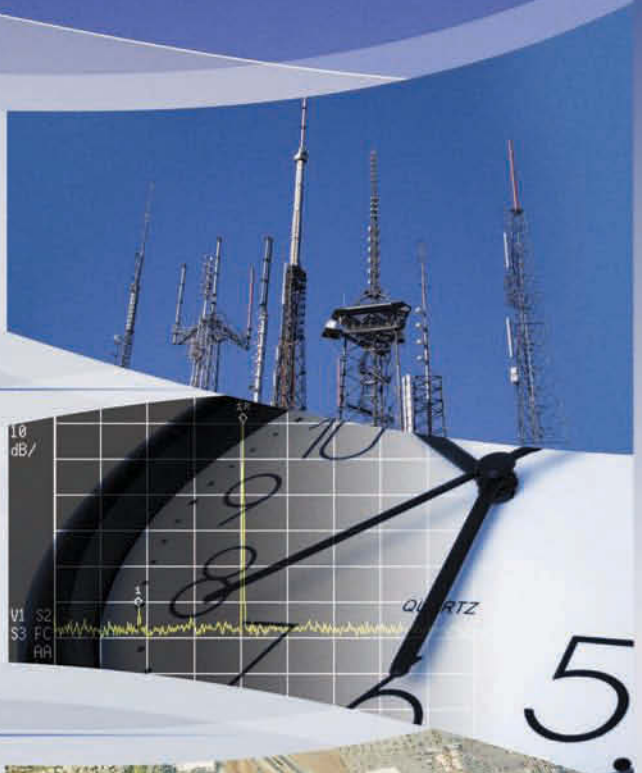

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A SEAT AT THE TABLE

When US Secretary of Defense Robert Gates gave his press conference early last month to discuss the FY10 DOD budget, the message was clear and insightful: things are going to change – a little bit. My biggest take-away from the press conference was not so much about the cuts he made to programs like the F-22 and Future Combat Systems. I was more interested in his decision to formalize budget planning for irregular warfare.

At one point, a reporter asked Gates if his FY10 budget proposal would "cure this building of next-war-itis." In his response, Gates said, "I mean, the reality is that – and let me put this very crudely – if you broke this budget out, it would probably be about 10 percent for irregular warfare; about 50 percent for traditional, strategic and conventional conflict; and about 40 percent dual-purpose capabilities. So this is not about irregular warfare putting the conventional capabilities in the shade. Quite the contrary: this is just a matter – for me, at least – of having the irregular-war constituency have a seat at the table for the first time when it comes to the base budget."

This, I think, is a potentially significant development for EW. As we have seen for the past several years, irregular warfare has huge EW requirements. Consider the billions of dollars the DOD has spent since 2001 on aircraft missile warning systems, DIRCM systems and flares, as well as IED jammers and COMINT systems. Obviously, control of the electromagnetic spectrum is just as important in counterinsurgency operations as it is in conventional operations. Until the Global War on Terror, however, this was not widely recognized as being true.

Based on past experience (i.e., the Cold War), EW was thought of almost exclusively in terms of supporting conventional and nuclear missions. EW requirements primarily were focused on providing combat survivability for platforms that represented the "tip of the spear," such as bombers, fighter jets, surface combatants and attack helicopters. Platforms that operated in support roles were not considered to be as vulnerable because they did not typically operate in harm's way. In irregular warfare, however, any aircraft, ship or ground vehicle that operates in theater needs to be protected from threats that rely on the electromagnetic spectrum, whether it is a radar-guided missile, IR threat, laser threat or remotely-controlled IED.

Until Secretary Gates's press conference last month, I was expecting the usual precipitous drop in EW advocacy (and funding) as the conflict in Iraq begins to wind down. As the saying goes, EW is a friend in war and a victim in peace. By "institutionalizing" irregular warfare, however, Gates has given formal authority to a new set of EW advocates, especially within the Army and the Marine Corps. I am hopeful that by giving irregular warfare a "seat at the table," EW will get a better, more permanent seat at the table as well.

– John Knowles

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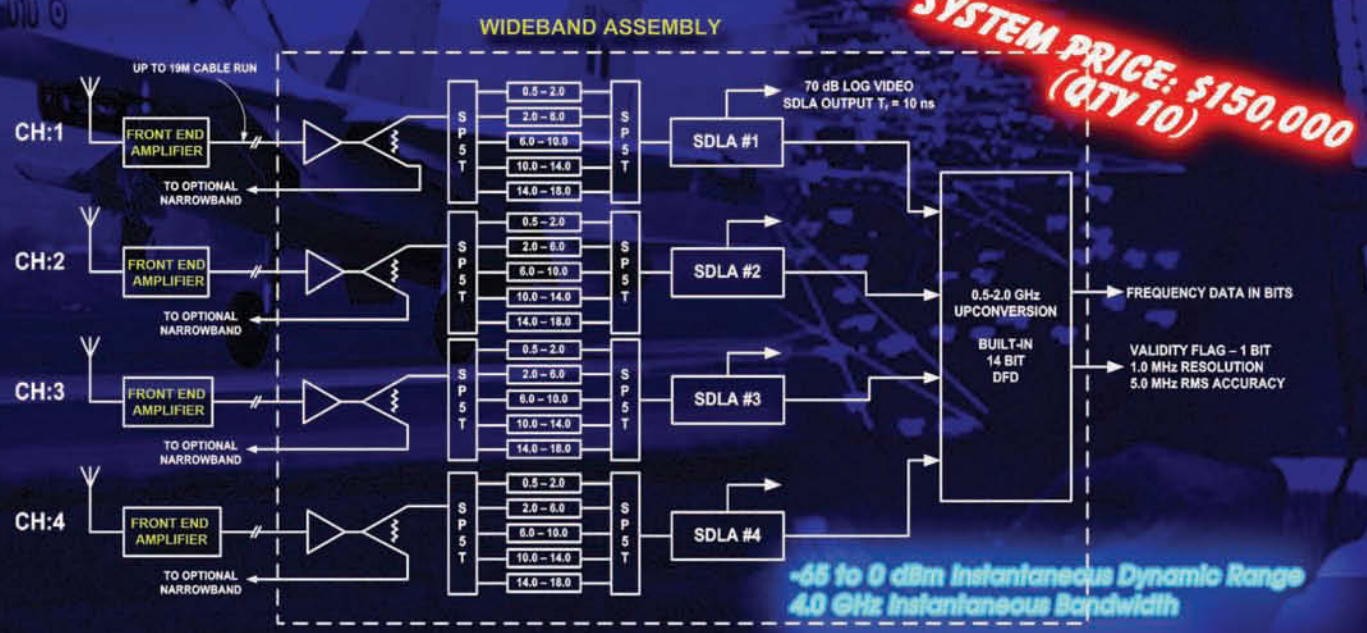

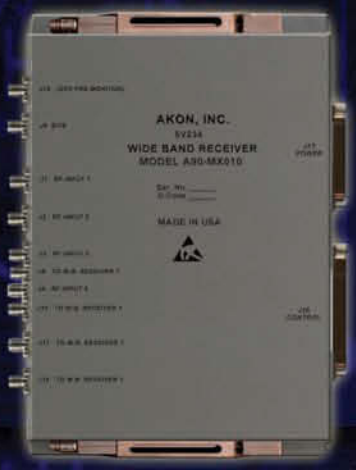

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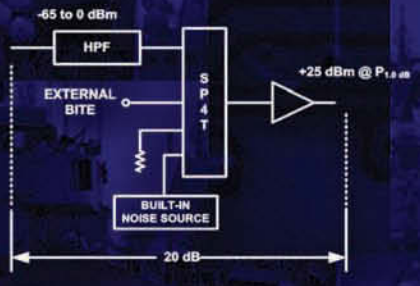

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EW INTEROPERABILITY

Last month, the North Atlantic Treaty Organization (NATO) celebrated its 60th anniversary. Born from need during the Cold War, it has transformed itself and remained extremely relevant in the post-Cold War era. As security alliances go, it is one of the most successful in history. However, it still has some issues to deal with regarding EW interoperability.

From industrial, operational and political perspectives, the alliance is extremely complex. Its military forces operate a diverse range of aircraft, ships and ground vehicles, most of them fitted with very different radar, EW, IFF and communications systems. Many of these weapons systems provide some degree of interoperability. In the EW arena, however, much work has to be done before "true interoperability" in the electromagnetic (EM) spectrum is achieved. By this, I mean that any NATO aircraft, ship or ground vehicle can share ESM and SIGINT data on a battle network in real time. As threat systems continue to proliferate and expand their engagement envelopes, it becomes more important to build a collective situational awareness picture on the network. This only can be achieved through EW interoperabilty.

Shortfalls in EW interoperability were a problem during Kosovo operations 10 years ago, and they are a lingering problem for NATO today. As NATO expands into Eastern Europe and extends membership to nations that are equipped with Warsaw Pact equipment, the interoperability problem becomes even more pronounced. This will be solved partly by modernization of these forces. But EW interoperability needs to be a solid requirement in these upgrade programs.

When I look beyond NATO, I see that the discipline required to develop EW interoperability is sporadic at best. Some countries in the Asia-Pacific region and the Middle East do extremely well at *planning* for interoperability with potential coalition partners. However, the execution of these plans is suspect, and it jeopardizes control of the EM spectrum by coalition forces.

I often wonder why any nation that is willing to spend hundreds of millions of dollars to acquire advanced EW systems would not insist on EW interoperability as an essential requirement. Yet in my job, I see international customers again and again ignoring EW interoperability, which renders the weapons system they are buying far less effective. At the same time, no one else in the acquisition process seems to address it, either – not the exporting government or EW system manufacturer or supplier.

It is not simply the responsibility of the customer to insist on EW interoperability. Everyone involved in the acquisition has a responsibility to address it. If a customer nation enters into a coalition operation (perhaps to defend its own territory!), its coalition partners certainly are going to wish someone had addressed interoperability requirements when he or she had the opportunity. *– Kermit Quick*

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USAF TO MAINTAIN PROWLER SUPPORT

The US Air Force's small 24-person 388th Electronic Combat Squadron at NAS Whidbey Island, WA, will start drawing down its presence there in 2011 and move to MCAS Cherry Point, NC, by 2012 to augment Marine Corps EA-6B Prowler air crews. Since the late 1990s, Air Force electronic countermeasures officers (ECMOs) from the 388th have flown aboard four-seat EA-6B Prowler support jamming aircraft belonging to the Navy's three "expeditionary" squadrons at Whidbey Island that are not assigned to carrier air wings – VAQ-133, VAQ-134 and VAQ-142. Each squadron has four Prowlers, and each aircraft is manned by a pilot and four ECMOs. The three expeditionary squadrons have deployed overseas regularly and supported Air Force, Army and Marine Corps tactical jamming requirements from land bases.

The Navy plans to deactivate these squadrons by the end of 2012 as it retires all of its Prowlers, and only plans to buy enough new replacement two-seat EA-18G Growlers to outfit 10 carrier air wings. The Marine Corps, however, plans to keep flying its EA-6Bs until 2018 to 2020. MCAS Cherry Point is the home base for all four of the Corps' EA-6B squadrons – VMAQ-1 through VMAQ-4 – each with five aircraft. USAF Col Bob Schwarze, Chief of EW and Cyber Warfare Requirements on the Air Staff, told *JED* that the Air Force and Marine Corps had reached agreement for the 388th to move to Cherry Point in 2011 to 2012 to begin augmenting the Corps' Prowler air crews with its ECMOs. In addition, he said, the Air Force and Navy are considering having two to four Air Force ECMOs fly aboard new Navy Growlers. – *G. Goodman*

USMC DEVELOPING FUTURE AEA STRATEGY

The US Marine Corps plans to continue flying EA-6B Prowler support jamming aircraft until 2018 to 2020, while all of the Navy's Prowlers will be replaced by new EA-18G Growlers by 2013. Speculation has surrounded the issue of what will replace the Marine Corps' EA-6Bs when they finally are retired. The service ruled out the Navy's Growler and has had its eye on a variant of the planned F-35 Joint Strike Fighter (JSF) to provide part of the solution, along with an unmanned aerial vehicle (UAV) with a jamming payload. *JED* asked Lt Gen George Trautman, the Deputy Commandant of the Marine Corps for Aviation, to clarify his service's position on the issue.

"Where we see things going is at least threefold," he said. "First is the JSF. This fifth-generation, low-observable strike fighter will have inherent capabilities that far exceed anything that any legacy platform can do. It is a true multi-role aircraft that's going to have excess capacity to work itself into the airborne electronic attack [AEA] mission with its inherent systems alone [e.g., active electronically scanned array radar], and I am convinced of that. And, oh, by the way, it will also be the best collector and disseminator of information in the battlespace.

"In addition to its inherent capabilities, what we have pressed for is that the planned Next-Generation Jammer [NGJ] not be built strictly as external pods for the Navy's EA-18G Growler. We would envision flying a mix of very low-

observable F-35s and not very low-observable F-35s equipped with NGJ pods, and it would be when and if needed. When and if we needed the capability resident in the NGJ, we could put them on the F-35 and go.

"The third leg, and probably in many ways the most important leg in my mind – because you have to think, 'Why put men in harm's way to do this very challenging mission?' – is unmanned aircraft systems, and exploiting the capability sets that are going to be available to go on them in the next decade. That includes using them to disseminate information around the battlespace similar to the Joint Capabilities Technology Demonstration called CORPORAL [Collaborative Online Reconnaissance Provider-Operationally Responsive Attack Link] that we are trying to push. Those three elements, we think, are going to create a distributed approach to airborne electronic attack whose capabilities will far exceed anything we have today." – *G. Goodman*

ARMY TO SOLICIT BIDS FOR DUKE IED JAMMER UPGRADE

The US Army is launching a program that will upgrade thousands of AN/VLQ-12(V)2s, also known as Duke V2s, counter radio-controlled improvised explosive device (RCIED) electronic warfare (CREW) jammers. The Project Director for Signals Warfare, under the Army's Program Executive Office for Intelligence, EW & Sensors (Fort Monmouth, NJ), plans to award one or two five-year indefinite-delivery/indefinite-quantity contracts in the August/September timeframe for the Duke V2 upgrade. The

GROWLER IN HOME STRETCH FOR FIELDING

Electronic Attack Squadron (VAQ) 132 at NAS Whidbey Island, WA, the "Scorpions," is the first of the US Navy's 10 carrier-based EA-6B Prowler support jamming aircraft squadrons slated for conversion to the new EA-18G Growler aircraft through 2012. VAQ-132's aircrews and maintenance personnel spent the month of March receiving EA-18G familiarization training at the Naval Air Facility in El Centro, CA, from members of VAQ-129, the large Prowler-Growler Fleet Replacement Squadron at Whidbey Island, according to a March 26 article in the *Northwest Navigator*. Thirteen pilots and seven electronic warfare officers (EWOs) from the VAQ-129 Vikings trained VAQ-132's six pilots and six EWOs. (The Prowler has one pilot and three electronic countermeasures officers or ECMOs; the Growler has one pilot and one EWO.) A total of 25 maintainers from VAQ-132 also were trained and achieved various specialty qualifications.

VAQ-132 will deploy to NAS Fallon, NV, in June for further training by VAQ-129 personnel. The Scorpions are scheduled to receive their new Growler aircraft in August as part of the eight- to nine-month instruction and certification process that began February 1. The five-aircraft squadron will achieve the EA-18G's initial operational capability (IOC) in September. – *G. Goodman*

program calls for high-volume production deliveries (starting at 100 units per month and quickly increasing to 1,000 units per month) beginning in early 2010. The upgrade of existing systems – not a replacement – is intended to maintain the jammer's relevancy to meet new and emerging threats over a broader frequency spectrum. The Army will evaluate production-ready upgrade solutions from bidders in lab tests at the Intelligence and Information Warfare Directorate and field tests at the Yuma Proving Ground to assess their performance. The Army has stated an average price goal of $36,000 per unit for the first 500 units.

SRCTec (Syracuse, NY) has been the incumbent Duke V2 supplier. The jammer was fielded in Iraq in early 2006. A March 30 industry day drew representatives from nearly a dozen EW manufacturers, including SRCTec, BAE Systems, Cobham DES, ITT, Lockheed Martin, General Dynamics, Pegasus, Harris and Rockwell Collins. At press time, the Army was expected to issue an request for proposals (RFP) in late April. The solicitation number is W15P7T-09-R-M615; the contracting officer at Fort Monmouth is Estelle Klose, e-mail: estelle.klose@us.army.mil.

In undertaking its Duke V2 upgrade effort, the Army's goal is to ensure that one of its primary IED jammers remains operationally effective for the next five to seven years by extending the Duke's frequency coverage and its stand-off jamming range. The decision to upgrade the Duke also suggests that the Army appears to be spurning the ongoing vehicle-mounted CREW 3.2 competitive procurement program led by the US Navy. The Navy is the Department of Defense's (DOD) executive agent for developing common ground-based CREW systems for the joint military services. This responsibility is carried out by Naval Sea Systems Command's CREW Program Office (PMS 408) at the Washington, DC, Navy Yard. PMS 408 plans to award multiple contracts soon for longer-term development of a new cutting-edge CREW 3.3 family of mounted, dismounted and fixed-site IED jammers with common components and open-architecture standards that will allow incremental

software rather than hardware upgrades to keep pace with changes in the threat. – *G. Goodman and J. Knowles*

AFRL TO DEVELOP "EW-CAPABLE RADAR"

The Air Force Research Lab's Sensors Directorate (Wright-Patterson AFB, OH) is planning to solicit proposals this month for the High-Band Objective System Study (HBOSS), a project that will focus on developing architectures for future multifunction high-band radars. The study will focus on integrating Air Moving Target Indication (AMTI), Ground Moving Target Indication (GMTI), Synthetic Aperture Radar (SAR), Air-to-Ground (A/G), Air-to-Air (A/A) and Radar Common Data Link (R-CDL) functions, as well as electronic attack (EA), electronic protection (EP) and Passive Multi-Mode Sensing (PMMS), into a high-band radar sensor suite system.

The HBOSS effort also will focus on specific areas, such as the antenna, waveforms, operational frequency range, instantaneous and tunable bandwidth and receiver performance. With a $1 mil-

lion budget, AFRL anticipates sponsoring two design architectures that could be developed further for outdoor range testing. Ultimately, the Air Force could develop a fully capable system.

The BAA is titled "Sensor Technology Research, Development, Test & Evaluation Open-Ended BAA (STROEB) II." The program point of contact is John Reynolds at 937-255-6427, ext. 4349, e-mail john.reynolds2@wpafb.af.mil. – *M. Kunkel*

SLQ-32 UPGRADES CONTINUE

Naval Sea Systems Command (NAVSEA) awarded General Dynamics Advanced Information Systems (Fairfax, VA) a 28-month, $40 million sole-source contract March 31 for continued Surface Electronic Warfare Improvement Program (SEWIP) Block 1B development, integration and production. The series of SEWIP Block 1 upgrades has included the addition of a modern signal-processing computer and some adjunct stand-alone sensor systems to the Navy's existing shipboard SLQ-32(V) EW system, along with improved control and display consoles for system operators. The new contract includes full-rate production of SEWIP Block 1B2 units – the stand-alone General Dynamics SSX-1 Small Ship Electronic Support Measures (SSESM) system with a specific emitter identification capability – and continued design and development of the SEWIP Block 1B3 upgrade. The latter features a specialized High-Gain (antenna)/High-Sensitivity (receiver) subsystem originally developed by the Naval Research Laboratory.

NAVSEA released a request for proposals (RFP) in late February for development of a new SEWIP Block 2 ESM system. It represents the first major hardware upgrade to key portions of the venerable SLQ-32, specifically its receiver/antenna group and combat system interface. Bids were due April 24, and NAVSEA plans to award a single industry contract this fall. – *G. Goodman*

IN BRIEF

ITT Electronic Systems (Clifton, NJ) reported March 30 that its Advanced Integrated Defensive EW System (AIDEWS) had successfully completed an 11-week Design Verification Test with the US Air Force, allowing it to enter a planned EW flight test program. AIDEWS, designated the ALQ-211(V)4, is an integrated radar warning and jamming countermeasure system. It is in full production, with more than 150 systems under contract for five nations and 82 delivered as part of Air Force F-16 fighter Foreign Military Sales (FMS) programs.

✪ ✪ ✪

Airborne Tactical Advantage Co. (Newport News, VA) was awarded a $35.2 million indefinite delivery-indefinite quantity contract from Naval Air Systems Command for contractor-owned and -operated Type III High Subsonic and Type IV Supersonic aircraft in support of the Navy's Commercial Air Services (CAS) program. Efforts to be provided through October include a wide variety of airborne threat simulation capabilities to train shipboard and aircraft squadron weapon systems operators and aircrews how to counter potential enemy EW and electronic attack operations. The Navy also has

CALL FOR PAPERS

The AOC is soliciting papers for the **46th International Symposium and Convention** to be held October 18-22, 2009, in Washington DC.

The symposium theme this year is **"Modernizing EW: Balancing Cost and Capability."** For specific topics, visit **www.crows.org**.

After Orlando 2007, which focused on the "new," and Reno 2008, which focused on the "how," the 2009 venue in Washington, DC will focus on the trade-space of EW affordability (both politically and economically) vs. EW capability (what is really required).

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awarded a $21 million contract to **L-3 Communications Flight International** (Newport News, VA) for airborne threat simulation training for shipboard and aircraft squadron weapon systems operators and aircrews. This contract also will run through October.

Kilgore Flares (Toone, TN) won a pair of awards to produce countermeasures flares. The US Air Force awarded a $6.7 million contract to the company for production of MJU-53/B flares, primarily for use on C-17 aircraft. The US Navy awarded a $15.1 million contract for production of MJU-38A/B flares, with final deliveries scheduled for December 2014.

Raytheon Technical Services Co. (Indianapolis, IN) was awarded a $11.4 million delivery order from Naval Air Systems Command against a previously issued basic order agreement for 180 ship sets of ALE-47 Dual Pod expendable countermeasures dispensers for the US Marine Corps' AH-1W Super Cobra attack helicopters.

The US Air Force's Air Armament Center at Eglin AFB, FL, accepted delivery of the first production unit of Raytheon Missile Systems' (Tucson, AZ) Miniature Air-Launched Decoy (MALD) in March. MALD entered low-rate initial production last June and will become operational in the fourth quarter of this year.

BAE Systems EIS (Nashua, NH) received a $33.6 million award for the fifth low-rate production lot of 323 ALE-55(V) fiber-optic towed decoy (FOTD) and 70 electronic frequency converters. Deliveries, which are expected to be completed in August 2011, will go to the US Navy and the Royal Australian Air Force for use on F/A-18E/F aircraft.

The US Navy's Airborne Threat Simulation Office (Point Mugu, CA) awarded a pair of contracts. **Computer Technology Associations Inc.** (Ridgecrest, CA) received a $6.5 million award for 609 electronic assemblies. **Symetrics Industries** (Melbourne, FL) also received a $6.5 million contract for delivery of 500 Technique Control Modulator (TCM) units and 950 TCM kits.

The Naval Surface Warfare Center-Crane Div. (Crane, IN) was among the winners of the FY08 Defense Department Value Engineering Awards announced March 20. Value engineering is a systematic process of functional analysis identifying actions that reduce cost, increase quality and improve mission capabilities across systems, processes and organizations. Crane's Airborne Electronic Attack Division won an award and Crane won a joint award with the Crane Army Ammunition Activity for the MJU Decoy Flare Rebuild Project, plus Crane's David Love won an individual award as well.

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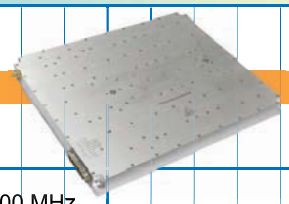

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SECDEF OFFERS FY10 BUDGET PREVIEW

The US Secretary of Defense, Robert Gates, took the extraordinary step last month of holding a press conference to discuss the major aspects of the FY10 Department of Defense (DOD) budget request more than a month before the document had been completed and sent to the White House. During the April 6 press briefing, he outlined a budget plan that reflects adjusted DOD priorities, such as acquisition reform and a greater emphasis on irregular warfare.

Secretary Gates announced decisions on several acquisition programs, such as capping F-22 production at 187 aircraft (the program of record since 2005 has been 183 aircraft) and cutting most of the ground vehicle portions of the Army's Future Combat Systems (FCS) program. These decisions were offset by increased spending on the F-35 and a promise to begin a new ground vehicle program for FCS that reflects updated requirements.

Gates did advocate for spending more money on programs that support irregular warfare, especially in the intelligence, surveillance and reconnaissance (ISR) arena. He said the FY10 budget request would include the acquisition of 50 additional Predator/Reaper-class unmanned aerial vehicles (UAVs), as well as more manned turboprop ISR aircraft.

Another major aspect of the FY10 budget is acquisition reform. Gates said the DOD would reduce its civilian workforce, which currently accounts for 39 percent of the overall DOD workforce. Instead, he would hire 13,000 new civil servants in 2010 and seek to hire a total of 30,000 new civil servants over the next five years.

In terms of the electronic warfare (EW) market, the FY10 budget request is something of a mixed bag. The F-22 production cap, for instance, was partially offset by the increased production of the F-35. However, the longer-term implications are good for the EW market, as the focus on irregular warfare creates more opportunities for EW and signals-intelligence (SIGINT) manufacturers.

The DOD is expected to finalize its budget request and send it to the White House this month. – *J. Knowles*

DOD ISSUES CHINESE MILITARY POWER REPORT

The Pentagon released its *Annual Report to Congress: Military Power of the People's Republic of China 2009* in late March. The following are excerpts.

"China's ability to sustain military power at a distance remains limited, but its armed forces continue to develop and field disruptive military technologies, including those for anti-access/area-denial, as well as for nuclear, space and cyber warfare, that are changing regional military balances and that have implications beyond the Asia-Pacific region.

"PRC military writings highlight the seizure of electromagnetic dominance in the early phases of a campaign as among the foremost tasks to ensure battlefield success. People's Liberation Army (PLA) theorists have coined the term 'integrated network electronic warfare' to describe the use of electronic warfare, computer network operations and kinetic strikes to disrupt battlefield network information systems that support an adversary's warfighting and power-projection capabilities. PLA writings on future models of joint operations identify 'integrated network electronic warfare' as one of the basic forms of 'integrated joint operations,' [again] suggesting the centrality of seizing and dominating the electromagnetic spectrum in PLA campaign theory.

"[One element] of an emerging area anti-access/area-denial strategy includes the electromagnetic and information spheres. PLA authors often cite the need in modern warfare to control information, sometimes termed 'information blockade' or 'information dominance,' and to seize the initiative as a critical function in the early phases of a campaign. China is improving information and operational security. It is also developing electronic and information warfare capabilities, as well as denial and deception strategies. China's 'information blockade' likely envisions employment of military and non-military instruments of state power across all dimensions of the modern battlespace, including outer space.

"The PLA is investing in electronic countermeasures, defenses against electronic attack (e.g., electronic and infrared decoys, angle reflectors, and false target generators), and computer network operations (CNO). China's CNO concepts include computer network attack (CNA), computer network exploitation (CNE), and computer network defense (CND). The PLA has established information warfare units to develop viruses to attack enemy computer systems and networks, and tactics and measures to protect friendly computer systems and networks. In 2005, the PLA began to incorporate offensive CNO into its exercises, primarily in first strikes against enemy networks.

"China has or is acquiring the ability to hold aircraft at risk over or near Chinese territory or forces (via imported and domestic fourth-generation aircraft, advanced long-range surface-to-air missile systems, air surveillance systems, and ship-borne air defenses). The air and air defense component of anti-access/area-denial includes surface-to-air missiles such as the HQ-9, SA-10, SA-20 (which has a reported limited ballistic and cruise missile defense capability), and the extended-range SA-20 PMU2." – JED *Staff*

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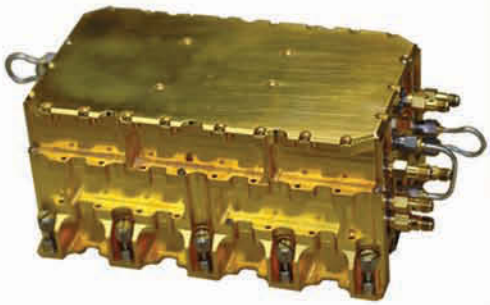

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CANADIAN NAVY BUYS NAVAL DECOYS

The Canadian government has awarded a five-year, $23 million contract to Rheinmetall Waffe Munition GmbH (Schneizlreuth, Germany) to deliver Multi Ammunition Softkill System (MASS) decoy launchers and decoy rounds for its *Halifax*-Class frigates. The buy is part of a larger modernization program that will enable the frigates to operate more effectively in littoral waters.

Under the terms of the contract, Rheinmetall will deliver 14 MASS systems. Twelve systems will be installed onboard the frigates, and the remaining two will be delivered to onshore support facilities. The MASS, which was introduced in 2002, uses a programmable, trainable launcher to deploy RF and IR decoys, as well as obscurants. It has become popular among European navies and also has been sold to the UAE. The *Halifax* contract marks its first sale to Canada.

The MASS will replace the AN/SLQ-502 *SHIELD II* Type 200 decoy launcher system currently installed on the frigates. MASS will be integrated into the ships' self-defense system, which will include a new radar ESM system from Elisra and the legacy SLQ-503 radar jammer. The ships also use the AN/SRD-504 combat direction-finding system made by Southwest Research Institute (SWRI). Last year, the Navy began taking deliveries of the Sirius IR Search and Track system from Thales Nederland and DRS Technologies Canada.

Deliveries of the MASS launchers will begin in 2010 and run until 2014. – *M. Kunkel and J. Knowles*

HELLENIC NAVY BUYS NAVAL ESM SYSTEMS

The Hellenic Navy has selected a range of Thales equipment, including ESM systems, for its two newest *Roussen*-Class fast attack craft (FAC).

The two FACs are being built by Elefsis Shipbuilding & Industrial Enterprises in Greece under license from BVT Surface Fleet Ltd. in the UK. The 62-meter vessels each will be fitted with Thales' Tacticos combat management system, DR3000 ESM system, MW08 medium-range surveillance radar, Sting EO Mk2 fire-control radar and the Mirador electro-optic weapon-control system. Thales will be responsible for integrating the sensors with the combat management system.

The Hellenic Navy has outfitted its five earlier *Roussen*-Class vessels, ordered in 2000 and 2003, with similar Thales naval equipment. The two newest vessels will be delivered in 2012 and 2013. – *J. Knowles*

EDA TO STUDY MULTIFUNCTION RADAR TECHNOLOGIES

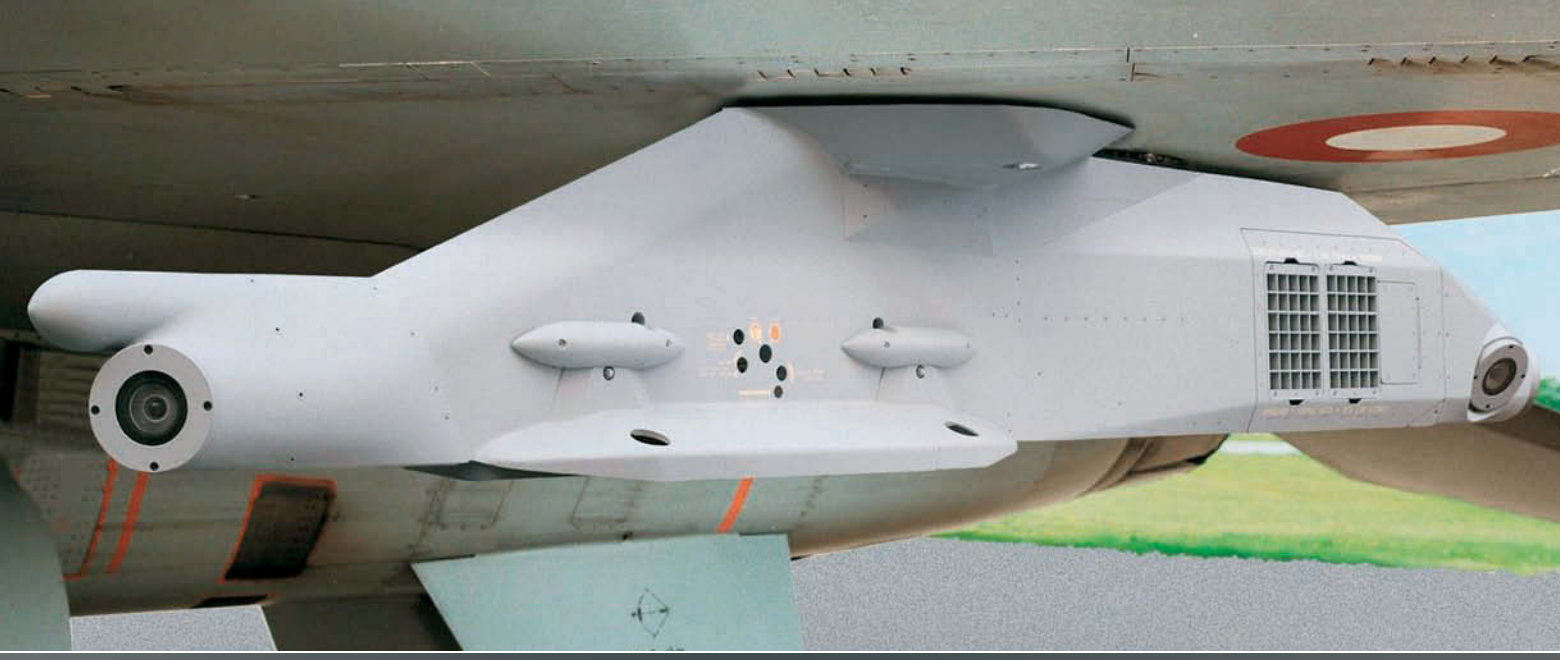
The European Defence Agency (EDA) in Brussels has signed a €21 million (US$27.3 million) contract with a consortium of four leading European radar manufacturers to begin studying new technologies for compact, lightweight multifunction radars. The project, named Studies for Integrated Multifunction Compact Lightweight Airborne Radars and Systems (SIMCLAIRS), began last month.

During the 48-month effort, Saab AB (Sweden), Thales Systèmes Aéroportés (France), Thales UK Ltd. (UK) and Selex Sensors and Airborne Systems (UK) will develop multifunction RF sensor technologies that can be integrated into UAV payloads. The companies will focus on research in the areas of synthetic aperture radar/moving target indicator (SAR/MTI), foliage penetrating (FOPEN) radar, ESM and possibly communications.

The project will use a relatively new mechanism called the Innovation and Technology Partnership (ITP) that will enable "free flow of technology and information across national boundaries between the participating entities," according to an announcement from the EDA. The consortium is expected to issue two open calls for Research Supplier Proposals during the project. – *J. Knowles*

IN BRIEF

- **Germany's Federal Office of Defense Technology and Procurement** (BWB) is planning to acquire RF simulators to evaluate the performance of ALR-95(V)2 ESM systems installed on the German navy's eight P-3C Orion aircraft. Tenders are due May 7. The contract office can be reached by phone at +49 (0) 261 400 5318, e-mail BWBL2.2@bwb.org.
- **Ampex Data Systems** has received a contract to supply its miniR 700 airborne data recorder systems to the Canadian Forces Aerospace Warfare Centre - Electronic Warfare Operational Support (EWOS) unit. The multi-channel data recorders will be used in the EWOS Common Multiplex Bus Recorder (CMBR) program. In addition to supplying the airborne recorder systems, Ampex will provide post-mission processing software and training.
- The **Indian air force** (IAF) has canceled its request for tenders for 22 attack helicopters after two US bidders pulled out of the competition and the remaining bids did not meet the IAF's requirements. The helicopters were to be outfitted with an advanced EW suite capable of identifying and geolocating threat radars. The IAF is expected to issue a new RFP soon, but deliveries could be delayed from 2010 to 2012.



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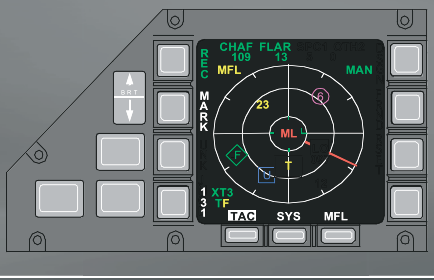

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Protecting

The Integrated Future of ASE

By Marianne Kunkel and John Knowles

As operations in Afghanistan and Iraq have demonstrated, helicopters are just as important to irregular warfare as they are to more conventional military operations. In countries where the road infrastructure is poor and where improvised explosive devices (IEDs) and landmines also can limit ground movement, utility and transport helicopters are essential for moving troops and supplies. But helicopters fly in a deadly threat envelope, where advanced infrared (IR)-guided Man-Portable Air Defense Systems (MANPADS), AK-47s and rocket-propelled grenades (RPGs) are effective, inexpensive and easy to obtain. In places like Iraq and Afghanistan, there is no Forward Line of Own Troops (FLOT), and helicopter crews know that insurgents can fire these weapons at their helicopter from just about anywhere at any time. This type of scenario represents one of the major market drivers in today's helicopter electronic warfare (EW) market.

THE AFFORDABILITY CHALLENGE

Due to their low flight profile and relatively slow speed, helicopters fly in a diverse and deadly threat environment that can include radio frequency (RF)-guided missiles, sensor-directed anti-aircraft artillery, IR-guided missiles, laser rangefinders, laser-guided weapons, small arms and RPGs. Developing an aircraft survivability equipment (ASE) suite for helicopters that can handle this multispectral threat environment presents a unique set of technical and cost challenges. A fully integrated EW suite, comprising a digital radar warning receiver/electronic support measures (RWR/ESM) system, an RF jammer, a laser warning system (LWS), a passive missile warning system (MWS), an all-laser directed IR countermeasures (DIRCM) system and multiple countermeasures dispensers, can cost $2 to $3 million (or more for a large helicopter like a CH-47). This figure, which represents today's technology, is well outside the affordability envelope for most users. The US Army, for instance, has said in the past that it expects to pay $500,000 for a multispectral ASE suite. This price goal may seem unrealistic, but the Army has 2,500 helicopters in its inventory. It cannot afford to upgrade this fleet with a full ASE suite at today's prices.

Over the next decade, EW manufacturers and their military customers will need to close the affordability gap and begin fielding full ASE suites across the majority of their helicopter fleets. As operations in Afghanistan and Iraq have demonstrated, the threat environment is becoming more deadly for helicopters. Since 2003, the US Army alone has lost 40 helicopters to enemy fire in Iraq and Afghanistan. Imaging IR-guided threats and advanced laser-cued/guided threats are proliferating in countries and among non-state organizations throughout the world. Small arms, although less effective, are far more numerous than guided threats. They account for the majority of helicopter shoot-downs in the Global War on Terror (GWOT). In addition, commercial technology is enabling radar-guided threats to become more effective and less expensive to buy and operate. All of these threat trends will drive the need for more comprehensive ASE suites on helicopters in the coming decade.

DRIVEN BY THE GWOT

The GWOT has forced the United States to invest heavily in helicopter EW over the past several years, primarily in the IR countermeasures arena. This has not been steady spending, however. In FY02, the US Army spent a mere

Helicopters

$7.3 million on ASE. In the months following 9/11, it decided to postpone production of its next-generation IR and RF EW systems by several years. When MANPADS and small arms began taking down its helicopters in Iraq in late 2003, the Army's attitude toward ASE began to change. Spending increased and the AAR-57 Common Missile Warning System made by BAE Systems was hurried into production, quickly reaching a rate of 60 systems per month. In FY08, the Army spent $905 million on ASE; it had spent $2.45 billion on ASE from FY03 to FY08, mostly on flares, new dispensers and the AAR-57. Of this $2.45 billion total, however, only $1.42 billion was part of the Army's base budget. The remaining $1 billion was either reprogrammed or was part of a supplemental defense budget. With President Obama vowing to eliminate the emergency supplemental budgets and fold all GWOT funding into the base budget (in order to get a legitimate grasp on the overall defense budget), the Army will have to integrate all of its ASE funding into its base budget, where it will compete against all of the other major and minor acquisition programs.

As mentioned earlier, the fielding of the AAR-57 has been rapid. The Army plans to buy more than 1,700 AAR-57s and configure more than 3,500 helicopters to carry the system. Currently, the program is focused on ensuring that all Army helicopters deploying to Iraq and Afghanistan are equipped with the AAR-57 and the Improved Countermeasures Dispenser (ICMD). The most recent AAR-57 update was the addition of a fifth sensor on all Army helicopters to cover a blind spot beneath them.

While the AAR-57 is making a difference in the field, the Army primarily depends on the ALQ-144 IR jammer and flares to defeat IR threats, and it has struggled to complete development of the ALQ-212 Advanced Threat Infrared Countermeasures (ATIRCM) system. The Army is buying the ATIRCM system on a quick reaction basis for its large CH-47D aircraft. But it wants to revisit the ATIRCM program and look for a lighter-weight jammer for most of its other helicopter models. The Army has tasked BAE Systems, acting as the CMWS/ATIRCM prime integrator, to contact potential DIRCM suppliers. Although the first round did not produce a solution, another effort is expected in the coming months.

In terms of IR countermeasures, the US Navy and US Marine Corps (USMC) entered the GWOT on slightly better footing. In FY02, the Navy was in the process of upgrading the performance of the AAR-47 MWS and developing a new sensor that incorporated a laser warning function. Unlike the Army, however, the Navy and Marine Corps did not have an imaging MWS that could cue a DIRCM. It, too, was dependent on the ALQ-144 and flares. When it began to lose helicopters in Iraq, the Navy and Marine Corps decided to buy a new MWS and DIRCM suite from Northrop Grumman, the AAQ-24(V)25, for 156 of its CH-46E and CH-53D/E helicopters. Known as the Department of the Navy Large Aircraft IR Countermeasures (DoN LAIRCM) program, the acquisition is the beginning of a larger investment plan that could see up to 1,350 missile warners and 450 DIRCM systems bought for US Navy and USMC helicopters through FY22.

This strategy focuses on two missile warning types – the AAR-47 and the Joint and Allied Threat Awareness System (JATAS). The AAR-47B(V)2 incorporates a new laser warning sensor and currently is in production. A future

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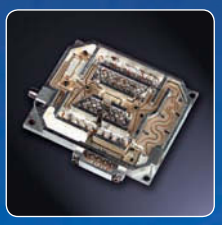

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AAR-47 upgrade is the Multi-Function Threat Detector (MFTD) capability, which is being developed by Alliant Techsystems (Clearwater, FL) and Solid State Scientific Corp. (Hollis, NH). Currently a Joint Concept Technology Demonstration (JCTD), the goal of the MFTD program is to develop a hostile-fire warning module that can be retrofitted into the AAR-47 (or possibly any other MWS) and warn aircrews of small arms and RPG fire. The JCTD runs until 2010, after which it could enter production and be retrofitted into about 600 AAR-47B(V)2 systems.

The JATAS program calls for development of a one- or two-color IR missile warner that will replace most of the first- and second-generation AAR-47s in the Navy and Marine Corps inventory. Unlike the AAR-47, the JATAS will be able to cue a DIRCM system, as well as offer a longer detection range while operating at higher altitudes. An option also may see the addition of a hostile fire indication (HFI) capability. The JATAS program is currently in source selection, with Northrop Grumman, Lockheed Martin and an Alliant Techsystems/BAE Systems team bidding for two technology demonstration contracts. JATAS development is scheduled to continue through FY12. Once production begins in the FY12-FY13 timeframe, the Navy and Marine Corps could begin replacing the AAR47B(V)2 with up to 800 JATAS systems planned for production through FY22.

After JATAS development gets underway, the Navy will turn its attention to buying a DIRCM, which is targeted for several of its rotary-wing types, such as the MV-22, CH-53K, MH-60R/S, UH-1Y and AH-1Z. The main goals of this program are affordability and reduced size. The Navy and the Army have agreed to develop a DIRCM system together in accordance with a recently drafted acquisition policy under which the Navy will be responsible for developing joint service rotary-wing missile warning systems and the Army will be responsible for joint service DIRCM systems for helicopters. As far as joint Army-Navy DIRCM acquisition goes, requirements are still being defined. But both services want smaller, less-expensive systems

than first-generation DIRCM systems, such as the ALQ-212 ATIRCM. The program is likely to attract interest from established DIRCM manufacturers BAE Systems and Northrop Grumman. Two other possible bidders are ITT Electronic Systems and Raytheon Missile Systems, each of which is developing a new lightweight DIRCM system.

RF COMPLACENCY?

Although the GWOT moved IR countermeasures to the front burner, the Department of Defense (DOD) has been slow to move forward with RF countermeasures programs. The RF threat has been relatively stable since the end of the Cold War, but this could change over the next decade with the commercial market providing more processing power and inexpensive, reliable components for radar systems. With the increasing availability of digital RWRs, advanced geolocation algorithms and specific emitter identification, helicopter crews are anxious to benefit from these capabilities in their cockpits.

The Army, along with the Navy and Marine Corps, is in the process of upgrading the 1980s-era APR-39A(V)1/4 systems under a three-phase program. The first phase, known as the APR-39A(V)X program, began in 2005 under a contract awarded to Northrop Grumman. The -A(V)X focuses on improving the performance and sustainability of the RWR. Performance improvements include faster processing, improved capabilities in dense RF environments, better parameter measurement accuracy and faster response time. Sustainment improvements include more memory (the -A(V)1's operational flight program (OFP) has not been upgraded since 1995 because the system ran out of memory and could not accept new algorithms), reduced parts count and reduced parts obsolescence. Although the Army originally had hoped the performance and sustainment upgrades would enter production in 2008, it has encountered delays, and the Army expects to make a procurement later this year. The second phase of the program, which could begin development in FY11 (depending on available funding), calls for integrating a new digital receiver into the -A(V)X. This is expected to be a competitive procurement, but the acquisition strategy and requirements document are awaiting Army approval. The third phase entails the development of a new RF jammer beginning in FY13. Again, funding and requirements need to be ironed out.

INTEGRATING FUTURE ASE SUITES

While the DOD is concerned with the immediate threats its helicopters are encountering in Afghanistan and Iraq, it also is looking at the future. The Army's Intelligence and Information Warfare Directorate (I2WD) and the Naval Research Lab are considering the entire spectrum of self-protection capabilities as they look to develop a new generation of fully-integrated ASE suites. Among the current technology gaps are HFI; low-cost digital RWRs; lightweight, low-cost DIRCM systems (including imaging seeker IRCM); countermeasures against laser-guided threats; low-cost, lightweight RF jammers; and multi-spectral sensors integrated into a single package. Some of these capabilities, such as HFI, will be addressed in the near-term due to urgent needs within the operational forces. Others, such as a new RF jammer and laser threat countermeasures, will not begin development for a few more years.

One of the Army's main objectives is ASE suite integration. This will be pursued on many levels – in the sensors,

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in the processors and in the Group A installations. One path entails developing multiple sensor technologies with an eye toward integrating them further down the road. HFI development, for example, will likely require a holistic approach rather than a single sensor technology such as acoustic or IR. One program completed last year by the Army's I2WD is the development of HFI software for the CMWS. This included maturing new HFI algorithms for the AAR-57 and modifying the APR-39A(V)1's cockpit display to show HFI symbology. Another I2WD effort, named Multi-Spectral Threat Warning (MSTW), will look at a single sensor package that integrates data from IR sensors, UV MWS and acoustic sensors. The goal is to further reduce CMWS false alarm rates by 25 percent to 50 percent and use the acoustic sensors to improve the system's HFI capability, especially in the presence of non-tracer rounds. The I2WD also is planning to fund a Threat Warning Receiver (TWR) project from FY10 to FY12 that will investigate the insertion of a single-channel digital receiver into the APR-39A(V). A related project in the same timeframe will develop dual-pole and sinuous antenna sensors for the RWR. These could eventually support what is notionally being called the Next-Gen Digital RWR program. Ultimately, the HFI, MSTW and TWR efforts could feed a future Army program to develop a new ASE aperture that combines RF, IR, UV, laser warning and acoustic sensors in a single package about the size of an existing RWR antenna or MWS sensor. This integrated sensor would simplify logistics and reduce A-kit costs, as well as improve data fusion.

Aside from developing new sensor and countermeasures technology, the DOD's rotary-wing community is looking to get a big boost in self-protection capability from fully integrated ASE suites. Aside from the special operations community, many of the legacy ASE suites in service today are essentially federated. This means that the suite's RWR, MWS and LWS display their information separately on the threat warning indicator. When the helicopter encounters a multispectral threat, such as China's PGZ-95 self-propelled anti-aircraft system, the multiple threat indications can confuse the actual situational awareness picture (by appearing as three different threats instead of one) or delay the helicopter crew's response. An integrated suite can fuse the various ASE sensor inputs to show one multispectral threat, overlay the threat on a digital map and communicate this situational awareness information to other aircraft or to the Aviation Tactical Operations Center via the battle network.

Helicopter users do not want to stop at merely integrating their EW suites, however. They also want a fully open architecture that enables "plug and play" capability – the ability to add and take away components simply by connecting them to the suite. A true open-system architecture would require ASE components to comply with a standard set of interfaces and protocols and would require no additional configuration or technical analysis. Any RWR, MWS, LWS, DIRCM system, RF jammer or dispenser that meets the open architecture standard could be "plugged in" and immediately recognized by the EW suite.

The Navy, for example, is using the JATAS program to establish a new open-system architecture baseline for Navy and

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USMC helicopters. This initially will focus on developing common interfaces and protocols for the IR missile warning, laser warning and DIRCM portions of the suite. The second phase of this effort will be extended to include RWRs, RF jammers and flare dispensers. Future increments could integrate additional HFI sensors or jammers. The idea is to create more flexibility in the system configuration of ASE suites, enable the Navy to buy from a wider range of suppliers (as long as they meet the open architecture standards) and insert new technologies onto the ASE suite with greater ease.

One company that has started to pursue this area is Northrop Grumman. In 2006, it began working on an integrated ASE suite, named the Defensive Electronic Countermeasures System (DECM), for the USMC's CH-53K program. The DECM suite includes the company's APR-39B(V)X RWR (slated to begin flight testing later this year), AAQ-24 DIRCM system (including an MWS/LWS) and the ALE-47 dispenser. This work formed the basis of the company's "Saturn" Processor, an EW management system and digital RWR that also serves as the single processor for LWS and MWS sensors, as well as DIRCM systems and countermeasures dispensers. This would enable an ASE suite to be configured without a dedicated laser warning and missile warning processor unit, DIRCM processor, laser warner and CMDS programmer. In the cockpit, all ASE controls and displays are combined into one relatively small unit, reducing crew workload and creating more room. In FY08, the company began funding the processor unit as an independent research and development (IR&D) project. It is expected to run lab demonstrations later this year.

EUROPEAN ASE

Helicopter ASE also has become something of a front-burner issue for many European nations, especially those whose defense forces are supporting NATO operations in Afghanistan. European EW companies are developing a wide range of EW systems for helicopters, as well as integrated ASE suites.

In Sweden, Saab Avitronics' newest helicopter EW suite is the Compact Integrated Defensive Aids Suite (CIDAS) family, which the company debuted in November 2007. The family consists of two systems, the CIDAS 300 and CIDAS 100. The smaller and more lightweight CIDAS 100 combines Saab's MAW 300 UV missile warner, LWS-310 laser warner, BOP-L series dispenser and EWC100 EW Controller. The CIDAS 300 adds to this package the RWS-300 dual front-end RWR, featuring a compact spiral antenna that covers pulsed emitters in the 0.7- to 40-GHz frequency range and continuous wave (CW) threats in the 0.7- to 18-GHz frequency range. In late 2008, under a contract totaling $24 million, the Indian air force ordered CIDAS systems for 16 of its Dhruv Advanced Light helicopters (ALHs). Follow-on orders are expected.

In the UK, the Ministry of Defence (MOD) has balanced its helicopter ASE investment between IR and RF countermeasures. The most widely deployed EW suite is the Helicopter Integrated

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Defensive Aids System (HIDAS) from Selex Sensors and Airborne Systems in the UK. The HIDAS comprises the company's Sky Guardian 2000 RWR and the 1223 LWS, the AAR-57 MWS from BAE Systems and the Thales Vicon 78 countermeasures dispenser. The system also includes a defensive aids system controller, plus optional directional IR and RF countermeasures. The main platform for HIDAS has been the AH-64 Apache. Besides its use in the UK (on the WAH-64), HIDAS is operational on Apaches in Kuwait and Greece. In September 2005, the UK selected the company's newest HIDAS version, HIDAS 15, for its 70-aircraft Future Lynx helicopter program. Selex also co-manufactures the AAQ-24 DIRCM system with Northrop Grumman. This system has been installed on several US and UK rotary-wing aircraft, such as the MH-53, EH-101, SeaKing, CV-22 and Lynx.

Last year, Boeing awarded a contract to Selex to supply the Aircraft Gateway Processor (AGP) for use in the AH-64 Apache program. The AGP evolved from the ASE suite controller used in the HIDAS and was developed under an 18-month effort. The single line replaceable unit (LRU) processor is being provided as a Group A upgrade that will reduce operator workload and optimize countermeasures. Selex expects the US Army to buy about 150 AGPs for its Block II Apache Longbow helicopters and those operated by international customers.

Bridging the UK and France is Thales, which manufactures a wide range of RF and IR EW systems for helicopters. Its newest product is the Elix-IR "multirole threat warner," which the company introduced last year at the Farnborough Air Show. The single-color IR threat warning system performs HFI and missile warning for helicopter and ground vehicles. Development was started in late 2006 under a technology development program from the UK MOD's Sensors, Avionics and Navigation Systems & Airborne Electronic Warfare Integrated Project Team. Some of the Elix-IR's components have been leveraged from the company's Air Defence Alerting Device (ADAD) and its PIRATE IR Search & Track (IRST) sensor on the Eurofighter Typhoon. France's DGA and Australia's DSTO have awarded Thales a pair of study contracts to investigate the system's application to their respective "SoftKill" AFV DAS and CTD-11 Vehicle Situational Awareness programs.

In France, the company's Airborne Systems division manufactures the Threat Warning Equipment (TWE) for Eurocopter's NH-90 and Tiger helicopter programs. The TWE forms part of an ASE suite for these aircraft that also includes the AAR-60 MWS from EADS and the Saphir-M dispenser from MBDA. The Tiger is being built in three configurations – UHT multi-role fire support for the German Army and HAD multi-role combat and HAP combat support for the French Army. The combined Franco-German requirement covers 240 helicopters, of which 160 have been ordered, with production beginning in 2002. Spain ordered 24 of the Tiger HAD variant, with deliveries ongoing through 2014. As with many of its defense programs, Spain has opted for a domestically manufactured EW suite from Indra SA. Its Tigers will

use the ALR-400 digital RWR, as well as the AAR-60 from EADS.

EADS has been very successful in the helicopter market with its many variations of the AAR-60. In addition to the Tiger and NH-90 programs, the company has been establishing strategic partnerships in markets such as India and South Korea. Last year, EADS opened a technology center in Bangalore, India, where it is working with India's Defence Avionics Research Establishment (DARE) to develop a new version of the AAR-60 for India's helicopter programs. Also underway is the production of AAR-60 systems for 245 utility helicopters ordered in 2007 by the Korean government as part of its Korean Helicopter Program (KHP), which is being conducted in partnership with Eurocopter. For the KHP program, EADS is working with LIG Nex1, a Korean company that manufactures a variety of EW systems for the Korean defense forces.

In Italy, Elettronica has won several programs in the helicopter EW market. Its ALR-733(V)4 ESM system is currently in production for Italy's NATO Frigate Helicopters. The company also supplies the ALR-735(V)3 ESM system for the Italian navy's fleet of AgustaWestland EH-101 Merlin helicopters. Also in Italy, the Italian army flies the A129 Mangusta attack helicopter. Italy presently has 45 A129 Mangusta helicopters and 15 AW129s, which is a combat configuration of the A129, and is not seeking further production. Italy's A129s are fitted with Elettronica's ELT-156 RWR and ELT-544 jammer, the RALM-101 laser warner from BAE Systems Italia, the ALQ-144 IR jammer from BAE Systems IES in Nashua, NH, and chaff and flare dispensers from MES of Italy. In 2002, EADS was selected to provide AAR-60 missile warners as part of a larger upgrade program. Also of note is Turkey's 2007 acquisition of 51 A129s, with an option for 41 more orders, for $3 billion. Turkey's A129s, which it calls T129s, will come in two configurations – the TUC-1 and TUC-2, with orders for 20 TUC-1s and 20 TUC-2s. The helicopters, which will be used by the Turkish army, will be fitted with an EW suite developed and produced by domestic EW manufacturer Aselsan.

ISRAELI SOLUTIONS

For its part, Israel is well-represented in the helicopter EW market through several domestic manufacturers. Elisra, for example, produces the SPS-45(V) and SPS-65(V) self-protection suites. Both suites integrate the company's SPS-20(V) wideband digital RWR for low-band operations and its SRS-25 superhet receiver for CW, high-pulse frequencies. The SPS-65(V) adds the LWS-20 laser warner. A newer version of the LWS-20, called the LWS-20V-3, was announced in 2008.

The company's newest EW suite, suitable for helicopters or fixed-wing aircraft, is the Spectrolite SPS-65(V), which performs all DAS functions from a single LRU. The suite integrates the SPS-20(V) RWR, NBDR-25 narrow-band digital receivers, the LWS-20 and an EW controller. Elisra also manufactures the Passive Approach Warning System (PAWS), an IR missile warning system. It includes an optional upgrade to the Situational Awareness Panoramic IR (SAPIR) configuration, which provides a panoramic view for both day and night missions and improves HFI capabilities. The EW suite also can be upgraded with Elisra's Small-arms fire Warning and Detection (SWAD) technology, which enhances a warfighter's day and night analysis and his ability to combat hostile fire.

Elisra's sister division, Electro-Optics Ltd. (El-Op), makes the Multi-Spectral Infrared Countermeasure (MUSIC) DIRCM system, which has evolved over the past several years from a lamp-based DIRCM to a laser-based system. The company is currently completing development of the MUSIC Fiber Laser DIRCM system, which uses fiber-optic cable to feed energy from a single diode-pumped solid-state laser out to multiple turrets, each housing a rotating mirror assembly that directs the laser energy onto the seeker of the incoming missile. This concept is similar to the US Naval Research Lab's Distributed Aperture IRCM (DAIRCM) program and represents a future path in DIRCM evolution. The 40-kg MUSIC Fiber Laser DIRCM system consists of three units – a laser generator, an electronic unit and the turret. The MUSIC tracks the missile with a high-frame-rate thermal camera. Fiber laser DIRCM systems will significantly lower the size, cost and weight of DIRCM protection because they provide helicopters with full spherical DIRCM coverage from just one laser. In 2007, El-Op and Elettronica announced their joint effort to complete development of the MUSIC system, and initial deliveries to military customers are scheduled to begin this year.

Rafael, also of Israel, is best known in the helicopter EW market for its HeliStar, a joint project with EADS that integrates the AAR-60 MWS with Rafael's JamAIR DIRCM system. First announced in 2004 and scheduled for flight tests later that year, the HeliStar system is designed to counter MANPADS using a lamp-based, rather than a laser-based, jammer. The company has not disclosed JamAIR customers.

MORE SELF-PROTECTION, LESS COST

Looking to the future, helicopters will continue to play a major role in conventional and counter-insurgency operations. The threat environments they face will be dense and diverse. However, the capabilities offered by their ASE suites are improving while manufacturers try to find innovative ways to reduce cost. During the next decade, the net result will be more affordable and (hopefully) widely fielded helicopter self-protection.

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Ground-Bas COMINT

By Glenn Goodman and John Knowles

In the days and weeks following the September 11 attacks, the US military leadership shifted much of its operational planning focus away from peer competitors like China and Russia and began to consider how to defeat its newest adversary – Al Qaeda. The Department of Defense (DOD) recognized that what was to become the Global War on Terror (GWOT) would depend on intelligence to a greater degree than any previous conflict. Finding targets that rarely used communications (and when they did communicate, it was usually hidden among commercial traffic) would be a challenge, to say the least.

US forces were not very well-equipped to monitor (or jam) commercial communications devices, primarily because previous adversaries had never made extensive use of them. The types of communications intelligence (COMINT) technology required to perform surveillance of commercial devices largely had been the responsibility of the National Security Agency. (Other armed forces, such as those of the UK, France and Israel, were somewhat better equipped to monitor commercial communications devices.) What followed over the next several years was a major re-tooling of US tactical COMINT capabilities.

The new requirements were challenging. COMINT systems would need to cover more frequencies to track 3G and 4G mobile phones (well above 2 GHz), as well as monitor low-power, push-to-talk (walkie-talkie) communications that could drive receiver requirements down to the 25-MHz region. This trend also demanded that COMINT systems cover a wide variety of commercial waveforms. In addition, selected targets of interest would need to be found from within a vast ocean of commercial communications. With inexpensive cell phones widely available, targets could change devices easily and frequently. This drove requirements for voice recognition and automated language translation capabilities.

Since 2001, signals intelligence (SIGINT) system manufacturers have responded to these challenges by developing a new

generation of software-defined radio (SDR)-based COMINT systems that cover a wide range of communications frequencies, perform automated searches, process more collected information and use advanced software algorithms to detect and identify targets of interest. Additionally, analysis software also has kept abreast of these developments in the form of improved language translation programs and voice recognition algorithms. At the same time, COMINT manufacturers also have managed to stay abreast of developments in the military communications arena. Today's COMINT systems monitor military radios that use advanced low-probability of detection (LPD) and low-probability of intercept (LPI) techniques. And networked COMINT systems, featuring time difference of arrival and frequency difference of arrival techniques, are enabling commanders to detect and locate emitters in just about any place, from dense signal environments in urban locations to areas that cover hundreds of square miles.

US ARMY: PROPHET

No program exemplifies the difficulties of staying on top of a rapidly evolving signal environment like the US Army's Prophet program, its principal ground-based tactical COMINT system. The vehicle-mounted electronic support (ES) sensor

ed Steps Up

provides force protection and intelligence information to brigade combat teams and armored cavalry regiments. According to an Army FY09 budget document, "Prophet stationary and on-the-move direction-finding (DF) information develops battlefield visualization, intelligence preparation of the battlefield and target development for enemy and gray emitters within radio line of sight across the brigade area of responsibility. This near-real-time information, when processed, provides a key component of the fused intelligence Common Operating Picture."

Since its inception in the late 1990s, the Prophet acquisition strategy has been based on a spiral acquisition concept, in which the Army first procured a "baseline" SIGINT capability (the AN/PRD-13(V)2 intercept and DF system from L-3 Linkabit) that could be mounted in a vehicle or used as a man-pack collection system. Upgrades, such as adding an electronic attack (EA) capability and upgrading the COMINT system to handle advanced communications systems, would be incrementally inserted. This approach enabled the Army to rapidly procure 83 Prophet Block 1 COMINT systems under a 2001 contract to L-3 Linkabit (San Diego, CA). The first systems were delivered in 2002, and the Block 1 system has played a vital role in Afghanistan and Iraq.

During the 2003 invasion of Iraq, the Block 1 system was well-suited to detecting, locating and monitoring the military communications systems used by the Iraqi army. As the Iraqi army melted away and the US forces transitioned to a "stability and support" mission in the late spring of 2003, the US Army determined that it needed to enhance the COMINT capabilities to handle a wider set of signals that included cell phones and other commercially available wireless communications systems used by Iraqi insurgents. The result was Prophet Spiral 1. The Army ordered 126 Humvee-mounted Prophet Spiral 1 ES systems from L-3 Linkabit and deliveries began in 2007. The Spiral 1 systems still used Linkabit's PRD-13(V)2 system, but they incorporated new capabilities to handle commercial communications signals. The Army also purchased 22 trailer-mounted Prophet EA jamming variants, built by General Dynamics C4 Systems (Scottsdale, AZ) and fitted with the USQ-146 communications jammer from Rockwell Collins (Cedar Rapids, IA).

Last year, at the request of its intelligence user community at Fort Huachuca, AZ, the service curtailed further orders of Prophet Spiral 1 and Prophet EA systems and initiated a fast-tracked competition for a new and improved Prophet Enhanced (PE) ES sensor system with an open architecture that would offer greater flexibility to keep pace with evolving threats. In February, General Dynamics won the PE competition. Its principal subcontractors are L-3 Linkabit and Northrop Grumman.

PE involves a retrofit of the existing Prophet Spiral 1 ES system in the form of an A-kit (installation kit with mounting hardware, cables, etc.) and a B-kit (sensors, antennas and associated hardware and software) for the M1165 up-armored Humvee, as well as the Cougar 6x6 Mine-Resistant Ambush-Protected (MRAP) armored vehicle. In addition, the B-kit will be removable to provide a dismounted capability. A PE capability beyond the baseline system that is desired by the Army is an EA subsystem integrated on the Humvee or Cougar PE vehicle itself instead of being trailer-mounted.

PE's open-system architecture will allow timely upgrades through the incorporation of new software applications – rather than by adding new hardware – to keep pace with the changing signals of interest resulting from the rapidly evolving communications products commercially available today.

General Dynamics will deliver the first PE kits later this year for rapid deployment to Iraq and Afghanistan. Other PE systems are being more thoroughly tested, leading to a First Unit Equipped milestone late this year or early next year.

USMC: SIGINT SUPPORT FOR THE MEU

The US Marine Corps' ground-based SIGINT/EA operations are conducted by three Radio Battalions (RadBns), each of which is part of a Marine Expeditionary Unit (MEU). The RadBns use a combination of vehicle-mounted SIGINT/EA systems and

dismounted SIGINT equipment to conduct their missions. Some RadBn units also support Marine Corps special operations missions.

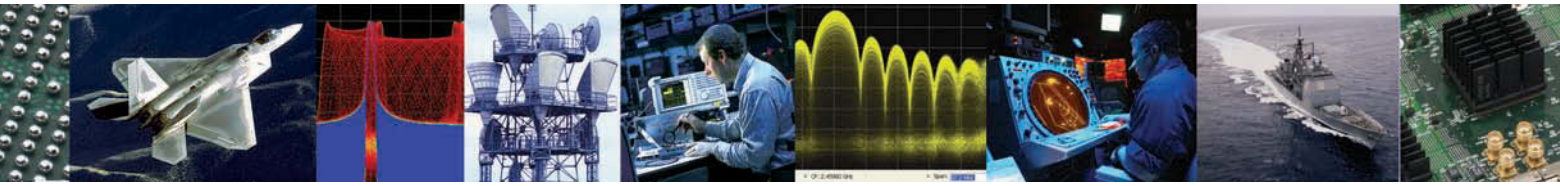
The RadBns are equipped by the Program Manager for Intelligence Systems (PM INTEL), which is under Product Group 12 Communications, Intelligence and Networking Systems (CINS) at Marine Corps Systems Command (Quantico, VA). PM INTEL manages four major SIGINT programs, with an emphasis on hardware commonality. This minimizes equipment training for the RadBn teams and simplifies logistics, especially during deployments.

PM INTEL's two man-portable SIGINT programs are the Radio Reconnaissance Equipment Program (RREP) and the Team Portable Collection System (TPCS). The RREP is a family of SIGINT/EA systems that are used by the RadBns' Radio Reconnaissance Platoons in support of Force Reconnaissance, early insertion and special operations units. The RREP has been developed in successive generations of suites dating back to the 1990s. The current iteration, SIGINT Suite 3 (SS-3), represents the fourth generation of RREP equipment. The Marines operate about 30 RREP SS-3 units, which is the first generation to incorporate communications EA capabilities. Development of SIGINT Suite 4 is currently under way, with an eye toward replacing SS-3 beginning in the FY11 timeframe, according to USMC documents.

The TPCS-Multi-Platform Compatible (TPCS-MPC) is a modular SIGINT system that performs intercept and location of enemy communications emitters. Users can operate it independently or as part of a larger SIGINT network in coordination with a Technical Control Analysis Center, which performs SIGINT/electronic warfare (EW) fusion from multiple sources. The "MPC" descriptor means that it can be installed on a vehicle, such as the Mobile EW Support System (MEWSS) or a High-Mobility Multipurpose Wheeled Vehicle (HMMWV), or it can be operated in a dismounted, stationary configuration. It also can be operated from boats or aircraft. All three RadBns use the TPCS-MPC, and the Marines plan to buy up to 63 systems in the Block 0 configuration. Its replacement, TPCS-MPC-Block 1, is slated to reach the field in the FY10-FY11 timeframe.

The USMC's two vehicle programs are the MEWSS and the Communication Emitter Sensing and Attacking System (CESAS). MEWSS is a light armored vehicle (LAV) that performs on-the-move collection, DF and exploitation of enemy signals. It achieved initial operational capability (IOC) in the early 1990s, and the Marines have regularly performed major and minor upgrades to its SIGINT and EA systems to keep up with the evolving signals environment. The Marines operate 12 MEWSS vehicles, and the latest version is the MEWSS(B), which is slated to reach full operational capability this year. The MEWSS(B) Increment 1 vehicle will incorporate the TPCS-MPC as its SIGINT system. The follow-on Increment 2 phase of the program will integrate the same EA suite as the CESAS.

Even as the MEWSS was entering service in the 1990s, the Marines knew they needed more than 12 vehicle-mounted communications jammers. The Marines'



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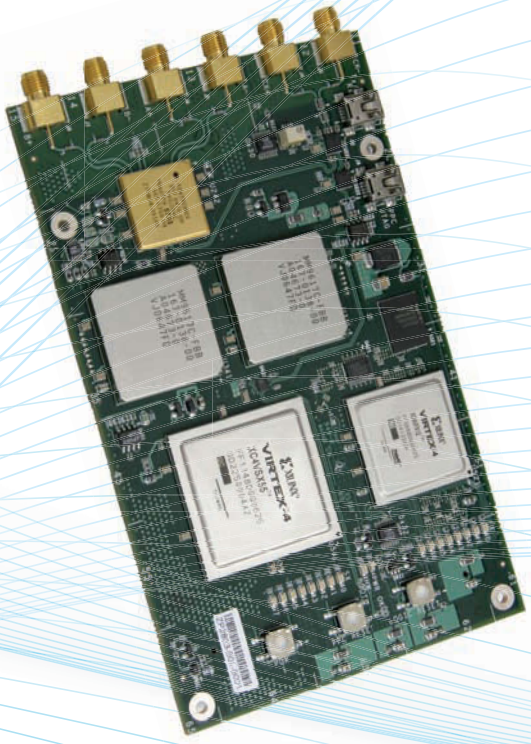

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other ground-based jammer, the ULQ-19, which covered a very limited frequency range, also was nearing the end of its service life. With the beginning of operations in Afghanistan in 2001, the need for additional ground-based jammers became critical and the Marines stepped up plans to buy the AN/ULQ-30 CESAS. The CESAS provides DF and COMINT coverage from 20 MHz to 2,500 MHz. It also uses the USQ-146 jammer to deny communications in the same frequency range. The CESAS is expected to achieve IOC this year. Marines plan to buy a total of 29 CESAS vehicles.

EUROPEAN SYSTEMS

In Europe, SIGINT requirements are equally demanding, especially since many nations are supporting NATO operations in Afghanistan. The UK is modernizing its ground-based SIGINT capabilities under the Soothsayer program, which fielded its first systems in 2006. The system can be fitted on armored as well as light-wheeled vehicles and is being used by units such as the 14 Signals Regiment of the British Army and Y Squadron, 3 Commando, of the Royal Marines. Unlike Prophet, which only performs COMINT collection, Soothsayer features COMINT and electronics intelligence (ELINT) (to detect battlefield radars) capabilities.

Lockheed Martin Systems Integration (Owego, NY) won the prime contract to supply the system in 2003. Soothsayer's core technology was developed under a UK Ministry of Defence (MOD) in-house research program by QinetiQ of the UK.

According to a Lockheed Martin press release, "Soothsayer will intercept and monitor many types of enemy communications or signals in real-time, including radar, multi-frequency emissions and other electronic data. Soothsayer will be supplied in hard- and soft-skin versions; both will be rapidly deployable, enabling expeditionary forces to gain rapid benefit from this new capability."

In 2004, Lockheed Martin UK Integrated Systems (Havant) awarded INSYS (Ampthill, UK) a platform integration contract for Soothsayer. In addition to full vehicle integration and shelter design, INSYS has provided a system integration facility and is the key contractor involved in transitioning US technology into the UK, particularly from Argon ST. Argon has coupled capabilities from its own Lighthouse product line with EW capabilities developed by QinetiQ to meet Soothsayer requirements. Lockheed Martin's other major subcontractors are Austin Information Systems (Austin, TX), LogicaCMG (Leatherhead), Detica (Guildford) and QinetiQ.

A portable COMINT/DF system in service with the British army and Royal Marines since 2003 is called Scarus, which is based on the Light Emitter Acquisition, Recording and Analysis System (LEARAS) produced by Synectics Systems Group (Sheffield, UK). The Scarus system is carried by between four and six soldiers. It performs on-the-move signal intercept and static automated DF and signal intercept. Scarus was designed to provide an early-entry capability for the Army's 16 (Air Assault) Brigade and 3 Commando Brigade of the Royal Marines. Its users have been elements of the 14 Signal

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Regiment supporting 16 (AA) Brigade and Radio Reconnaissance Teams from Y Squadron of 3 Commando Brigade, which deployed the system to Iraq.

LEARAS is configured around an Operator Control and DF unit, which provides the hardware interface between the operator, the receiver and the DF system. LEARAS includes a fast acquisition "staring" spectrum display capability. This uses state-of-the-art analog-to-digital converters and, combined with digital signal processing techniques, allows short-duration, frequency-agile communications to be identified. Known as the Wideband Acquisition and Spectrum Processor (WASP) in this configuration, it is able to identify the presence and frequency of signals with a duration of less than 2 milliseconds. It allows the operator to identify frequencies or signals of interest and hand them off to the DF receiver. The signals can be further handed off to an independent monitor receiver. This receiver is used for long-term monitoring, releasing the WASP and DF system for further acquisition and analysis tasks.

LEARAS uses commercial off-the-shelf (COTS) hardware and flexible software. A vehicle-mounted version of LEARAS is called FEARAS, which features roof-mounted antennas and masts.

In France, the French defense procurement agency DGA awarded Thales Land & Joint Systems (Colombes, France) a contract in 2004 to supply eight Station d'Appui Electronique de Contact or SAEC (Tactical Electronic Support Station) vehicles for the French army. Deliveries began in March 2008. The SAEC stations integrate COMINT, as well as ELINT sensors, on a VAB armored vehicle. They are operated by the 54th Regiment de Transmission based in Mutzig, France. The system can be used on the move or halted when an integral hydraulic mast is elevated from a horizontal position.

In May 2008, Thales introduced a new family of COMINT and EA equipment called "Q," with the set of solutions for army tactical users called Land Q. Mission packages rely on the same core equipment capabilities for interception, analysis, DF and command-and-control warfare or force protection, which can be tailored to meet specific needs. Among the range of Q systems is the TRC 6200 tactical wideband direction-finder, a compact (maximum 15 kg) digital COMINT/electronic support measures (ESM) system covering the 20-MHz to 3-GHz band with high 1-degree DF accuracy. An inflatable Nomad antenna makes it possible to use a reasonably large antenna, which still can be stored in a limited space.

Germany has a long history in developing and manufacturing military COMINT/DF equipment. Rohde & Schwarz (Munich) offers wideband and narrowband COMINT systems for automatic and manual interception, monitoring and analysis of radio communications. The company's RAMON family of COMINT systems uses standardized modular hardware and software components to enable a system to be tailored to meet a military customer's requirements. Tactical configurations include small portable single-operator and vehicle-mounted mobile applications. Rohde & Schwarz says its RAMON systems already have been successfully

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integrated in a wide variety of tactical platforms, including armored and non-armored land vehicles and shelters. The company's R&S ESMB receiver features digital signal processing and operates in the HF, VHF and UHF bands.

PLATH (Hamburg) is currently offering the Automatic COMINT System (ACOS), which operates in the HF band and features full automation of signals collection. According to a company release, "Since more and more digital RF communication methods are being used, individual emissions can no longer be identified by content or call signs. In ACOS, the individual emitters are therefore described by technical parameters. If modulation and decoding techniques are known, the individual emission will be analyzed down to the message content. DFP 5400 broadband direction-finders are used at the individual DF sites." The company's DFP 2400 broadband direction-finder covers the VHF and UHF frequency bands.

IZT's (Erlangen) R3000 family of wideband digital receivers provides an automated signal detection sensor for direction finders, signal recording and COMINT systems. IZT's R3240 model offers the same performance as the IZT R3000 across the HF, VHF and UHF bands in a compact, 19-inch, rack-mounted design.

MEDAV's (Uttenreuth) CRS-8000 Communication Reconnaissance System is designed for tactical surveillance, early warning and COMINT. It integrates wideband interception, DF and signal processing and analysis across the HF, VHF and UHF bands. In a tactical ESM role, the system is optimized to provide automated acquisition and analysis of signals, with the added functionality of selected COMINT functions. In the COMINT role, additional information can be extracted from the intercepted signals. The COMINT processor runs software modules for DF, segmentation, classification, demodulation, decoding and recording.

ISRAELI SYSTEMS

Israel Aerospace Industries' ELTA Systems (Ashdod, Israel) offers its EL/K-7036 family of ground-based, wideband, COMINT/DF systems to monitor and intercept VHF and UHF radio emissions within a dense communication environment. The EL/K-7036 can handle short (burst) transmissions and frequency-hopping signals. The company says it features advanced screening algorithms that focus system resources on high-priority signals, reducing operator workload, and a modular open architecture with growth potential. ELTA's similar EL/K-7038 family covers the HF band.

Tadiran Electronic Systems (Holon, Israel), a subsidiary of Elisra, offers its TDF 1200 multi-channel DF system for the VHF and UHF bands. It features high scanning rates and, like ELTA's EL/K-7036, can handle short-duration and frequency-hopping communications and dense signal environments. Both systems are housed in a shelter on the back of a tactical wheeled vehicle, with a high mast-mounted antenna array. The TDF 1200 can be operated either as a standalone system for automated direction-of-arrival measurement or as part of a larger DF network for emitter location. It features a large selection of displays for presenting measured and highly detailed results, including graphic map displays and simultaneous displays of various categories.

Tadiran's MP-DF 100 is a lightweight, man-pack COMINT/DF system. It covers the VHF and UHF bands, performing wide-spectrum scanning, and uses a tall tripod-mounted antenna carried in a backpack. It features a small palmtop computer, and its receiver-processor and battery pack are carried in a specially designed vest. The MP-DF 100 also can be used in a handheld mode in which the operator, holding a 90-degree antenna, advances in a nearby emitter's general direction and aims the antenna to locate it.

SOUTH AFRICA

Grintek Ewation (Pretoria), a joint venture between the Grintek Group (Pretoria) and EADS Defense and Security (Munich, Germany), has produced many COMINT/DF systems installed in both soft-skin and hard-skin vehicles and sold around the world. The company integrates its various products, such as its wideband COMINT and DF receivers and narrowband receivers, as building blocks for different customer system configurations operating across the HF, VHF and UHF bands. Two of these products are the MRR8000 Direct Sampling Wideband Receiver and Analysis system and the MRWA8000 Wideband Offline Analyzer, which processes files recorded on the MRR8000. Grintek's Sigma 5000 COMINT/DF system has been housed in a Mine-Resistant Ambush-Protected (MRAP) armored wheeled vehicle with a mast-mounted DF antenna. The self-contained system provides workstations for two operators. A DF/search operator performs wideband spectrum surveillance and wideband DF; a monitoring operator performs narrowband, fixed-frequency monitoring and digital demodulation.

Grintek Ewation, along with EADS of Germany and Spain's Indra, makes up the MRCM alliance of companies, which pooled their resources and marketing efforts in the COMINT and communications EA domains. MRCM offers a family of signal identification (MRSI) products, which form the core elements that are combined with the alliance members' wideband DF and receiver systems to provide communications ESM/COMINT system solutions. The MRSI products provide rapid automated search and detection, as well as automated modulation recognition and signal parameter estimation. The latter capability speeds up the process of technical signal analysis, MRCM says, and significantly improves the identification of signals of interest. The MRSI core products include the MRSI 5000 processing unit, which coordinates all DF, narrowband and wideband receivers and automatically generates active signal reports and performs signal identification and signal collection.

THE GROWING COMINT MARKET

There are hundreds of companies serving the global COMINT market as hardware providers, software application developers and system integrators. This article only provides a sampling of the programs and activity in this area. With the commercial telecommunications market constantly introducing new standards and technologies and showing few signs of slowing down, the COMINT mission is sure to evolve and adapt to new challenges in the coming years.

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UK Chapter

By Marianne Kunkel

It is fitting that the AOC's UK Chapter is headquartered in London. What people worldwide know and admire about London – its rich history, its distinct culture and its impressive size – also are the traits that the UK Chapter is best-known for. The 480-member-strong chapter, begun more than 30 years ago in 1972, represents a group of past and present electronic warfare (EW) specialists from military, industry and academic fields throughout the United Kingdom. In this month's AOC chapter profile, JED *shines a spotlight on northwestern Europe, highlighting the achievements and innovation of the UK Chapter's EW community.*

"I see the mission of the UK Chapter at this time as being to carry a torch for EW," said John Clifford in a speech he gave in February when he became chapter president. A former wing commander in the Royal Air Force (RAF), Clifford's goal is to lead with the same sense of gumption that first inspired the chapter's birth. His plans to draw more public attention to EW and recruit a more diverse membership go hand in hand; with a greater number of military and younger members, the chapter will be better able to catch the interest of influential people and publicize EW.

Clearly stated on the UK Chapter's website (www.ukaoc.org) is a summary of the future EW market – over the next 10 years, as much as $27.8 billion will be funneled into developing and producing major EW systems. This is a number that the chapter takes seriously. In 2009 alone, it has scheduled chapter visits to five EW houses, including Chemring Countermeasures, Selex Galileo's EW support facility in Lincoln and BAE Systems' UK division in Warton. The chapter plans these classified and unclassified visits every year to stay up-to-date on future EW technology.

Also on this year's UK Chapter calendar is the AOC/Shephard EW 2009 Conference & Exhibition, held May 14-15 at the Novotel Hotel in West London. Last year's event in Interlaken, Switzerland, drew more than 450 attendees and 38 exhibitors. This year, with a dynamic list of UK military and industry officials slated to speak at the event – including Air Chief Marshal Sir Christopher Moran, Commander-in-Chief of RAF Air Command – the UK Chapter hopes to see even more local, national and international attendees. Said David Kitching, executive director of the chapter, about the event, "We look forward to welcoming our American cousins and showing them the international side of the AOC."

A long-standing tradition of the UK Chapter is its annual meeting, held at the start of every year. Here, the chapter mixes business and fun, combining the inauguration of a new chapter president and staff with an EW presentation from a guest speaker. At this year's meeting February 5, chapter members heard from RAF Squadron Leader Richard Birchenall, who shared with the group his Defence Academy Military Electronic Systems Engineering (MESE) course thesis about the reverse engineering of Man-Portable Air Defense Systems (MANPADS). Birchenall received the Defence Academy's "Best EW Thesis" award for his research.

The UK Chapter gives out awards as well. In an effort to reach the full UK armed services EW community, it distributes a total of seven monetary awards annually. These awards go to best students in the Royal Navy Petty Officer (EW) Professional Qualifying Course and the Defence Academy's MESE course, to the best personal thesis on the RAF Aerosystems Course at the RAF College Cranwell, and the chapter gives out an EW Operational Award for units deployed on the front lines, plus a Royal Navy Fleet EW Effectiveness trophy and a biennial RAF Smallwood Trophy. New last year was a "Most Improved Student" award for the Basic Communications Exploitation Course (BCEC) at the Defence Intelligence and Security Centre (DISC).

The chapter's appreciation of its role in the larger community is reflected through its charitable giving to museums. It has long been a supporter of Bletchley Park, hailed as the birthplace of the computer, and the City of Norwich Aviation Museum (CNAM), which both struggle for adequate funding.

A chapter that covers so much territory could be considered too far-reaching, but the UK Chapter manages to maintain, and even strengthen, its EW campaign every day. For these chapter members, nothing comes more naturally than carrying a torch for EW.

Communications EW – Part 24

Jamming LPI Signals

In the next few columns, we will discuss techniques for jamming low-probability-of-intercept (LPI) communications. LPI signals were discussed in the May 1998 through July 1998 "EW 101" columns. Other related columns that you might find profitable to review are the October 2007 EW 101 and November 2007 EW 101 columns on digital communication, and the April 2008 EW 101 through October 2008 EW 101 columns on the location of communications emitters.

LPI COMMUNICATION SIGNALS

Signals associated with LPI communications have special modulations designed to make them difficult for normal types of receivers to detect. Ideally, a hostile receiver will not even be able to determine that such a signal is present. This is accomplished by spreading the frequency range over the LPI signal that is broadcast. Thus, the signals also are called spread-spectrum signals. As shown in **Figure 1**, a special second modulation is applied to this type of signal to spread its spectrum. Three types of spreading modulations are used:

- **Frequency hopping**, in which the transmitter periodically hops to a pseudo-randomly selected frequency. The hopping range is much greater than the bandwidth of the signal carrying the information being communicated (i.e., the information bandwidth).
- **Chirp**, in which the transmitter is rapidly tuned across a frequency range that is significantly wider than the information bandwidth.
- **Direct Sequence Spread Spectrum**, in which the signal is digitized at a rate much higher than required to carry the information, thereby spreading the energy of the signal across a wide bandwidth.

There also are LPI signals in which more than one of the above spreading techniques is employed.

The spreading demodulator (in the receiver) shown in **Figure 1** must be synchronized with the spreading modulator (in the transmitter) to reverse the spreading modulation (see **Figure 2**). This returns the signal to the same bandwidth that it had before spreading. We call this the information bandwidth. The synchronization requires that both the modulator and demodulator be controlled by the same pseudo-random function, based on a digital code sequence. In addition, the code in the receiver must be in phase with the transmitter code. This requires a synchronization procedure at system start-up, and also at any time the receiver or transmitter has been out of communication for an extended time. Except for the synchronization requirements, the spreading/despreading process is transparent to the people or computers passing information from the transmitting location to the receiving location. In some circumstances, synchronization requires a delay before transmission can begin.

We will discuss each of the frequency spreading techniques in separate columns that also describe the techniques used to jam them. Note that we will have a later series of columns discussing the generation and uses of codes.

PROCESSING GAIN

Removing the spreading modulation from an LPI signal is said to create a processing gain. This refers to the fact that the spread signal has a very low signal-to-noise ratio when received by a normal receiver. After despreading, the received signal has a significantly higher signal-to-noise ratio. However,

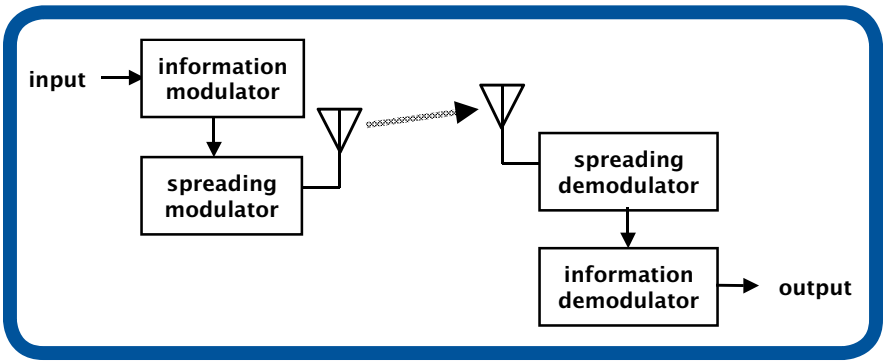

Figure 1: LPI communication systems add special frequency spreading modulations for transmission security.

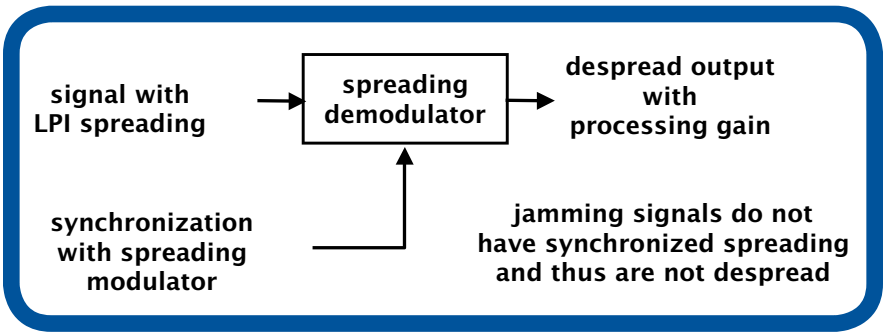

Figure 2: Synchronization with the spreading modulator allows the spreading modulation to be removed from the intended received signal but not from jamming signals.

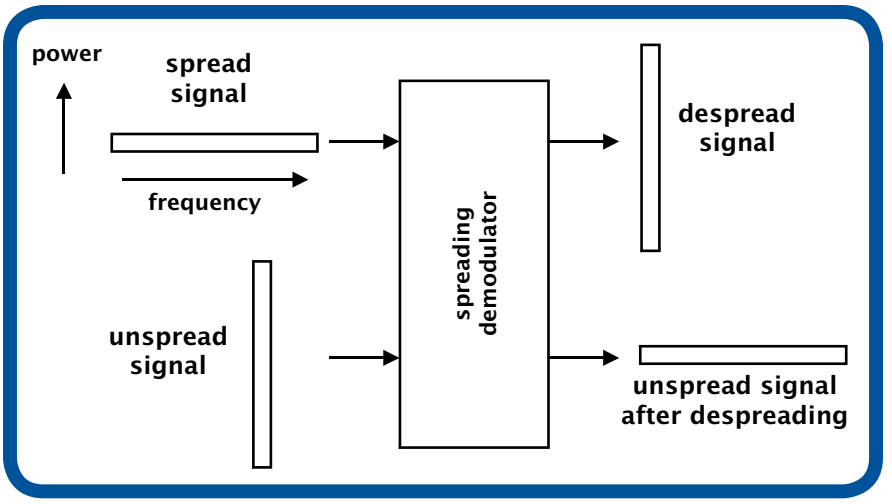

Figure 3: The spreading demodulator compresses the matching LPI signal into its information bandwidth. It also spreads a narrowband signal.

signals that do not have precisely the correct spreading modulation will not be despread and thus are not subject to the processing gain. Further, the spreading demodulator actually will spread a narrowband signal, reducing its signal strength in the output channel as shown in **Figure 3**.

ANTI-JAM ADVANTAGE

Figure 4 shows the anti-jam advantage for an LPI communication system. The anti-jam advantage is the amount of signal power that must be received at an LPI system receiver location to provide the same jamming-to-signal ratio (J/S) that would be achieved if the entire jamming signal power were within the bandwidth of a non-spread system receiver. This is the ratio between the information bandwidth and the transmission bandwidth of the LPI signal. This assumes that the jamming signal is spread across the whole spread spectrum frequency range of the LPI signal. As we will see, there are sophisticated jamming techniques that partially overcome this advantage in some cases.

LPI SIGNALS MUST BE DIGITAL

As you will see in the following columns, each of the spectrum spreading techniques requires that the input signals be in digital form. Digitizing allows the signal to be time-compressed and broadcast between transmission gaps required in some spreading schemes. It also can be required by the nature of the modulation approach. Because the requirement is specific to the spreading technique used, this matter will be discussed in the applicable following columns.

The implication is that successful jamming of a spread spectrum signal requires only 0 dB J/S and that it may require significantly less than 100 percent duty cycle. Jamming of digital signals is effective in that it causes bit errors. The bit error rate is the number of incorrectly received bits divided by the total number of bits received. As shown in **Figure 5**, the bit error rate can never be greater than 50 percent, regardless of the J/S. At 0 dB J/S, the bit error rate almost is 50 percent. Increasing the jamming power above this point causes very few additional errors. A widely honored, experience-based assumption is that when the bit error rate is at least 33 percent over a few milliseconds, no information can be recovered from the jammed signal (some authors place this as low as 20 percent).

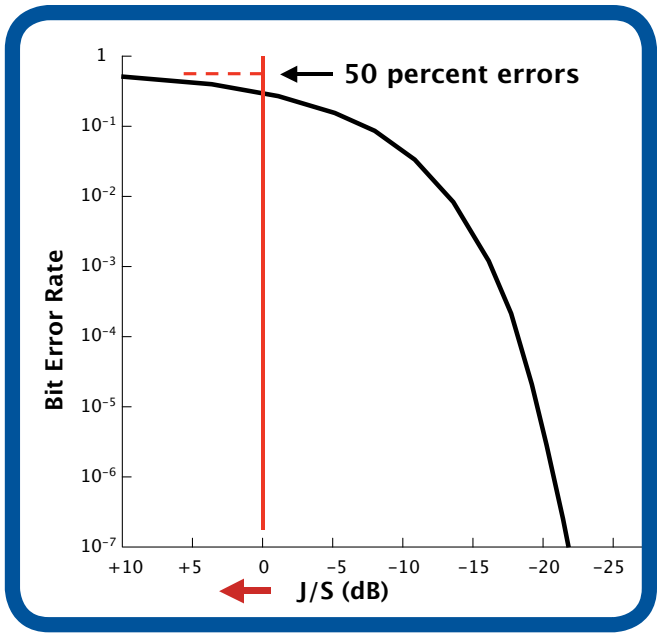

Figure 5: The bit error rate in a digital signal receiver cannot exceed 50 percent. 0 dB J/S causes close to this level of errors.

As you will see in the following columns, the digital nature of LPI signals allows some clever jamming techniques to be employed.

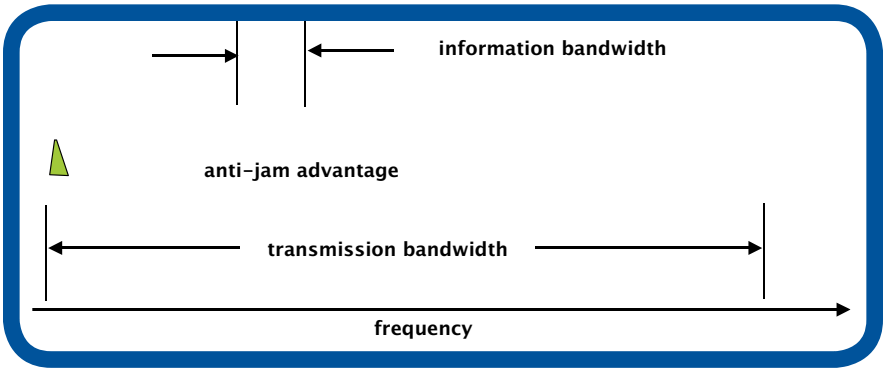

Figure 4: The anti-jam advantage of LPI communication is the ratio of the transmission bandwidth to the information bandwidth.

WHAT'S NEXT

Next month, we will cover jamming of frequency hoppers. For your comments and suggestions, Dave Adamy can be reached at dave@lynxpub.com.

AOC REMEMBERS KITTYHAWK CROW

Joseph Scott Conway passed away February 24 in Kettering, OH, at age 83. An AOC member since 1969, Joe was well-known for his enthusiastic participation in the Kittyhawk Chapter, based in Dayton. He was a faithful attendee of the chapter's annual Scholarship Outing Committee, its Awards Committee and its Program Committee.

Joe graduated from DePaul Academy in 1941. His interest in defense electronics was encouraged by his assignment as a radio operator for the US Navy during World War II. Following his service, he was hired by IITRI in Chicago, IL, and then relocated to Dayton in the 1960s. Over his lifetime, Joe worked at Litton Applied Technology Division (ATD) and the Mercer Engineering Research Center (MERC) as well. He was an avid golfer and enjoyed vacations with his family.

Joe is survived by his wife of 53 years, Mary; his sister; his two sons and three daughters; as well as 11 grandchildren. Donations in his name can be made to the Mercy Home for Boys & Girls, 1140 W. Jackson Blvd., Chicago, IL 60607, www.mercyhome.org.

DEFENSE ENGINEERING PRESIDENT VISITS CHESAPEAKE BAY ROOST

The AOC's Chesapeake Bay Roost hosted Dr. Mike Pacsale, president of Engenium Technologies Corp. (ETC), as the guest speaker for its March luncheon. ETC, headquartered in Columbia, MD, is an electrical and computer engineering design firm serving Department of Defense (DOD) and intelligence customers.

For his presentation, Dr. Pascale spoke to the Roost members about Doppler-based geolocation from space and the French Argos satellite system. He gave an overview of several Doppler-based geolocation techniques and provided examples of the types of performance that are achieved from space systems such as the French Argos system.

The Chesapeake Bay Roost holds luncheons on the third Thursday of every month from September to May at the National Electronics Museum in Linthicum, MD. To learn more about the Roost and all of its activities, contact Roost President John Hawkins at hawkinsje@comcast.net.

Pictured above, left to right, are Dr. Mike Pascale, president of the Engenium Technologies Corporation (ETC), and Charles Senft, the acting luncheon chairman.

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