August 2009
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The AOC Electronic Warfare Publication
www.crows.org

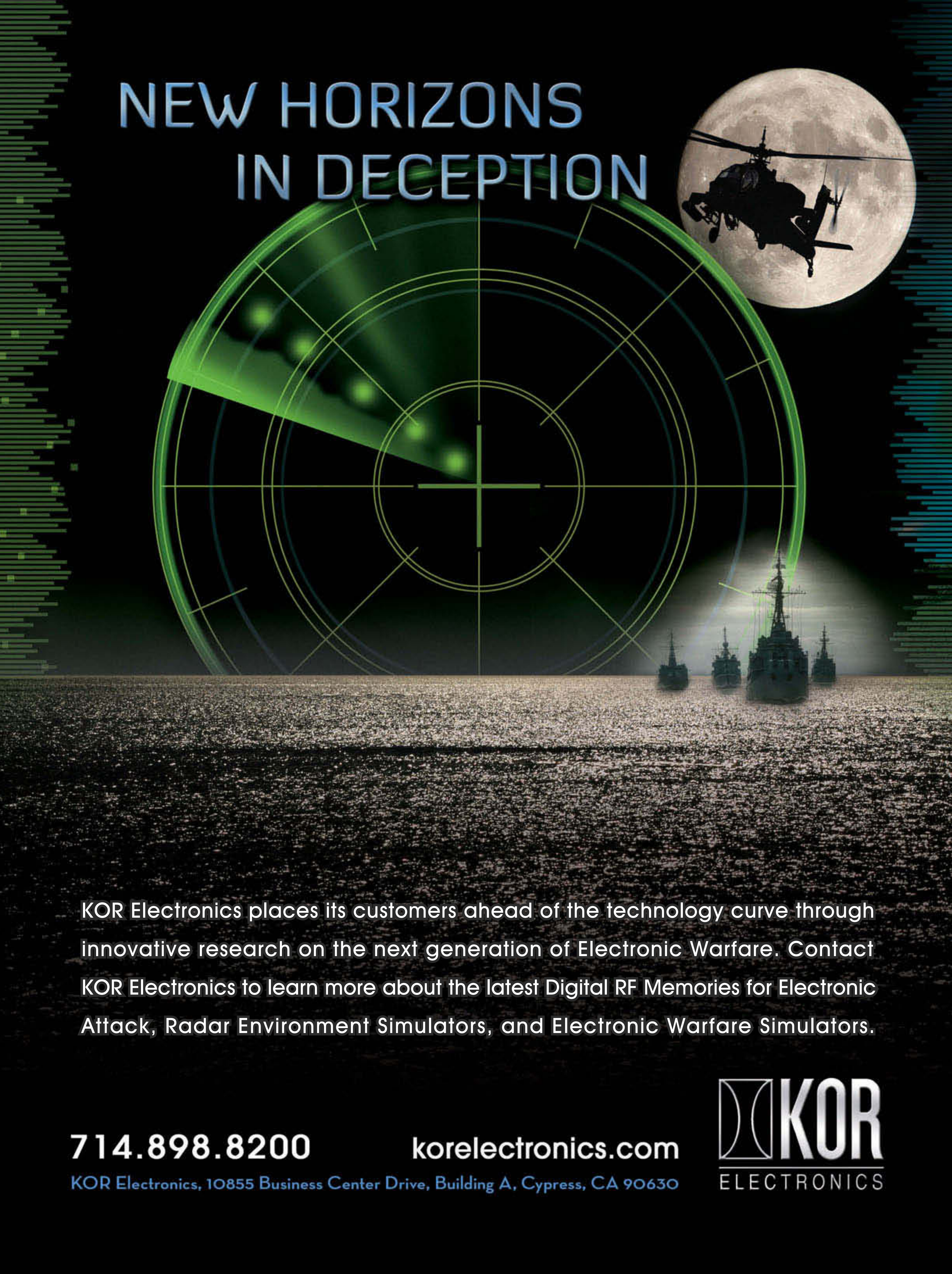
JED
The Journal of Electronic Defense

THE TOP 20 EW PROGRAMS

Also in this issue:

Interview: Roy Azevedo

Technology Survey: SIGINT Antennas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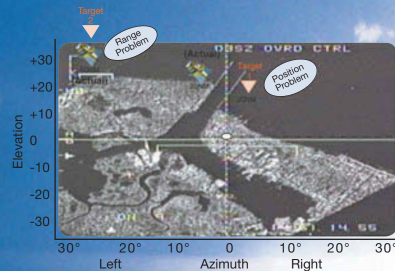
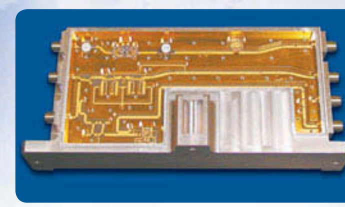


Target 1: Azimuth and/or elevation position error

Target 2: Not detected but actually within radar range



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the view from here

BUILDING THE EW-CYBER RELATIONSHIP

The Obama administration has done a good job of focusing the government's attention on cyber policy in all of its aspects, both civilian and military. This is very welcome news and long overdue, considering that the DOD has been earnestly building a cyber-dependent network-centric fighting force for more than 15 years.

Within the DOD, cyberspace is finally being recognized as an important warfighting domain – a domain that is based on information technology infrastructures. Just like the other four warfighting domains – air, land, sea and space – cyber relies on EW in order to achieve control of and enjoy free access to the electromagnetic spectrum. In short, EW supports cyber. That is the essence of the relationship between cyber and EW, and that relationship must be developed.

In fact, the EW-cyber relationship is being developed every day at the operational level. The problem has been at the policy level. A few years ago, the Air Force put forward the idea that EW was part of cyber. (That's a very different notion from the concept that EW supports cyber.) While the senior leadership of the Air Force, the OSD and the Joint Staff ultimately rejected the idea that EW was part of cyber, it has managed to generate a lot of residual effects. The Air Force did such a good job with its original cyber public relations campaign that there are still a lot of defense officials out there who think EW *is* part of cyber or *should be* part of cyber.

EW is very different from cyber, from the perspective of training, equipping and fighting. You don't want cyber warriors trying to quarterback the battle against IEDs in Iraq, because it would be a serious (and fatal) misapplication of skills and equipment. For the same reason, you don't want an EWO protecting your information networks from a cyber attack. Once senior defense leaders recognize the fundamental differences between EW and cyber, it will become obvious that controlling the electromagnetic spectrum via EW is a very different concept from controlling the information domain via cyber. There are parallels between EW and cyber, but they are clearly not the same thing.

While it is frustrating to watch the "EW is part of cyber" debate resurface again and again in the DOD, I think this exercise will serve a useful purpose in the end. Each time the EW community has to explain to senior leaders why this thinking is wrong, it lays the intellectual foundation for those leaders to ultimately recognize that the electromagnetic environment is a warfighting domain alongside air, land, sea, space and cyberspace. This is good for EW because electronic protect, electronic warfare support and electronic attack are the basis of spectrum control.

For the moment, I think the DOD is too busy manning and organizing its cyber infrastructure to recognize the electromagnetic environment as a warfighting domain and to organize its EW infrastructure accordingly. However, this recognition will come in time, and the EW community needs to be ready to seize that opportunity when it arrives.

– John Knowles

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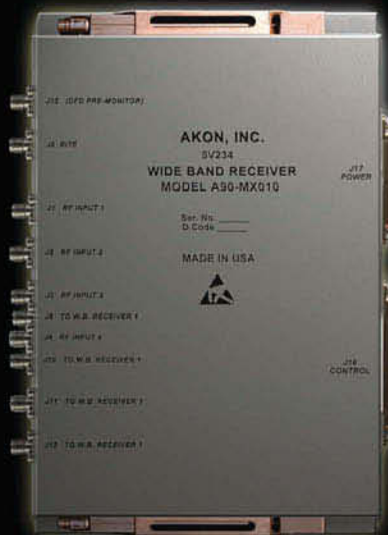

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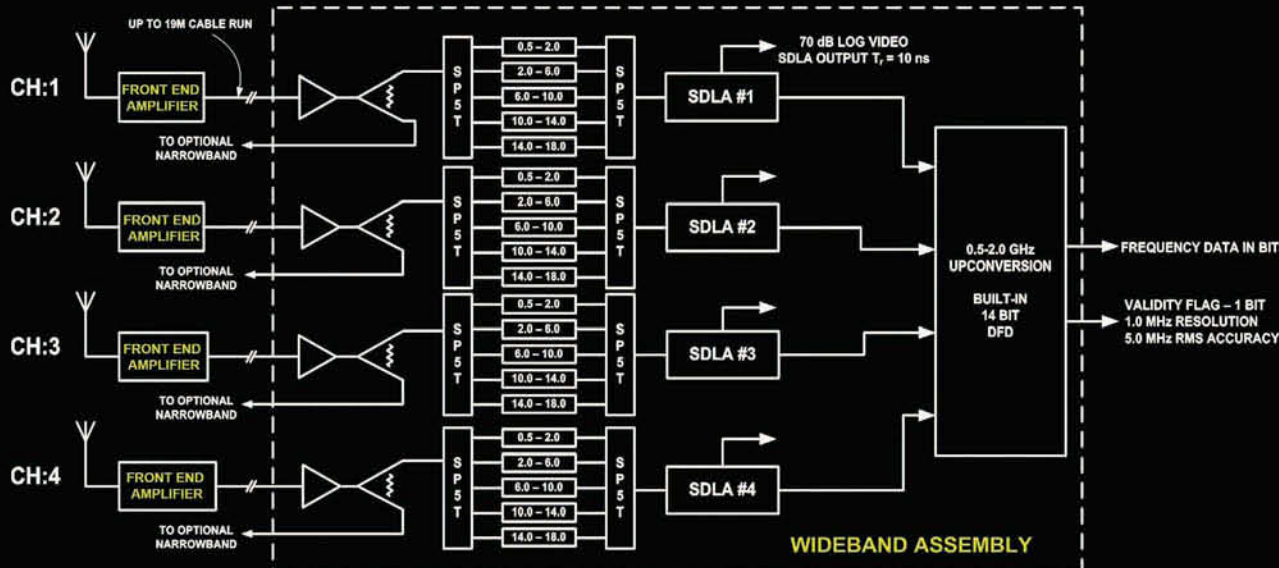

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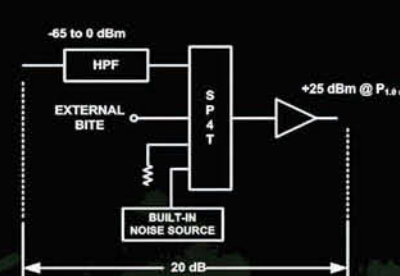

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www.deps.org

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Space Protection Conference
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2009 Homeland Security Conference
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Monterey, CA
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SEPTEMBER

54th Joint EW Conference
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DSEi
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www.dsei.co.uk

AFA National Convention
September 12-13
Washington, DC
www.afa.org

C4ISR Symposium
September 14-17
Atlantic City, NJ
www.afcea.org

Passive Covert Radar Conference
September 15-17
Verona, NY
www.crows.org

Modern Day Marine
September 29-October 1
Quantico, VA
www.marinemilitaryexpos.com

OCTOBER

2009 AUSA Annual Meeting & Exposition
October 5-7
Washington, DC
www.ausa.org

NMIA 2009 Fall Intelligence Symposium
October 6-7
McLean, VA
www.nmia.org

Worldwide EW Infrastructure Conference
October 6-8
Atlanta, GA
www.crows.org

AOC 46th Annual Convention
October 18-21
Washington, DC
www.crows.org

MILICOM 2009
October 19-21
Boston, MA
www.afcea.org

NOVEMBER

12th Annual Directed Energy Symposium
November 2-6
San Antonio, TX
www.deps.org

2nd Annual EWIIP Conference
November 3-5
Virginia Beach, VA
www.crows.org

Low Probability of Intercept ELINT/ SIGINT Conference
November 17-19
NPGS, Monterey, CA
www.crows.org

DECEMBER

EW Symposium
December 2-3
Shrivenham, UK
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AUGUST

Fundamentals of Airborne Electronic Combat Test and Evaluation
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SEPTEMBER

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Boulder, CO
www.pe.gatech.edu

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www.pe.gatech.edu

The US Intelligence Community
September 15-17
Fairfax, VA
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Infrared Technology and Applications
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Atlanta, GA
www.pe.gatech.edu

Digital Radio Frequency Memory (DRFM) Technology
September 22-24
Atlanta, GA
www.pe.gatech.edu

Principles of Radar Electronic Protection
September 29-October 1
Atlanta, GA
www.pe.gatech.edu

Basic RF EW Concepts
September 29-October 2
Atlanta, GA
www.pe.gatech.edu

OCTOBER

Electromagnetic Environmental Effects (E3) and Spectrum Supportability (SS) for Program Managers
October 1
Fairfax, VA
www.afcea.org

Fundamentals of Radar Signal Processing
October 5-9
Atlanta, GA
www.pe.gatech.edu

Tactical Battlefield Communications Electronic Warfare
October 13-16
Washington, DC
www.crows.org

NOVEMBER

Military Electronic Warfare Course
November 10-14
Shrivenham, UK
www.cranfield.ac.uk

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message
from the president

CLOSING THE EW LEADERSHIP GAP

One of the most significant issues facing our discipline is a general perception of military leaders, who do not see electronic warfare (EW) as a force multiplier and, more importantly, as a means to controlling the electromagnetic spectrum (EMS). This is a fact that stretches across all military services among all nations. When senior military leaders meet to discuss requirements, training, budgets, etc., expert EW advice comes from field officers – colonels and navy captains at the far end of the table, at best. I can think of very few military organizations in any country that include an EW assignment within the general officer ranks.

I realize this is not earth-shaking news to most Crows. However, in today's military conflicts, where control of the EMS is an essential component of fighting in air, land, sea, space and cyberspace, having leaders that do not understand the EW discipline and what it can bring to the fight throughout all phases of a military operation is a reality our warfighters should not have to face.

This was not always the case. During the last decades of the Cold War, NATO built up its EW leadership (as well as its EW profession and career paths) in order to match its Warsaw Pact adversaries, who also understood that the EMS is a critical part of the battlespace. To say that those days are "gone" is one thing. However, when EW shortfalls are a common occurrence, and today's military leaders recognize them and then present no realistic budget to meet those shortfalls, that is deplorable, especially in the face of acknowledged EMS threats. It would be interesting if we had EW officers in positions of authority building realistic budgets to properly resource EW capabilities – everything from manning and training of EW personnel to developing and purchasing advanced EW technologies.

During my 40-year career in EW, I have known and worked with many intelligent and charismatic EWs who could and should have pinned on stars, but for a lack of career opportunity in the EW field. Today, we are producing a new cadre of bright, hard working and experienced EW professionals who have outstanding leadership skills. I am frustrated by the thought that, statistically speaking, nearly all of them will never rise above the field ranks. And, if by chance one or two of these future leaders do make it to a flag position where they can influence important decisions, it will not be in an EW assignment – if the status quo is maintained by the current leadership development structure.

After 20 years of atrophying EW leadership, it's time to create general officer positions in all services that specifically address requirements, planning and budget authority for spectrum control. Otherwise, we will continue to live with a military EW leadership gap that will ultimately weaken our EMS-dependant network-centric forces.

– Kermit Quick


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US ARMY TO KICK OFF EW AND SIGINT PROGRAMS

The US Army is set to move forward with several EW and SIGINT development programs in the coming weeks and months.

This month, the Army's Program Executive Office for Intelligence, Electronic Warfare and Sensors (PEO IEW&S) is expected to issue the final request for proposals (RFP) for the Aerial Common Sensor (ACS) program. ACS is a major program to develop an airborne multi-intelligence (MULTI-INT) platform capable of performing signals intelligence (SIGINT), imagery intelligence (IMINT) and measurement and signatures intelligence (MASINT).

The Army plans to award two technology development (TD) contracts, valued at more than $270 million each, in the first quarter of FY2010. The contractor teams will provide flying prototypes, one of which will be downselected for the engineering and manufacturing development (EMD) phase, scheduled to begin in 2012 and continue through 2014.

Much of the ACS COMINT suite will be derived from the RC-12 Guardrail Modernization Program, which includes the Enhanced Situational Awareness (ESA) system, a derivative of Northrop Grumman's Airborne SIGINT Payload that will provide the core search, intercept and DF capabilities. Other systems leveraged from the Guardrail Modernization Program will include derivatives of the Communications High Accuracy Location System-Compact (CHALS-C) from Lockheed Martin, X-MIDAS signal processing from Zeta Associates, and a high-band COMINT system from Argon ST.

Another Army SIGINT program due to issue an RFP soon is the Enhanced Tactical SIGINT Program (ETSP), a follow-on to the Tactical SIGINT Payload contracted to BAE Systems (Nashua, NH). The ETSP will be integrated onto UAVs and will give commanders an emitter mapping and situational awareness capability that can be fused with SIGINT data from ACS aircraft and ground-based Prophet systems. The Army plans to award a $22 million non-developmental item engineering contract in the first quarter of 2010. The contract will include a $94.5 million production option. The technical point of contact is Michael Schwartz, (732) 427-1915.

The Army also is looking to begin two self-protection programs that are currently awaiting acquisition approval. The Common Infrared Countermeasures (CIRCM) is a joint program to develop a lightweight directed IR countermeasures (DIRCM) system for Army, Navy and Marine Corps rotary-wing aircraft. It would be cued by systems such as the Navy's Joint and Allied Threat Awareness System (JATAS) program, which is expected to announce two TD phase contract winners this month. The Army is expected to issue an RFP for the CIRCM (pronounced "kerkum") program in the coming months. It could select a single EMD contractor in the spring of 2010. The technical point of contact is Darrell Quarles, (256) 955-0304, Darrell.quarles@us.army.mil.

Another joint effort between the Army, Navy and Marine Corps that is taking shape is modernization of the APR-39 radar warning receiver. The APR-39 has been developed in several variants over the past two decades. The joint upgrade program would retrofit a digital receiver into many existing variants of the system.

The PEO IEW&S also is seeking approval to begin the Hostile Fire Detection System (HFDS) program. The HFDS will warn helicopter crews of small arms fire, rocket propelled grenades and anti-aircraft artillery. In June, the Army issued a request for information in which it sought to determine if HFDS solutions existed at Technical Readiness Level 6 and Manufacturing Readiness Level 6. The HFDS capability is most likely to be integrated into the Army's AAR-57 Common Missile Warning System, which is its most widely deployed missile warner. The HFDS program is valued at $25 million. The technical point of contact is Suzanne Birdsong, (256) 313-5844, suzanne.birdsong@us.army.mil. The program could receive Milestone A approval by mid 2010. – *J. Knowles*

US ARMY TO BEGIN CREW JAMMER UPGRADE

In a July 20 pre-solicitation notice (N0002409R6314), US Naval Sea Systems Command (NAVSEA) said it was "contemplating" awarding a sole-source, indefinite delivery-indefinite quantity contract to ITT Electronic Systems (Thousand Oaks, CA) to begin producing an upgraded Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (CREW) 2.1 jammer in a single box that can operate "through Band C."

NAVSEA is the DOD's executive agent for developing and procuring common ground-based CREW systems for the joint military services. CREW 2.1 Vehicle Receiver Jammers (CVRJs) have been in production only at ITT and are the latest to be deployed in Iraq and Afghanistan. In late June, NAVSEA ordered an additional 548

CVRJs from the company for $36.3 million. ITT developed a CREW 2.1 upgrade kit that NAVSEA said has passed its testing and is ready for immediate production. It retains the existing single-box configuration. The kit would be integrated into ITT's CVRJ production line and provided for systems already delivered.

Newer commercial off-the-shelf CREW 3.1 dismounted backpack and CREW 3.2 vehicle-mounted jammers are on a fast-track for fielding. Sierra Nevada won the 3.1 production contract in June; ITT, Northrop Grumman and SRCTec are competing to be the CREW 3.2 supplier. Due to weight limitations, Sierra Nevada's CREW 3.1 man-portable jammer features three interchangeable modules that cover Bands A, B and C. – *G. Goodman*

US NAVY TO UPGRADE AAR-47 MWS

Naval Air Systems Command's Advanced Tactical Aircraft Protection Systems (ATAPS) Program Office (PMA-272) has announced plans to award a pair of sole-source contracts to Alliant Techsystems (Clearwater, FL) to upgrade the AAR-47 missile warning system (MWS), which is manufactured by the company.

The first contract calls for the company to improve the AAR-47's missile angle-of-arrival (AOA) resolution. The AOA data will be handed off to the ALE-47 countermeasures dispenser, enabling it to perform "smart dispense" of flares

continued on page 18

SIGINT PAYLOAD FOR PREDATOR

The US Air Force awarded a $71 million contract in late June to Northrop Grumman Mission Systems' Electromagnetic Systems Laboratory (San Jose, CA) to produce Airborne Signals Intelligence Payload (ASIP)-1C communications-intelligence (COMINT) sensors for the service's MQ-1 Predator unmanned aerial vehicles (UAVs) built by General Atomics. ASIP-1C is a scaled-down version of the full ASIP COMINT/electronic intelligence (ELINT) system operational on the U-2 high-altitude reconnaissance aircraft.

The ASIP is being flight-tested this year on the new Block 30 variant of the Air Force's large RQ-4B Global Hawk UAV built by Northrop Grumman Integrated Systems. Another scaled-down ASIP-2C version also is being developed for integration on the Air Force's MQ-9 Reaper (Predator B) UAV from General Atomics.

ASIP's electronics are housed in unpressurized compartments on the high-altitude Global Hawk, the Air Force says, thanks to patented liquid cooling technology from Spray-Cool (Liberty Lake, WA). A fine mist of a non-corrosive liquid is sprayed in a thin layer, which evaporates and cools the electronics within a sealed enclosure. – *G. Goodman*

and IR decoys. The contract will cover development, design and performance prediction leading to a preliminary design review.

The second contract, a modification to a previous delivery order, calls for the company to "provide implementation" of a Hostile Fire Indication (HFI) capability into the AAR-47. The Navy has previously awarded a Small Business Innovative Research contract to Solid State Scientific Corp. (Hollis, NH) to develop a "Multi-Function Threat Detector" as an HFI adjunct sensor for the AAR-47. The AAR-47 contract modification also tasks Alliant with delivering an operational flight program update to reduce false alarms in the AAR-47's laser warning function and study an HFI implementation in the countermeasures sensor stimulators. – *J. Knowles*

NAVY SEEKS INFO FOR AREA CHAFF DISPENSER

The US Navy has issued a sources sought announcement to gather information about area chaff dispensers. The Navy currently relies on the ALE-43, a pod-mounted system designed in the 1980s for training applications.

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US ARMY GRADUATES FIRST "EW" WARRANT OFFICERS

The US Army has graduated its first eight EW Warrant Officers from the EW Technicians Course at Fort Sill, OK, according to an article published on www.army.mil. The graduation marks an important milestone in the Army's effort to train approximately 4,000 enlisted personnel, non-commissioned officers, warrant officers and officers to serve as EW operators and specialists.

The eight warrant officers completed a 16-week EW Technician Course. All are assigned to deploying units, where they will advise at brigade and higher headquarters.

The EW Technician Course is a pilot course that will evolve in terms of size and subject matter. Ultimately the course will grow to 25 students and include a basic and an advanced level. The course was designed and taught by contractor personnel from Northrop Grumman.

The Army will begin to staff EW positions next year, but the recent graduates are being trained early because they are assigned to deploying units.

With the US Navy planning to hand over most EW support positions at CENTCOM to the US Army in 2012, the Army is training a new cadre of EW professionals to fill those critical billets. According to the news article, the Army is training EW personnel to serve in every unit, from battery or company to the highest headquarters. Enlisted personnel will serve primarily as technicians. NCOs, warrant officers and officers will serve in battalions and higher headquarters. Many of the EW positions in these units will be authorized next year. – *JED Staff*

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Although it was developed for training purposes, the Navy adapted the ALE-43 pods for operational use. The pods were structurally modified for aircraft carrier use by EA-6Bs, as well as limited use on F/A-18C/Ds. With the Navy's planned retirement of its last EA-6Bs in 2012, the Navy plans to utilize the EA-18G Growler and the F/A-18E/F Super Hornet for area chaff missions in order to meet the needs of combatant commanders.

The Navy is planning to study area chaff alternatives in order to determine the best path forward. The study will look at alternatives including, integrating the ALE-43 pod on F/A-18E/F and EA-18G aircraft; repackaging ALE-43 components into an existing pod or drop tank that is already carrier certified for the Growler and Super Hornet; developing a new dispensing system into a pod or for internal carriage.

The study will help support a decision that could include an FY2012 EMD program to develop a new dispenser. Responses to the sources sought announcement are due August 17. The contracting point of contact is Ms. Robyn Warner, (301) 757-7106, robyn.warner@navy.mil. – *J. Knowles*

IN BRIEF

The 41st Expeditionary Electronic Combat Squadron, stationed at Bagram Airfield in Afghanistan, recently completed the unit's 2,000th mission in support of Operation Enduring Freedom. The July 8 mission, which lasted seven hours, was described as "almost routine" by the EC-130H Compass Call aircrew members who flew the mission. They were not aware of the milestone until much later, they said. EC-130H aircrews have been supporting Operation Enduring Freedom since the beginning in 2001.

✪ ✪ ✪

Cobham Sensor Systems (Lansdale, PA) received a $32 million modification to a previously awarded contract from US Naval Air Systems Command to supply an additional 37 Low-Band Transmitters (LBTs) for the ALQ-99 jamming system used on the EA-6B Prowler aircraft, bringing the total number of LBTs ordered by the Navy to 157 for $217 million. The company had delivered 46 LBTs at the time of the announcement. The service plans to buy a total of 292 units.

✪ ✪ ✪

Argon ST (Fairfax, VA) received $29.8 million in new contract awards for upgrades to US maritime intelligence, surveillance and reconnaissance (ISR) systems. One of the contracts calls for a system based on Argon's Lighthouse transportable signal intelligence (SIGINT) sensor system. Argon was also awarded an $8.3 million contract from the US Army's Communications-Electronics Command (CECOM) Acquisition Center in Fort Monmouth, NJ to perform research and development services in airborne communications intelligence development. The contract has the capacity to accommodate up to $30 million over three years of research and development.

✪ ✪ ✪

Raytheon Technical Services, Co. LLC (Indianapolis, IN) announced July 6 that the company will receive a $13.2 million firm-fixed-price contract from the Naval Air Systems Command for the procurement of 188 AN/ALE-47 Forward Firing/Dual Dispenser Pod shipsets for rapid installation on US Marine Corps CH-53D/E helicopters. The contract also provides for the procurement of a 3D Product Technical Data Package on the CH-53D/E ALE-47 Forward Firing/Dual Dispenser Pod system.

✪ ✪ ✪

Northrop Grumman Systems Corp. (Bethpage, NY) is being awarded a $14.8 million contract modification by the Naval Surface Warfare Center to a previously awarded contract to increase the ceiling amount for Systems Engineering and Systems Software/Firmware support for the Electronic Warfare (EW) systems for the AN/SLQ-32 system, which is the Navy's primary shipboard EW system.

✪ ✪ ✪

ITT Corporation (Clifton, NJ) announced that its Advanced Integrated Defensive Electronic Warfare System (AIDEWS) has successfully completed software development. AIDEWS is an integrated radar warning and jamming countermeasure system currently in full production with more than 150 systems under contract for five nations – Chile, Oman, Poland, Pakistan and Turkey – as part of the US government's F-16 Foreign Military Sales Program. The final software version is being released by the US Air Force in preparation for retrofit AIDEWS installs on the F-16s.

✪ ✪ ✪

Northrop Grumman Corporation (Linthicum, MD) announced that it successfully demonstrated key electronic protection capabilities of the F-35 Lightning II Joint Strike Fighter's APG-81 radar during the recent Northern Edge 2009 (NE09) joint military exercise. The APG-81 radar is currently undergoing integrated avionics flight testing aboard the Lockheed Martin Cooperative Avionics Test Bed (CATBird) aircraft and is being installed in production F-35s on the aircraft assembly line in Fort Worth, TX.

✪ ✪ ✪

The US Army Intelligence Center (USAIC) (Ft. Huachuca, AZ) has issued a request for information (RFI) on a project that will provide specialized Signals Intelligence (SIGINT) training support to Ft. Huachuca by providing software and analytic course material. The contractor will be responsible for updating USAIC's SIGINT infrastructure, bringing it in parallel with the National Security Agency's (NSA) current SIGINT exploitation capability. The point of contact is Andy Fainer, (520) 533-0269.

✪ ✪ ✪

BAE Systems Information and Electronics (Totowa, NJ) received a task order and option on a previously awarded $60.5 million contract to supply 62 ALR-56M radar warning receivers and 27 spares for the C-130J. The Defense Supply Center Warner Robins AFB, GA manages the contract.

✪ ✪ ✪

Northrop Grumman Corp., Electronic Systems, Defensive Systems Division (Rolling Meadows, IL) has been awarded a $6 million delivery order from the Naval Air Systems Command (NAVAIR) against a previously issued basic ordering agreement to perform configuration upgrades to the US Bell-Boeing V-22 tiltrotor aircraft's large aircraft infrared countermeasures (LAIRCM) system. The contract includes qualification testing and acceptance test reports.

✪ ✪ ✪

Northrop Grumman Space and Mission Systems Corp. (Van Nuys, CA), **Ball Aerospace & Technologies Corp.** (Boulder, CO) and **General Dynamics** Advanced Information Systems (Dayton, OH) received a combined $600 million indefinite delivery/quantity contract to support the National Air and Space Intelligence Center's (NASIC) Advanced Technical Exploitation Program (ATEP). The three companies will compete for work under this contract to provide NASIC with intelligence analysis, software systems development and support and sensor exploitation research and development of space-based and airborne sensor data for ATEP.

✪ ✪ ✪

LaBarge Inc. (St. Louis, MO) has received a $2.3 million follow-on contract from Northrop Grumman to provide components for the Directional Infrared Countermeasure (DIRCM) system. LaBarge has worked on Northrop Grumman's DIRCM program, designed to protect aircraft from heat-seeking missiles, for more than 10 years.

✪ ✪ ✪

Lockheed Martin Sippican (Marion, MA) will enter a five-year Basic Ordering Agreement (BOA) with the Naval Surface Warfare Center (NSWC) Crane Division (Crane, IN). The BOA will be unpriced with a ceiling of $45 million and orders issued will be for the support and advancement of the ship-launched, rocket-propelled Nulka Electronic Decoy Cartridges (EDC). Lockheed Martin Sippican currently provides Nulka's electronic payload and fire-control system.

✪ ✪ ✪

The US Air Force's Warner Robins Air Logistics Center (Robins AFB, GA) has announced plans to award a sole source contract to BAE Systems Manufacturing Technology Inc. for engineering services for the ALQ-161A electronic warfare (EW) system. The company will analyze and investigate and test corrective-action candidates to improve the ALQ-161A's RF pulse processing system deficiencies. The system, which flies on the B-1B, has "limited pulse processing capability when in a dense RF environment, is costly to sustain and is plagued with Diminishing Manufacturing Sources (DMS) issues" according to the contracting notice. Among the goals is maximizing the potential of the Enhanced Preprocessor Avionics Control Unit Replacement Computer capability and providing the ability to make future changes through software updates to face emerging threats.

washington report

GEN CARTWRIGHT SUPPORTS MORE GROWLERS

During the July Congressional debate in July that eventually lead to the decision not to fund more than the 187 planned Air Force F-22 fighters, USMC Gen James Cartwright, vice chairman of the Joint Chiefs of Staff, revealed that US regional combatant commanders perceive a greater need for more airborne electronic attack (AEA) assets, i.e., additional Navy/Boeing EA-18G Growler support jamming aircraft. The Navy is retiring its venerable EA-6B Prowlers by 2013 and replacing them with only enough new Growlers – about 85 – for carrier air wing fleet missions. It plans to deactivate its three "expeditionary" squadrons of land-based EA-6Bs that have provided standoff jamming support for Air Force fighters and bombers. Cartwright indicated that those commanders' concerns about the lack of sufficient joint AEA capabilities in the future were a significant factor in the Pentagon's decision not to buy additional F-22s. The first Growlers are set to become operational next month. *– G. Goodman*

SASC FY10 BUDGET MARKUP

The Senate Armed Services Committee (SASC) released its report on the FY10 Defense Authorization Bill in July. The following were EW-related highlights.

Nulka Ship-Launched Decoy: The Navy budget request includes $88.9 million for ship self-defense soft-kill systems development, including $4.8 million for various activities related to the Nulka rocket-propelled anti-ship missile active decoy system. Developed under a joint Australian-US program, Nulka employs a broadband radio-frequency (RF) repeater mounted atop a hovering rocket to radiate a large ship-like radar signature that lures away incoming radar-guided missiles. The SASC authorized an increase of $9 million to continue the following Navy Nulka development activities: keeping pace with anti-ship cruise missile threats with long pulse capability by incorporating RF and digital design enhancements; designing an architecture that will ensure flawless operation with the new SPY-3 multi-function radar (MFR); integrating Nulka into the Navy's Aegis weapon control system open architecture; and providing shipboard test and trial support.

Combat Training Ranges: The Committee noted that the Air Force's budget request includes $40.6 million for combat training ranges, but no funds to continue the Unmanned Modular Threat Emitter (UMTE) modernization program. Stating that "current threat emitters supporting the Air Warfare Center Nellis [AFB, NV] Range Complex are out of date and inadequate for training, particularly with the F-22 and F-35 fighters," the SASC report authorized an additional $3 million for UMTE. The panel also authorized an extra $3.2 million to purchase more of a new infrared threat simulator, called the aviation crew trainer (ACT), which enables the Air Force to field the system at all of its training ranges. ACT augments the Joint Threat Emitter (JTE) system, which is funded at $7.1 million in the Air Force's budget request. The Committee approved that figure, saying that JTE "increases the capability to support realistic air-to-air, air-to-ground, ground-to-air and electronic warfare training, along with the ability to record and play back events for aircrew debriefing and analysis."

Countermeasures Testing: The DOD's budget request includes $145.1 million for testing investments. The Committee recommended an additional $4 million to address the following shortfall identified in the 2007 Strategic Plan for Department of Defense Test and Evaluation Resources: "Outdated threat missile fly-out models reduced the effectiveness of both active and passive countermeasures testing."

Big Crow Aircraft: The SASC recommended a provision that would permit the Secretary of the Air Force to transfer two Big Crow aircraft to an appropriate private entity, if it is determined to be in the best interests of the Air Force and the DOD to do so. The Big Crow aircraft have been used for a number of test and evaluation and operational missions related to electronic warfare and other areas for a variety of joint customers. The SASC report noted, "The committee understands that the Air Force must fund large sustainment and refurbishment costs for the aircraft, but believes that the capabilities provided by the systems are of high value to the Department of Defense. The committee believes that it may be possible to give the DOD access to these critical test assets by transferring them to a private sector entity, who would then be responsible for their maintenance and operation in order to keep them in service to potential defense customers."

Aircraft Survivability Systems: The Army's FY10 R&D budget request includes $19.2 million for development of electronic warfare technologies. The panel noted that the Army "has established a technology objective to develop and integrate threat-warning sensors and countermeasures to protect aircraft against small arms, rocket-propelled grenades, man-portable air defense systems and other threats. Consistent with that objective, the committee recommends an additional $2 million for development of laser technologies to improve aircraf survivability against missile threats." – *JED Staff*


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world report

ITALIAN AIR FORCE PONDERS DIRCM SOLUTION

The Italian Air Force is nearing a decision to procure an advanced laser-based directed IR countermeasures system (DIRCM) to protect its fleet of fixed and rotary wing platforms against the emerging threat of Man-Portable Air Defense Systems (MANPADS) during out-of-area operations. El-Op of Israel and domestic EW supplier Elettronica are offering the ELT/572 DIRCM system (based on El-Op's MUSIC system) to meet this requirement.

The program is structured in two phases and funded within Italy's defense budget, with €65 million for the 2009-2012 period. According to Italian Air Force sources, the ongoing first phase involves the ELT/572 and the yet to be selected missile warning system (MWS) installation and integration feasibility studies on the initially chosen platforms, which will last until the beginning of 2010. The follow-on phase will be dedicated to systems acquisition and installation, which, according to the Italian Air Force, will be undertaken for the transport and tanker fleet. These include the Alenia Aeronautica C-27J Spartan, Lockheed Martin C-130J Hercules II, Boeing KC-767A, and the soon-to-be acquired CSAR and Special Forces support version of AgustaWestland AW101 helicopter. The Italian Ministry of Defense also identified the ELT/572 as a candidate for the recently launched ATR72MP maritime patrol aircraft program. Industry is privately funding integration activities on Piaggio Aero Industries' Avanti business aircraft. The Italian Air Force's ELT/572 program also involves the acquisition of in-house laser-code sourcing jamming generation capability in order to autonomously develop countermeasures for future IR threats.

The Italian Air Force is also working to identify a common MWS to be integrated with the ELT/572 DIRCM system. Candidate systems include the AAR-47 from ATK and the EADS/Selex Communications AAR-60 (MILDS II) system. – *L. Peruzzi*

ISRAEL TO INSTALL DIRCM SYSTEMS ON ITS AIRLINERS

Israeli commercial airliners will be outfitted with laser-based directed infrared countermeasures (DIRCM) systems as a result of a $76 million contract awarded by Israel's Ministry of Transportation to Elbit Systems subsidiary El-Op in late June. El-Op's C-MUSIC (commercial multi-spectral IRCM), a variant of the company's MUSIC system, was selected. C-MUSIC, which has a more powerful laser than earlier versions of MUSIC, successfully completed a recent series of flight tests on a civilian helicopter, El-Op said.

C-MUSIC is contained in a gondola-shaped pod, weighing about 110 pounds, under the aircraft's belly. PAWS missile warning sensors from Elbit subsidiary Elisra are situated at each end of the pod, providing hemispheric coverage, and a turret with a thermal imaging target tracker and a laser beam director is attached at the middle of the pod. Unlike other laser-based DIRCMs, El-Op says, C-MUSIC uses a fiber laser, placing the laser exciter in the pod, rather than in the turret, thus saving weight and reducing its size. The C-MUSIC systems will be installed aboard a variety of commercial passenger aircraft operated by the Israeli airlines El-Al, Arkia and Israir. – *G. Goodman*

UK DOWNSELECTS MANPACK SIGINT COMPANIES

The UK Ministry of Defence has selected six companies to bid for its upcoming Project Seer acquisition. Under Project Seer, the British Army will acquire 58 man-pack communications ESM and jamming systems.

The downselected bidders are all UK-based companies. They are ADM Shine Technologies Ltd. (Whetstone, Leicester), Communications Audit UK Ltd. (Cheltenham, Gloucestershire), Marlborough Communications Ltd. (Horley, Surrey), Roke Manor Research (Romsey, Hampshire) and Synectics Systems Group (Tewkesbury, Gloucestershire).

The UK is seeking the EW systems to support operations in Afghanistan. The requirement calls for fully developed systems that can transition to production quickly. – *JED Staff*

IN BRIEF

- **Ultra Electronics** (London, UK) has acquired Australia's **Avalon Systems** for AUS $16.5 million. Avalon designs and manufactures EW subsystems and provides engineering consultancy services and through-life support.
- Australia's Echidna Electronic Warfare Self Protection (EWSP) system was recently put through a successful airborne trial conducted jointly by Echidna developer **BAE Systems Australia** and the government's **Defence Materiel Organisation** (DMO). Echidna integrates a radar warning receiver, a missile warning system, a countermeasures dispensing system, dedicated controls and display. The trials exercised the entire system, according to the DMO, including full countermeasures tactics functionality and in-flight training.

interview

ROY AZEVEDO
Deputy Vice President, Tactical Airborne Systems and Manager, Electronic Warfare Raytheon Space and Airborne Systems Goleta, CA

Roy Azevedo began his career in EW more than 20 years ago, when he joined Raytheon's Electronic Warfare Business as an antenna engineer. He spent the next two decades at Raytheon working in EW through a series of increasingly senior positions, including Systems Engineering Manager, Technical Director for ALE-50 Programs, and Director of Advanced Programs. In 2006, he was named Manager, Electronic Warfare and Deputy Vice President, Tactical Airborne Systems, of the company's Space and Airborne Systems business, where he is also a member of the leadership team. He manages an EW business comprising approximately 600 employees that is a leading developer and manufacturer of ESM receivers, RF jammers and towed decoys. Through his two decades of experience in the EW field, he has developed a unique insight into the EW market – an insight he recently shared with JED *Editor John Knowles.*

You have described your company's ALR-69A as the world's first and only true all-digital radar warning receiver developed to date. How do you define a digital RWR?

Once you get past the antenna, if you are working on digital signals from that point on, it's a digital receiver – as opposed to having a bunch of analog signals that are being decomposed and put through a digital signal processor.

Some RWRs available today incorporate digital elements but fundamentally have an analog architecture. The ALR-69A, which is in low-rate initial production for the US Air Force, is a digital open-architecture design, which permits easy reprogramming to keep pace with future threats. We believe it provides the optimal wideband receiver front-end for an integrated electronic warfare suite, particularly if that suite includes a DRFM [digital radio-frequency memory]-based jammer.

Without question, there is still a market for analog RWRs – affordability alone will dictate that military aircraft worldwide will have them for years to come. But if a digital RWR is affordable, it is definitely preferable to an analog RWR. When we have briefed our ALR-69A's cost and capability to prospective military customers, we have generally received very positive responses.

What advantages do digital RWRs offer?

A digital RWR offers higher sensitivity, which provides longer threat radar detection ranges than analog RWRs and better signal recognition in dense signal environments. In particular, a digital RWR gives you the ability to accurately identify threat signals earlier and unambiguously, which is an issue with older analog RWRs. That gives you a big advantage in terms of aircraft survivability.

Our customers also are seeking threat emitter precision geo-location using multiple RWRs, an emerging capability that a digital RWR facilitates. The ALR-69A provides it with the Advanced Tactical Targeting Technology [AT3] modification that we have developed. It's essentially just a drop-in circuit card that allows networking of multiple ALR-69As to share precise signal measurements and rapidly and accurately locate RF emitters without the use of external hardware.

Digital RWRs mark a big advance in airborne electronic warfare technology. By comparison, however, RF countermeasures, despite DRFMs and better processors, still use the same basic jamming transmitter technology, i.e., traveling wave tubes.

I agree entirely. What I believe will greatly evolve the transmitter side of the equation is the Navy's Next-Generation

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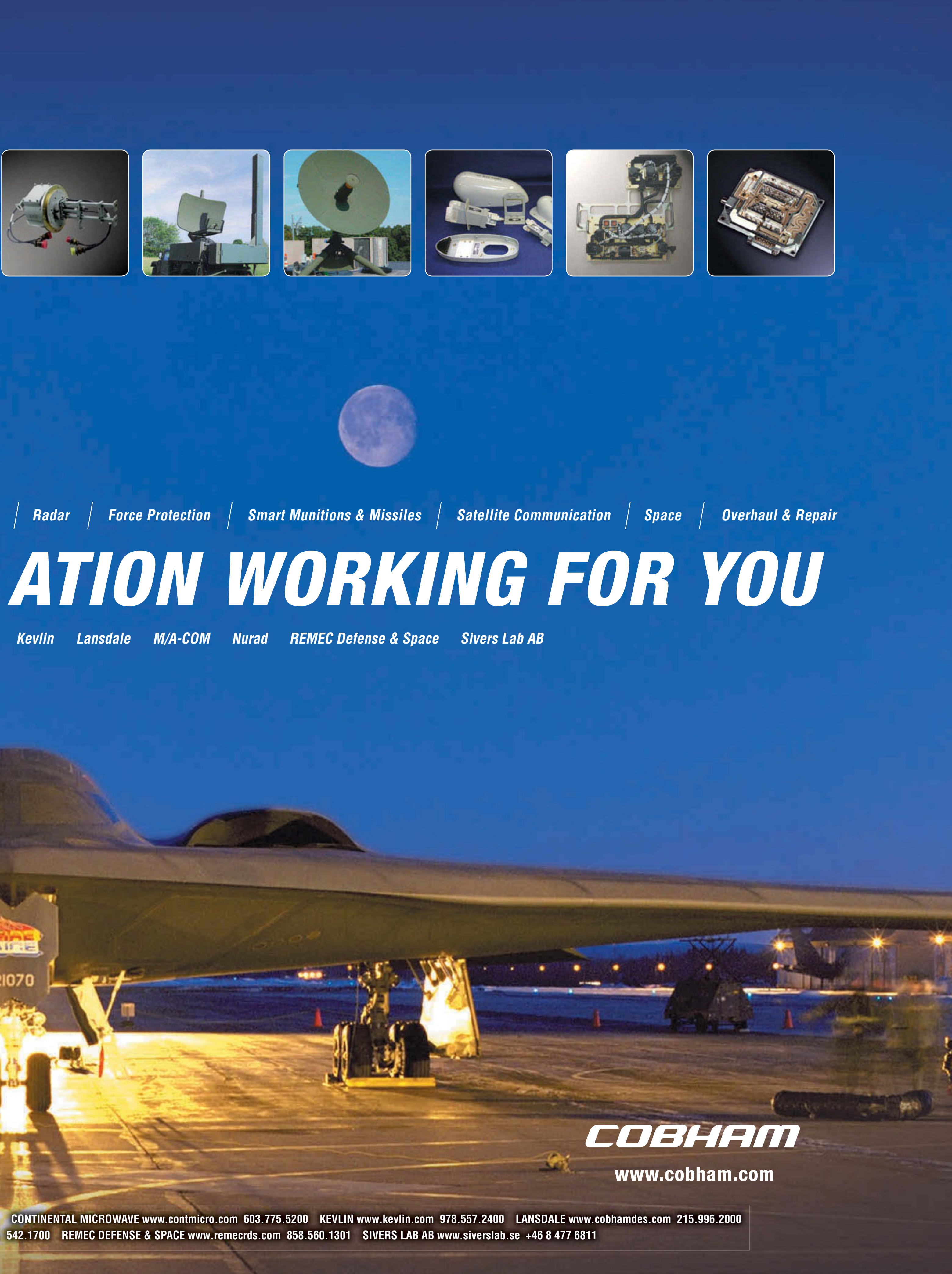

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Jammer competition. [Editor: The Next-Generation Jammer program aims to develop a replacement for the venerable ALQ-99 jamming pods on US Navy EA-6B Prowlers that will transition to the new EA-18G Growler.] I include in that the techniques generation part of it and not just the antenna arrays and solid-state drivers. Unless the program's scope changes significantly, I believe that it will advance jamming technology applicable to multiple platforms and will drive that technology for many years to come.

We were one of the four companies – the others were BAE Systems-Cobham, ITT-Boeing and Northrop Grumman – awarded six-month technology-maturation trade-study contracts last February supporting development of innovative concept solutions at the system level. At Raytheon, we are applying a combination of multi-beam jamming techniques and antenna array technology to achieve a more effective, robust, open-architecture jammer.

The US fighter community has remained focused on RF threats as opposed to infrared threats and missile warning systems. Do you see that focus changing to include IR threats?

I believe that the fighter community will remain RF-centric. Fighters typically fly at medium altitudes above the reach of IR threats. But if IR-guided missiles become a major threat to tactical fighters, as they have to low-flying rotary-wing aircraft, the Navy and Air Force will have to respond.

Affordability is a big constraint. Even if you can buy inexpensive missile warning or other IR countermeasures systems, if you have to start cutting holes in an airplane, that starts to drive up the installation and integration costs. Weight is such an important parameter for fighter aircraft that any new system is going to have to buy its way on to the aircraft.

Is Raytheon working on upgrades to your ALR-67(V)3 RWR in use on the Navy's F/A-18E/F Super Hornets?

We work in a true partnership with the Navy and [F/A-18 manufacturer] Boeing on a technology roadmap for the ALR-67(V)3, whose capabilities continue to evolve. It already underwent an upgrade about two years ago in which we inserted digital channelized receivers like the ALR-69A's and a new processor with greater memory capacity, which increased its performance dramatically.

The ALR-67(V)3 offers a high degree of interoperability with Raytheon's APG-79 digital AESA [active electronically scanned array] radar also on Navy Super Hornets. The radar and the RWR can fully function simultaneously without interfering with each other, which is a major advance. It's well known that having a very good receiver in proximity to a transmitter poses integration challenges.

We received a follow-on contract award from the Navy in May, our 11th full-rate production lot, for ALR-67(V)3s to be used on Navy Super Hornets, Australian Super Hornets and older F/A-18A/B Hornets, and Canadian and Swiss F/A-18A/B Hornets. The Navy has ordered a total of 594 ALR-67(V)3 systems to date for itself and those international customers. And we are pleased that the Navy has decided to purchase ALR-67(V)3s to replace the ALR-67(V)2s on its legacy F/A-18C/D Hornets beginning in FY2010.

What are the next big international fighter competitions on which you are focused?

India's ongoing MMRCA [Medium Multi-Role Combat Aircraft] competition for 126 aircraft is one of the largest since the early 1990s. Our ACES EW suite is part of Lockheed Martin's F-16 bid, and Boeing's Super Hornet offering includes our ALR-67(V)3 RWR. Those aircraft are competing against Sweden's JAS-39 Gripen, the Eurofighter Typhoon, France's Rafale and Russia's MiG-35. Brazil's F-X2 fighter competition, which could be decided in October, could total 100-120 aircraft over a decade. Our ALR-67(V)3 is on Boeing's Super Hornet offering, which is up against the Gripen and the Rafale.

Most of the fighter aircraft offered today appear to have only a limited selection of integrated EW suites with predefined subsystems from which to choose. On the other hand, the US rotary-wing community, initially with the Joint and Allied Threat Awareness System [JATAS] program at Naval Air Systems Command, is moving toward the goal of an open-system, plug 'n' play EW architecture common to multiple aircraft types. This approach allows the user to mix and match various EW subsystems from different manufacturers that meet common interface standards without significant and costly integration challenges to each type of aircraft. Why isn't the fighter aircraft community moving in that direction?

I do believe that the fighter aircraft community wants to achieve that as well. It certainly would be beneficial for the airframe manufacturers to have an open mission systems architecture, because they could compete each of the subsystems one by one and eliminate the need for non-recurring engineering and integration work. From an EW standpoint, it would be desirable to be able to take a [jamming] technique implemented in one hardware set and implement it in another. But legacy architectures are very hardware-specific. That makes it difficult to port a technique from Box A to Box B. If we can overcome that challenge, it will provide a major benefit. And while it sounds easy to have plug 'n' play EW hardware, it's not.

Raytheon is significantly investing in – and considers it critically important for our systems engineers to be able to develop – open architectures. We are listening to what we are hearing from our customers, and we absolutely are addressing it with our investments.

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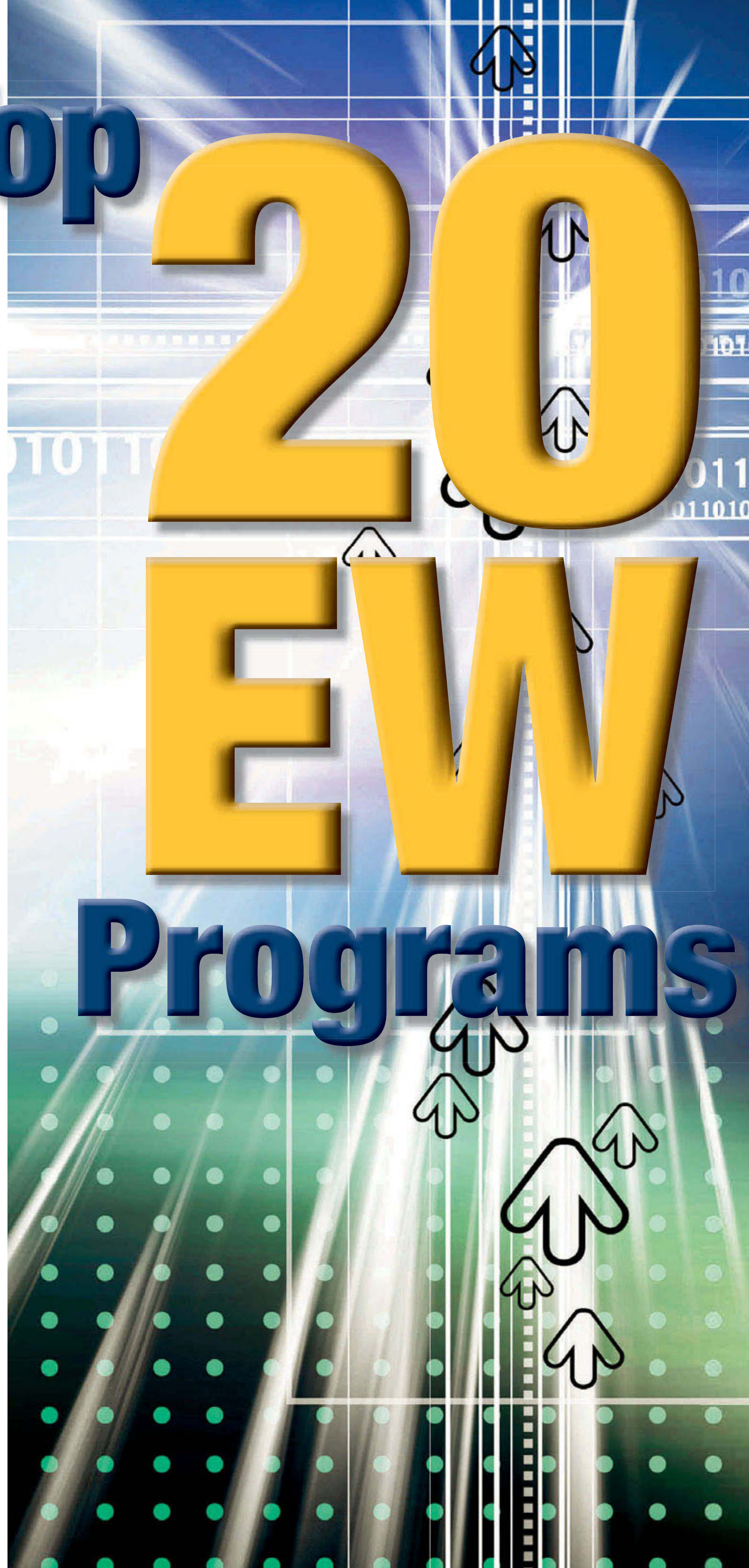
The Top 20 EW Programs



By Andrew Dardine and John Knowles

This month, *JED* is taking a slightly different approach to its annual Top 20 ranking. Whereas our past rankings have focused on EW- and SIGINT-related sales at companies, this year's ranking looks at the Top 20 EW and SIGINT programs, based on forecasted value during the five-year period 2010-2014.

Forecast International and the *JED* editorial staff calculated the program values. Where possible, we tried to focus on the EW/SIGINT content of these programs. For example, in the case of fighter aircraft, we focused on the value of the RWR, RF jammer, chaff/flare dispenser and missile warning system (including integration costs). However, if a program involved a dedicated EW or SIGINT platform, such as the EA-18G, an RC-135 or the Prophet vehicle, we estimated the value of the entire weapons system, including the EW/SIGINT mission system and the host platform.

The 2010-2014 timeframe poses several funding scenarios, in part because operations in Afghanistan and Iraq are currently driving spending on a variety of items, such as flares, missile warning systems, directed infrared countermeasures systems, IED jammers and COMINT systems. For the purposes of this article, we are forecasting that operations in Iraq will wind down significantly during this period, but operations in Afghanistan will intensify, driving urgent EW requirements for US and European forces deployed to that theater. Aside from those developments, evolving threat trends and various national defense modernization plans, especially in the fighter aircraft market, account for much of the spending.

Note: All figures are in US dollars.

1. EA-18G Growler/ALQ-99 .... $4.75 billion
2. EuroDASS .... $1.18 billion
3. ALQ-212 ATIRCM/AAR-57 CMWS .... $1.5 billion
4. Aerial Common Sensor (ACS) .... $1.4 billion
5. RC-135V/W Rivet Joint .... $1.35 billion
6. AAQ-24 DIRCM/LAIRCM .... $990 million
7. EPX .... $962 million
8. Spectra EW Suite .... $875 million
9. JCREW .... $829 million
10. G550 SIGINT Aircraft .... $810 million
11. Next Generation Jammer .... $725 million
12. Prophet Enhanced System .... $700 million
13. JSF EW Suite .... $672 million
14. ALR-67(V)3 RWR/ALQ-214 IDECM .... $644 million
15. Airborne IR Countermeasures Munition (AIRCMM) .... $555 million
16. ALQ-211 (SIRFC/AIDEWS) .... $516 million
17. AGM-88E Advanced Anti-Radiation Guided Missile (AARGM) .... $426.6 million
18. EW Suite for NH90 and Tiger Helicopters .... $391 million
19. Helicopter Integrated Defensive Aids System (HIDAS) .... $360 million
20. Ships Signal Exploitation Equipment (SSEE) .... $340 million

1

EA-18G Growler/ALQ-99

Estimated 5-yr value: $4.75 billion ($172 million ALQ-99 procurement for EA-6B, $249 million for EA-18G R&D, $4.3 billion for EA-18G procurement)

Combining Boeing's F/A-18F Block 2 Super Hornet, Northrop Grumman's ICAP III Suite and the ALQ-99 Jammer, this next-generation jamming aircraft will replace the EA-6B Prowler, planned for retirement in 2013. Production of the ALQ-99 jamming system will continue into the next decade. While the ALQ-99 will continue to be produced for these two major applications, the US Navy is actively pursuing the development of a new system via the Next-Generation Jammer (NGJ) program (see number 11).

2

EuroDASS

Estimated 5-yr value: $1.18 billion

The EuroDASS consortium (Selex Galileo, Elettronica, Indra and EADS) is producing the Praetorian Defensive Aids Suite (DASS) for the Eurofighter Typhoon for the four partner nations, Germany, Italy, Spain and the United Kingdom. Production of Tranche 2 Typhoon aircraft is well underway and will run through 2013. In May, the partner nations committed to Tranche 3 production. In addition to export customers, such as Saudi Arabia, the Eurofighter is likely to win at least two or three significant fighter competitions in the 2010-2014 timeframe.

3

ALQ-212 ATIRCM/ AAR-57 CMWS

Estimated 5-yr value: $1.5 billion

BAE Systems' ALQ-212 Advanced Threat Infrared Countermeasure (ATIRCM) system, along with its AAR-57 Common Missile Warning System (CMWS) and the Improved Countermeasure Dispenser (ICMD), makes up the Suite of Integrated Infrared Countermeasures (SIIRCM) installed on a wide variety of US Army rotary-wing aircraft. High rates of production are expected to continue over the next few years as the nature of fighting in Iraq and Afghanistan continues to drive demand for rapid procurement and deployment. The next several years should see steady production of these systems for installations on AH-64, UH-60 and CH-47 aircraft.

4

Aerial Common Sensor (ACS)

Estimated 5-yr value: $1.4 billion

The US Army's Aerial Common Sensor (ACS) program is a long-awaited effort to merge and improve the capabilities of the RC-12 Guardrail and RC-7 Airborne Reconnaissance Low platforms into a single integrated ISR system. The ACS payload will consist of a suite of modular, scalable signals intelligence (SIGINT), imagery intelligence (IMINT) and measurement and signature intelligence (MASINT) sensors and processors. Most of the ACS funding in the 2010-2014 timeframe will be spent on research and development.

5

RC-135V/W Rivet Joint

Estimated 5-yr value: $1.35 billion

The US Air Force's RC-135V/W Rivet Joint program is its largest manned SIGINT program. L-3 Communications performs sustainment and modernization of the US Air Force's fleet of 17 aircraft. In addition, the UK's Royal Air Force is planning to buy three Rivet Joint aircraft to replace its three Nimrod R.1 SIGINT aircraft. The value of that acquisition alone is in excess of $1 billion.

6

AAQ-24 DIRCM/LAIRCM

Estimated 5-yr value: $990 million

Northrop Grumman and Selex Galileo will produce the AAQ-24 Directed Infrared Countermeasure (DIRCM) system, as well as Northrop Grumman's NexGen Missile Warning System, in steady numbers over the next several years, primarily for the US Air Force and the US Navy under the Large Aircraft IR Countermeasures (LAIRCM) program and for a variety of UK platforms, including the Royal Air Force's (RAF) air-to-air refueling and transport aircraft. It is possible that the US and UK may ease export restrictions for the system during the next five years, which could lead to LAIRCM acquisition among NATO allies supporting operations in Afghanistan.

7

EPX

Estimated 5-year value: $962 million

The EPX is the recapitalization of existing EP-3E Aries SIGINT aircraft and will fulfill US Navy requirements for a manned ISR capability after 2015. During the 2010-2014 timeframe, the EPX program will be in the development phase. Companies competing for this program include Boeing, Lockheed Martin and Northrop Grumman.

8

Spectra EW Suite

Estimated 5-yr value: $875 million

In addition to domestic production for the French Air Force and the French Navy, the Rafale has been a contender in many recent fighter competitions around the world. Thales is the prime integrator of the Rafale's Spectra EW suite and supplies the RF threat warning and RF countermeasures subsystems. MBDA manufactures the suite's missile warning and chaff/flare dispensers. While domestic production will continue through the 2010-2014 timeframe, the aircraft is also likely to pick up a few export customers, such as the UAE and possibly Brazil. These production orders, along with research and development for future upgrades, should boost the program value to $875 million over the next five years.

9

JCREW

Estimated 5-yr value: $829 million

Operations in Iraq and Afghanistan will continue to drive spending for the DOD's Joint Counter Radio Controlled IED Electronic Warfare (JCREW) program. CREW 2.1 and 2.2 production (including upgrades) will continue, even as production for CREW 3.1 and 3.2 continue to ramp up. The systems are being produced in large numbers to equip US Army HMMWV's, MRAPs, and other vehicles. As the US turns its attention increasingly toward Afghanistan, JCREW systems will be produced for troops and vehicles headed to that theater.

10

G550 SIGINT Aircraft

Estimated 5-year value: $810 million

The Israeli Air Force's Nachshon program began in 2001, under a contract to Israel Aerospace Industries that called for the company to deliver three SIGINT aircraft based on the Gulfstream G550 platform. IAI's Elta subsidiary provided the mission suite, which included the EL/I-3001 SIGINT system. IAI has been aggressively marketing the G550 SIGINT aircraft, and sales are expected to Asia-Pacific customers throughout the 2010-2014 timeframe.

11

Next Generation Jammer

Estimated 5-yr value: $725 million

The US Navy's plan for replacement of the EA-18G's ALQ-99 jamming pod is based on a desire to enhance the Navy's jamming capability for stand-off missions outside defended airspace and mod-escort missions inside defended airspace. The system will have to address a myriad of existing and emerging threats. Because one of the conditions of accepting any proposal for the NGJ


The newest CREW devices provided to U.S. Forces, CREW Vehicle Receiver Jammers (CVRJs), are based on a technically mature, low-risk architecture and have the capacity to address threats at operationally effective distances, while maintaining high levels of performance in the presence of multiple threats. ITT is dedicated to ensuring our systems will always support the Warfighters' missions, providing protection and flexibility in the evolving threat environment. While threats have been the principal focus, interoperability with other CREW systems and compatibility with tactical communications systems have been priorities at ITT and are reflected in our designs and in continuing research and development activities. Learn more at www.ITT.com.
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is that it provides some eventual cost savings, the estimated value should be relatively close to ALQ-99 sustainment and modernization costs.

12

Prophet Enhanced System

Estimated 5-yr value: $700 million

Earlier this year, the US Army awarded a General Dynamics-led team a six-year contract with an estimated potential value of $866 million to integrate Prophet Enhanced systems into Medium Mine Protected Vehicles (MMPV), as well as HMMWVs. In addition to being the Army's principle communications intelligence (COMINT) system for ground-based platforms, it is also expected to include a future electronic attack capability. Demand for this system is being driven by the US military's immediate need to provide enhanced COMINT support for deployed troops in Iraq and Afghanistan. Teaming with General Dynamics are L-3 Communications and Northrop Grumman.

13

JSF EW Suite

Estimated 5-yr value: $672 million

BAE Systems and main subcontractor Northrop Grumman are completing development of the AN/ASQ-239, also known as the Barracuda EW suite, for the F-35 Joint Strike Fighter. This is undoubtedly the market's largest fighter EW program over the long-term. During 2010-2014, the JSF will be in low-rate initial production (LRIP). With recently announced plans to increase LRIP quantities, we are estimating production funding for 450 ASQ-239 systems during the forecast period, plus off-board countermeasures and additional research and development funding totaling $672 million.

14

ALR-67 RWR/ALQ-214 IDECM

Estimated 5-yr value: $644 million

The F/A-18E/F Super Hornet's EW suite – based on the ALR-67(V)3 RWR from Raytheon and the ALQ-214 jammer from ITT Electronic Systems – has been in production for many years now. In addition, the ALE-55 Fiber-Optic Towed Decoy (FOTD) from BAE Systems is approaching full-rate production. With a future Super Hornet multi-year production contract under consideration, as well as export sales, the order book for the EW suite remains strong. In addition, ALR-67(V)3 and ALQ-214 retrofits on some older F/A-18A/B/C/D Hornets (for US Navy and international users) also will contribute to the program value during the 2010-2014 timeframe.

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15

AIRCMM

Estimated 5-year value: $555 million

Countermeasure flare production started to increase significantly beginning in 2004-2005 and it has remained at record levels ever since. Most rotary-wing aircraft in Iraq and Afghanistan depend on a three-flare cocktail comprising two Advanced IR Countermeasures Munition (AIRCMM) flares – the M211 and M212 as well as the standard M206 MTV flare (see M206 entry at Number 21). Continuing operations, especially in Afghanistan, where IEDs and a poor road network require high dependence on helicopters, will continue to drive AIRCMM flare production.

16

ALQ-211 (SIRFC/AIDEWS)

Estimated 5-year value: $516 million

The ALQ-211 Suite of Integrated RF Countermeasures/Advanced Integrated Defensive EW Suite (SIRFC/AIDEWS) will be produced in steady numbers over the next several years. A $78.1 million contract awarded to ITT in March 2008 will see production of the ALQ-211 for Pakistan's F-16 fleet. Under a $57.2 million contract, awarded two months later, the system is also being produced for US Special Operations Forces' MH-47 aircraft. Another US customer is Air Force Special Operations Command, which is installing the system on its CV-22 aircraft. Besides being a central controller for the whole EW suite, the ALQ-211 is a main RF jammer, RWR and countermeasures provider. There are now at least eight main variants in play, each tailored for a specific application.

17

AGM-88E Advanced Anti-Radiation Guided Missile (AARGM)

Estimated 5-yr value: $426.6 million

The AGM-88E AARGM will become the US Navy's primary anti-radiation missile, and it will likely continue to meet this need for many years to come. The US Navy developed the AARGM under a contract to Alliant Techsystems beginning in 2003, although earlier development began in the 1990s. The AARGM received production approval in September 2008. First units will be fielded in 2010. Full-rate production will begin in FY2010, with a total requirement for more than 1,800 modification kits, about a quarter of which will be produced in the 2010-2014 timeframe. AARGM will be flown on US Navy F/A-18C/D Hornets, F/A-18E/F Super Hornets, EA-18G Growlers and F-35 JSFs. Germany and Italy will also buy AARGMS for their ECR Tornado aircraft.

18

EW Suite for NH90 and Tiger Helicopters

Estimated 5-yr value: $391 million

The EW suite for Eurocopter's NH90 and Tiger helicopter programs comprises the Threat Warning Equipment (TWE) RWR from Thales, the AAR-60 missile warner from EADS and MBDA's Saphir-M countermeasures dispensing system (CMDS). Countries expected to buy the NH90 include Australia, Belgium, Greece, New Zealand and Oman. Potential NH90 customers include Chile, Iceland, Japan, Norway and Saudi Arabia. Additionally, France, Germany, Italy and Spain may exercise options to purchase additional NH90 helicopters in the years ahead. Tiger is a potential candidate to fill requirements in Brazil, Canada, India, Libya, Portugal and South Korea. The next five years are likely to see production of 391 TWE/AAR-60/Saphir-M suites for NH90 and Tiger helicopters.

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19

HIDAS

Estimated 5-year value: $360 million

SELEX Sensors and Airborne Systems' Helicopter Integrated Defensive Aids System (HIDAS) has been ordered for AH-64D Apache helicopters for Kuwait and Greece and, perhaps most significantly, has been selected for the UK's Future Lynx program of a combined 68 helicopters for the British Army and Royal Navy. In addition, the Aircraft Gateway Processor (AGP), a derivative subsystem of the HIDAS, is an aircraft survivability equipment controller that is being installed on all AH-64D Longbow Apaches. Demand for the HIDAS system over the next few years should remain strong.

20

SSEE

Estimated 5-yr value: $340 million

The AN/SSQ-137 Ships Signal Exploitation Equipment (SSEE) is the US Navy's largest shipboard SIGINT program. Argon ST is producing SSEE Increment E and Increment F systems. Production for SSEE Increment E is winding down, but upgrades, such as the Hostile Integrated Targeting System (HITS) will be implemented. More significant is the planned 2010 start of SSEE Increment F production, which will run through 2014.

The Next Five

21
M206 Flare Production
Estimated 5-yr value: $335 million

22
SEWIP
Estimated 5-yr value: $325 million

23
Gripen EW Suite
Estimated 5-yr value: $320 million

24
MUSIC Directed Infrared Countermeasure (DIRCM) Systems
Estimated 5-year value: $310 million

25
Compass Call Upgrades
Estimated 5-yr value: $300 million

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John Knowles *is the Editor of* JED.

TECHNOLOGY SURVEY

SAMPLING OF SIGINT ANTENNAS

This month's survey covers SIGINT antennas. The responses received cover the complete frequency range from VHF through Millimeter Wave and many different antenna types.

What is an antenna? According to the dictionary it is a conductor or an arrangement of conductors that, when placed into an electromagnetic field, an alternating current is induced between the terminals. Some different types of antennas are horns, dipoles, spirals and biconicals. When multiple antenna elements are connected together they produce an array. Arrays are created for two reasons; to increase gain and to provide directivity.

Different antenna types have different directivity and polarization patterns. A directivity pattern of an antenna is defined by the loci of points around the antenna that have equal gain. The simplest is a vertical rod. Its pattern is a horizontal circle around the vertical rod. Other antenna types have different patterns. An antenna that has a very directional pattern but is rotated mechanically to move the pattern over a predetermined field of view is called a spinner. A spinner can be any of the above types of antenna. The only difference is that by mechanically moving it, a wider field of view can be obtained. Some common types of antenna patterns are omni, conical and beam.

The gain of an antenna is usually referenced to an isotropic radiator. This hypothetical antenna has unity gain with a spherical antenna pattern. Typical antenna gains are defined in dBi or dB above an isotropic radiator.

Polarization defines the relationship of the electric field either created by or received by the antenna with respect to the earth's surface. Typically antennas are divided into two classes of polarization; linear and circular. A linear polarized antenna creates or receives an electric field in a particular orientation, which is usually either horizontal or vertical. Sometimes a linear antenna element will be placed in a slant position, neither horizontal nor vertical, in order to detect both horizontal and vertical signals. These antennas are referred to as slant linear. The other common polarization is circular. A transmitting circular polarized antenna continuously varies the electric field in a circular motion with regard to the earth's surface. So a receiving circular antenna is designed to react to a rotating E-Field. Circular polarized antennas are typically either right-hand or left-hand polarized. It is also important that antennas should be matched in order to provide the best performance. If the receive antennas are not matched to the transmitting antenna, a reduction in antenna gain occurs.

An antenna's beamwidth is typically referring to the field of view over which the antenna has its maximum gain. Typically this spatial area is defined by the points at which the antenna's gain is reduced to 3 dB less than its maximum gain. So an antenna's beamwidth is the spatial coverage from its 3-dB point through its maximum gain point to its 3-dB point on the opposite side. Typically higher gain antennas will have smaller beamwidths and be more directive then lower gain antennas.

This month's survey also asked about an antenna's ability to support a direction finding (DF) function. Typical responses were "yes" and referenced different types of DF functions supported. Most antennas will support some form of DF. Typical DF techniques listed in the survey are time, amplitude and phase interferometer. Time techniques typically require two or more antenna systems spaced some distance apart so that the time-of-arrival delta between the same signals at the different antennas can be measured and converted into an angle of arrival. For amplitude, again at least two and preferably four (one facing each 90 degree sector) separated antenna elements facing different directions with well known antenna patterns are required. For this technique, the power received at each antenna is compared to determine the angle of arrival. For phase interferometry, again at least two antenna elements are required and the phase difference at a point in time between the received signals at each antenna is measured and then used to compute the angle of arrival. In all cases at least two separated antennas are required. The more antennas used will increase the accuracy the angle of arrival.

JED sent survey questionnaires to more than 30 antenna companies. Of these companies, eleven responded with SIGINT antenna products. The surveyed companies were asked to provide information for up to five of their SIGINT antenna products for inclusion in this survey. These responses addressed their products that could be used in the military environment. Only information supplied by the survey respondents was used in this compilation.

JED*'s next survey, covering ELINT systems, will appear in November.*

E-mail editor@crows.org, to request a survey questionnaire.

TECHNOLOGY SURVEY: SIGINT ANTENNAS

MODEL	TYPE	OP FREQ	PATTERN	TYP INST GAIN	POLARIZATION
Cobham CDES-M/A-COM SIGINT Products; Hunt Valley, MD, USA; sigintsales10@cobhamdes.com					
AN-016980	spiral	2-40 GHz	Gaussian	0 dBLi, nominal	circular
AN-016163	spiral	18-40 GHz	Gaussian	0 dBLi, nominal	circular
AN-015498	ridged horn	2-18 GHz	directional	6 to 12 dBLi, typical	linear
AN-015944	conical horn	92-96 GHz	directional	22.5 dBLi, nominal	linear
AN-019509	composite	0.6-40 GHz	Gaussian	-5dBiC at 1 GHz 8dBiC at 4 GHz 15dBiC at 10-40 GHz	RHCP
DRS Codem Systems, Inc.; Merrimack, NH, USA; +1-603-429-0111; www.drs.com					
CDF-9200/AVM-1 DF Antenna	array	1.5-1,200 MHz	omni	low gain annular slot technologies	vertical
ZA-1036 Transportable DF Antenna Array	array	20-3,000 MHz	omni	-1 dBi or greater from 80 to 3,00 MHz, -22 dBi at 20 MHz	vertical
ZA-1450 UHF DF Antenna Array	array	500-3,000 MHz	omni	0 dBi (nominal)	vertical
ZA-1050 High-Gain Antenna Array	array	100-1,000 MHz	directional	>+4.5 dBi	vertical
ZS-4510 Mobile Mast-Mount DF Antenna Array	array	30-3,000 MHz	omni	-5 dBi or greater from 200 to 3,000 MHZ, -37 dBi at 30 MHz	vertical
ETS-Lindgren; Cedar Park, TX, USA; +1-512-531-6400; www.ets-lindgren.com					
3164-05	open boundary quadridged horn	2-18 GHz	directional	5-12 dB	dual linear
3164-08	open boundary quadridged horn	0.7-10 GHz	directional	4-12 dB	dual linear
3182	side-fed biconical	.03-1 GHz	omni	-20-0 dB	linear
3183	end-fed biconical	1-18 GHz	omni	-10-0 dB	linear
3181	end-fed biconical	0.5-9 GHz	omni	-10-0 dB	linear
Electro-Metrics Corp.; Johnstown, NY, USA; 518-762-2600; www.electro-metrics.com					
EM-6855	omni	4.5-40 GHz	Omnidirectional in horizontal plane.	0 dBi	vertical
EM-6104 Omni-Directional Antenna	omni, dual-band, hybrid	Upper Band: 1000-18000 MHz, Lower Band: 20-1000 MHz	Omnidirectional in the horizontal plane.	20-1000 MHz, 1000-18000 MHz, -15 dBi @ 20 MHz, -2 to +5 dBi, +20 dBi @100MHz	vertical
EM-5517	directional, flat-panel, dual-band	810 MHz - 960 MHz; 1710 MHz - 2200MHz	directional	>8 dBi low band, >12 dBi high band	vertical
EM-5512	omni	824 - 894 MHz	omni	>3.5 dBi	vertical
EM-5542	omni	1850 - 1990 MHz	omni	>3.5 dBi	vertical
L-3 Communications – Applied Signal & Image Technology; Linthicum Heights, MD, USA; +1-443-457-111;, www.l-3com.com/asit					
DF-90A	DF array with intercept	100-3000 MHz	omnidirectional monopole arrays	0 dBi typ	vertical
DF-125C	DF array	30-3000 MHz	omnidirectional monopole arrays	0 dBi typ	vertical
DF-80A	downconverting DF array with intercept	3000-6000 MHz	directional element array	0 dBi typ	vertical
BIA-2	broadband intercept	100-3000 MHz	omnidirectional VHF whip element and UHF discone	3 dB typ	vertical
DF-25C	DF array	30-3000 MHz	omnidirectional monopole arrays	0 dBi typ	vertical

BEAMWIDTH	SUPPORT DF	SIZE (in in./cm)	PLATFORM	WEIGHT (in lbs/kg)	FEATURES
80 deg, nominal	yes	3 x 1.5 in. (D x H)	*	6 oz.	20:1 BW
70 deg nominal	yes	0.5 x 2 in. (D x H)	*	1 oz	amplitude and phase tracking applications
50 deg, nominal	no	5 x 4 in. (W x H)	*	10 oz.	9:1 BW, test set and test range applications
E plane: 10 deg H plane: 15 deg	no	0.95 x 0.79 in. (D x H)	*	2 oz.	MIL-HDBK-5400 compliant
90 deg to 8 deg	yes	19 x 18 x 30 in.	*	*	MIL-HDBK-5400 compliant
each element 125 deg typical	Yes, amplitude only, amplitude and phase.	28 x 25 x 5 in.(max)	grd-mob	18 lbs	Magnetic mount to vehicles.
*	Yes, amplitude only, time, amplitude and phase.	113.8 x 82.2 in. (H x D)	grd-mob/grd-fix	285 lbs	
*	Yes, amplitude only, time, amplitude and phase.	14 x 23 in. (H x D)	air/grd-mob	37 lbs	Designed for airborne environment.
120 deg	Yes, amplitude only, time, amplitude and phase.	tower mount subject to config	grd-fix	*	configurable
*	Yes, amplitude only, time, amplitude and phase.	26.1 x 43.3 in. (H x W)	grd-mob/grd-fix	66 lbs	
35 deg above 5GHz	no	6.7 x 6.7 x 7.3/17.1 x 17.1 x 18.4 in.	fix	1.56 lbs	
35 deg above 2GHz	no	14.2 x 14.2 x 14.4/ 36 x 36 x 36.5 in.	fix	11.4 lbs	
less than 90 deg in E plane	no	21 x 6 x 13/53 x 13 x 33 in.	fix	*	
less than 90 deg in E plane	no	14 x 6 x 6 in.	fix	*	
less than 90 deg in E plane	no	14 x 6 x 6 in.	fix	*	
	no	2.25 x 2.25 in. D x H)	grd-fix	.25 lbs	
omni	no	12 x 10 in. (D x H)	grd-mob/grd-fix	1.8 lbs	Active in the 20- to 1000-MHz range, requires external clean +12VDC.
60 deg horizontal, 50 deg vertical	no	9.25 x 2 in. (diameter x D)	grd-fix	1.12 lbs	
360 deg horizontal, 90 deg vertical	no	23.5 x 2.5 in. (L x diameter)	grd-mob/grd-fix	1.1 lbs	
360 deg horizontal, 90 deg vertical	no	11.5 x 1.25 in. (L x diameter)	grd-mob/grd-fix	22 lbs	
360 deg	amplitude and phase	13.7 x 8.7 in. (diameter x H)(with elements removed and without EFR-3)	grd-mob/grd-fix	12 lbs	DF and intercept antenna for tripod, vehicle roof, mast, and manpack applications.
360 deg	amplitude and phase	33 x 15 in. (diameter x H)	grd-mob	40 lbs	Low-frequency, high-accuracy DF performance for vehicle roof-mount applications.
360 deg	amplitude and phase	9.0 x 9.5 in. (diameter x H)	grd-mob/grd-fix	10 lbs	SHF DF and intercept antenna with integrated coherent downconverter for vehicle roof and mast applications.
360 deg	no	7.5 x 9.25 in. (diameter x H) (with whip element removed)	grd-mob/grd-fix	4 lbs	Consistent broadband intercept gain for vehicle roof and mast applications.
360 deg	amplitude and phase	32 Dia. X 25 H (with elements removed)	grd-fix	48 lbs	Low-frequency, high-accuracy DF performance for mast-mount applications.

TECHNOLOGY SURVEY: SIGINT ANTENNAS

MODEL	TYPE	OP FREQ	PATTERN	TYP INST GAIN	POLARIZATION
L-3 Communications Linkabit Division; San Diego, CA, USA; 800-331-940; www.l-3com.com					
MA-445C	3-band array	2-2000 MHz	omni	16 dB	vertical
MA-458	array	2-2000 MHz	omni	20 dB	vertical
PLATH GmbH; Hamburg, Germany; +49-40-23-73-40; www.plath.de					
CMA 2400	DF, 7 antenna elements	20-3000 MHz	omni	*	vertical
DFA 2405	DF, 7 antenna elements	20-3000 MHz	omni	*	vertical
U646	DF, passive monopoles	1-30 MHz	omni	*	vertical
AAU7480	DF, active monopoles	1-30 MHz	omni	*	vertical
FAA321	DF, ferrite loops	0.5-30 MHz	omni	*	vertical
Q-par Angus Ltd.; Leominster, Herefordshire, UK; +44-1568-612138; www.q-par.com					
ELINT Positioner System	cylindrical paraboloid	2-18 GHz	fan beam	13.5-24.1 dBi	slant linear
Rockwell Collins; Richardson, TX, USA; +1-972-705-1765; www.rockwellcollins.com/ewsigint					
CS-3120	interferometer array	2-18 GHz	conical	2 dBi	circular
CS-1018ABN	spinning	0.5-18 GHz	cos	5-20 dBi	slant linear
CS-1040ABN	spinning	0.5-40 GHz	cos	5-20 dBi	slant linear
CS-1018	spinning	0.5-18 GHz	cos	5-20 dBi	slant linear
CS-1040	spinning	0.5-40 GHz	cos	5-20 dBi	slant linear
Rohde & Schwarz; Munich, Germany; www.rohde-schwarz.com					
R&S ADD216	array	50kHz-3GHz	omnidirectional and sector	- 60-15 dBi	vertical
R&S HF907OM	biconical	0.8 MHz-26.5 GHz	omni	1-5 dBi	linear, vertical
R&S HL050	log periodic dipole	0.85 MHz-26.5 GHz	directional	8.5 dBi	linear
R&S AC025DP	parabolic reflector	18-40 GHz	directional	26-32 dBi	dual linear
R&S AC008	parabolic reflector	0.85-26.5 GHz	directional	15-40 dBi	linear, horizontal and vertical; RHCP, LHCP
Trival Antene D.O.O.; Kamnik, Slovenia; +386-8314-396; www.trival-antennas-masts.com					
AD-22/A	log periodic	100-470 MHz	directional	6 dBi	horizontal/vertical
AD-22/B	log periodic	200-470 MHz	directional	7 dBi	horizontal/vertical
AD-22/C	log periodic	80-1300 MHz	directional	6 dBi	horizontal/vertical
AD-22/D	log periodic	1300-2700 MHz	directional	9 dBi	horizontal/vertical

BEAMWIDTH	SUPPORT DF	SIZE (in in./cm)	PLATFORM	WEIGHT (in lbs/kg)	FEATURES
	single-channel interferometer	33 x 14 cm (diameter x H)	grd-mob	4.08 kg	1 W max; fully tactical and waterproof
	single-channel interferometer	91.4 x 11.4 cm (diameter x H)	grd-mob	15.87 kg	2.5 W typical; fully tactical and waterproof
*	yes, correlative interferometer, Watson-Watt	80 x 75 x 75 cm	grd-mob/grd-fix	35 kg	integrated compass and monitoring antenna
*	yes, correlative interferometer	430 x 320 x 320 cm	grd-fix	150 kg	very high bearing accuracy
*	yes, Watson-Watt	1500 x 4000 x 4000 cm	grd-fix	*	self-supporting masts, low-maintenance
*	yes, Watson-Watt	230 x 3000 x 3000 cm	grd-mob/grd-fix	*	semi-mobile and camouflaged use
*	yes, Watson-Watt	47 x 44 x 44 cm	grd-mob/grd-fix	10 kg	low power consumption, camouflaged use
AZ: 30 deg-4 deg. EL: 35 deg-11 deg.	*	32.7 x 23.6 in. (H x D)	grd/shp	45 kg	Also available without positioner.
AZ: 120 deg EL: 30 deg	phase, 120-deg FOV	27 x 12 x 5 in.	air/ship/grd-mob/grd-fix	30 lbs	Includes antennas, low noise front end, BIT and microwave receivers. Option for 0.5 to 18 GHz.
AZ: 2-30 deg EL: 20 deg	amplitude, 360-deg FOV	20.5 x 19.5 in. (H x diameter)	air	46 lbs	Field proven, small form factor, airborne high gain antenna with integrated low noise front end.
AZ: 2-30 deg EL: 20 deg	amplitude, 360-deg FOV	20.5 x 19.5 in. (H x diameter)	air	46 lbs	Spin, point, sector sweep modes. High reliability brushless DC motor.
AZ: 2-30 deg EL: 20 deg	amplitude, 360-deg FOV	40 x 19.5 in. (H x diameter)	grd-mob/grd-fix/shp	80 lbs	Integrated DF & omni antenna array in a rugged, field proven package. Spin, point, sector sweep modes.
AZ: 2-30 deg EL: 20 deg	amplitude, 360-deg FOV	40 x 19.5 in. (H x diameter)	grd-mob/grd-fix/shp	80 lbs	Antenna's radome enclosed. High reliability brushless DC motor.
AZ: 360 deg (omnidirectional mode); 120-180 deg (sector mode)	amplitude; phase	82.6 x 55 cm (H x diameter)	grd-mob/grd-fix/shp/sub	48 kgW	
AZ: 360 deg EL: approx. 150 deg to 20 deg	*	approx. 26.5 x 21 cm (H x diameter)	grd-mob/grd-fix/shp	1.5 kg	
E plane and H plane: approx. 70 deg to 50 deg	*	approx. 30 x 21 cm (L x diameter)	grd-mob/grd-fix/shp	0.7 kg	
E plane and H plane: approx. 4.5 deg to 2 deg	*	approx. 35 x 32 cm (L x diameter)	grd-mob/grd-fix/shp	5 kg	
approx. 20 deg to 1.5 deg	*	approx. 90 cm (reflector diameter)	grd-mob	12 kg	
E plane 70 deg; H plane 130 deg	amplitude	47 x 55 in. (L x W)	grd-mob/grd-fix	3 kg	
E plane 60 deg; H plane 100 deg	amplitude	39 x 27 in. (L x W)	grd-mob/grd-fix	3 kg	
E plane 70 deg; H plane 110 deg	amplitude	70 x 78 in. (L x W)	grd-mob/grd-fix	13.2 kg	
E plane 50 deg; H plane 60 deg	amplitude	17 x 4 in. (L x W)	grd-mob/grd-fix	1.8 kg	

Survey Key – SIGINT Antennas

MODEL
Product name or model number
- DF = direction-finding

TYPE
Antenna type

OP FREQ
Operating frequency in kilohertz (kHz), megahertz (MHz) or gigahertz (GHz)

PATTERN
Antenna pattern.
cos = cosine

TYP INST GAIN
Typical installed gain in decibels expressed as dB, dBi, dBLi, and dBiC

POLARIZATION
Antenna polarization
LHCP = left-hand circular polarized
RHCP = right-hand circular polarized

BEAMWIDTH
Antenna beamwidth in degrees
- AZ = azimuth
- EL = elevation
- *E plane = electric field vector*
- *H plane = magnetizing field vector*

SUPPORT DF
Does it support DF and with what technology?

SIZE
Antenna size in inches (in.) or centimeters (cm)
Size by length x width x height (L x W x H) unless indicated.
D = depth

PLATFORM
Host platform
- air= Airborne
- grd= ground
- grd-fix = ground-fixed
- grd-mob = ground-mobile
- shp = shipboard
- sub = submarine
- spc = space

WEIGHT
Weight in pounds (lbs) or kilograms (kg)

FEATURES
Additional features
- SHF = super high frequency

November 2009 Product Survey: ELINT systems
This survey will cover electronics intelligence (ELINT) systems. Please e-mail editor@crows.org to request a survey questionnaire.

OTHER ABBREVIATIONS USED
- > = greater than
- AZ = azimuth
- BW = bandwidth
- config = configuration
- deg = degree
- dia = diameter
- DF = direction finding
- EL = elevation
- FOV = field of view
- freq = frequency
- max = maximum
- omni = omnidirectional
- typ = typical
- UHF = ultra high frequency
- VHF = very high frequency

* *Indicates answer is classified, not releasable or no answer was given.*

OTHER COMPANIES
This reference list includes websites for additional companies in the field that were unable to provide survey information due to security constraints or publication deadlines, or that declined to participate.

Company Name	Website
Advanced Technical Materials	www.atmmicrowave.com
Andrew Corp.	www.andrew.com
Antenna Authority	www.antennaauthorityinc.com
Antenna Products	www.antennaproducts.com
Antenna Research Associates	www.ara-inc.com
Astron Wireless Technologies	www.astronwireless.com
FS Antennentechnik GmbH	www.fsant.de
General Dynamics AIS	www.gd-ais.com
Herley	www.herley.com
IFI	www.ifi.com
L-3 Communications Randtron Antenna Systems	www.l-3com.com/randtron
MTI Wireless Edge	www.mtiwe.com
Poynting Antennas	www.poynting.co.za
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Raven Research UK	www.raven-research.com
RDF Products	www.rdfproducts.com
Saab Grintek Technologies	www.saabgrintek.com/antennas_defence.htm
Southwest Research Institute	www.swri.com
Tadiran Communications	www.tadsys.com/electro_s.htm
TCI	www.tcibr.com
Wang Electro-Opto	www.weo.com

Communications EW – Part 27

Jamming Frequency Hopping Signals *(continued)*

There are three approaches to jamming frequency hoppers. Last month we discussed barrage jamming and partial band jamming. This month we will discuss follow jamming, which requires significantly higher technology.

Follower Jammer

The follower jammer determines the frequency to which a frequency hopper is tuned in a small portion of the hop period. It then sets a jammer to that frequency to jam the rest of the hop. A wideband digital receiver can use fast Fourier Transform (FFT) processing to quickly measure the signal frequency. However, the high density of the tactical signal environment gives the system an additional requirement. **Figure 1** shows frequency vs. emitter location in a very low density environment. Each dot in the diagram represents the signal frequency and emitter location for a transmission. A frequency hopper has many frequencies from a single location. In a real-world environment, up to 10 percent of available channels could be occupied at any instant. This means that over the 30- to 88-MHz VHF band, there would be about 232 signals (assuming 25 kHz per signal channel). This means that a follower jammer must determine the frequency and location of each of those 232 signals and determine the frequency being emitted from the target location. The follower jammer is then set to that frequency.

An important side note: We have been saying that you jam the receiver, not the transmitter. However, by determining the frequency of a transmitter in a hostile net, we know the frequency to which the receivers in the net are tuned. Jamming at the transmitted frequency will jam all hostile receivers in the net.

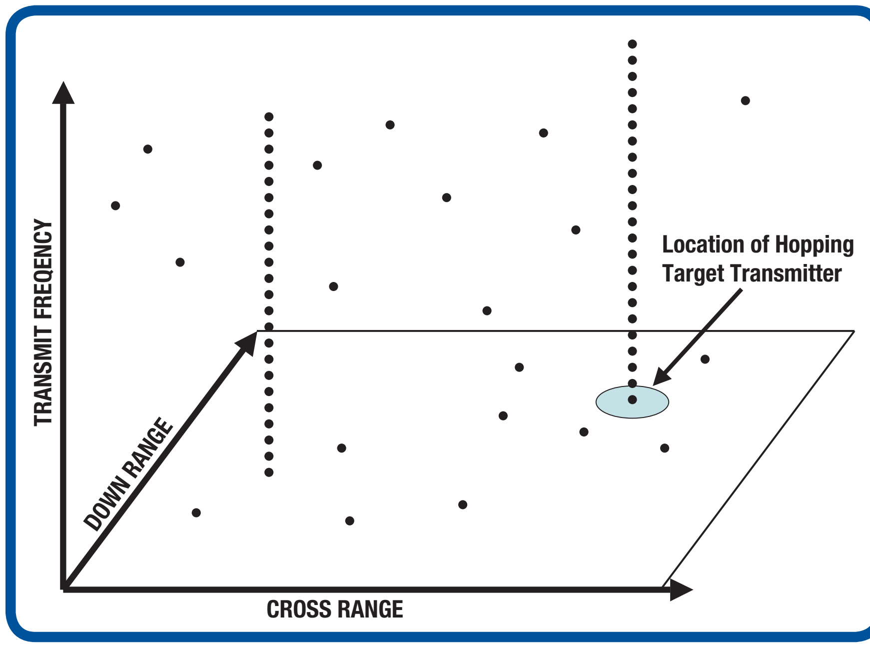

Figure 1: The follower jammer must apply jamming at the frequency of the emitter at the target location.

Follower jamming has the great advantage that it places all of its jamming power into the channel being used by the jammed hopping system. It also has the advantage that it jams only the frequency being used (at that moment) by the enemy. There is a very low probability that friendly hopping systems will be using that frequency at that time – hence fratricide is minimized.

Figure 2 shows the timing in a follower jammer. During the first part of the hop period, the hopper is settling onto its new frequency. Then, the jammer must find the frequency and location of all signals present and select the frequency to jam (i.e., the frequency emitted from the target signal location). Then there is propagation delay allowance (discussed below). After all of those processes are complete, the remaining part of the hop period is available for jamming. If the jamming duration is at least one-third of the hop period, jamming will be effective.

FFT Timing

The speed at which a follower jammer can determine the proper jamming frequency depends on the receiver configuration and the speed of the processor. Consider the system configuration in **Figure 3** as an example. The jammer includes a phase-matched two-channel interferometer to determine the direction of arrival of each received signal. The RF front end covers a portion of the frequency range of interest and out puts an intermediate frequency (IF) signal to the digitizer. The I&Q digitizer captures both the amplitude and phase of the IF signal at a very rapid sampling rate. The digital signal processor (DSP) performs an FFT to determine the phase of any signal present in any of the signal channels it determines. The FFT will channelize the digitized IF data into a number of channels equal to half the number of samples processed. For example, if 2,000 samples are input to the FFT process, the signal will be processed into 1,000 channels. Note that I&Q samples are in effect independent, so 1,000 I&Q samples will allow analysis into 1,000 channels.

If a second digital interferometer system inputs simultaneous direction-of-arrival information on all signals present, the computer controlling the jammer will know the location of each received signal, and can set the jammer to the instantaneous frequency of the signal at the target location (i.e., the target signal hop frequency).

In the December 2006 "EW 101" column, a digital interferometric direction finder is described. With the system restrictions defined in that column, the frequency and direction of arrival of all 232 signals assumed present in the 30- to 88-MHz range is determined in 1.464 msec. Two such systems would cooperatively determine the emitter locations in this amount of time.

Propagation Delays in Follower Jamming

Radio signals propagate at the speed of light. The signal from the transmitter must reach the jamming site. After analysis and frequency set-on, the jammer signal must reach the receiver location. **Figure 4** shows a jamming geometry for illustration. The target system transmitter and receiver are separated by 5 km, so there must be a 16.7 µsec propagation allowance built into the system. For discussion, let's place our jammer 50 km away. Now there is a 167 µsec propagation delay in either direction. This means that 334 µsec of the time after the transmitter has settled onto its new hop is not available for analysis or jamming.

Jamming Time Available

Combining the location analysis and propagation delay times in the described system and deployment geometry, 1,798 msec is unavailable for jamming. If a frequency hopper has 100 hops per second, the time available for jamming each hop is:

10 msec – 15 percent settling time – 1.798 msec = 10 -1.5 -1.798 msec = 6.702 msec.

Compared to the time the target transmitter has available to send data (10 msec – 1.5 msec – 16.7 msec = 8.483 msec) we are jamming 80 percent of the transmitted bits. Thus the jamming will be effective.

However, now consider a target signal at 500 hops per second. Now, the hops are only 2 msec long, leaving 1.7 msec of data after 15 percent settling time. Our analysis and propagation delay time (1.798 msec) is longer than that, so this system in this deployment geometry will not effectively jam the signal.

As an added protection against jamming, signal data bits are sometimes front loaded in the hop as shown in **Figure 5**. This reduces the amount of time available to a hostile receiver for determination of the hop frequency of a target emitter.

The point of this discussion is that it is necessary to consider the digitization parameters and the deployment to predict the effectiveness of a follower jammer. In the 500 hops per second example, a faster digitizer and/or shorter jamming range is clearly required.

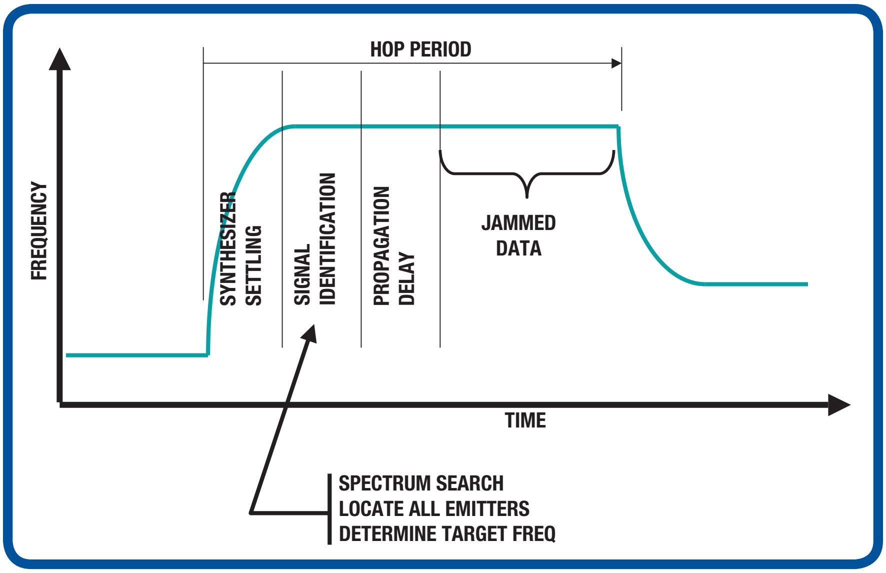

Figure 2: Follower jamming requires fast enough analysis to allow time for settling, propagation delay, and adequate jamming duty factor.

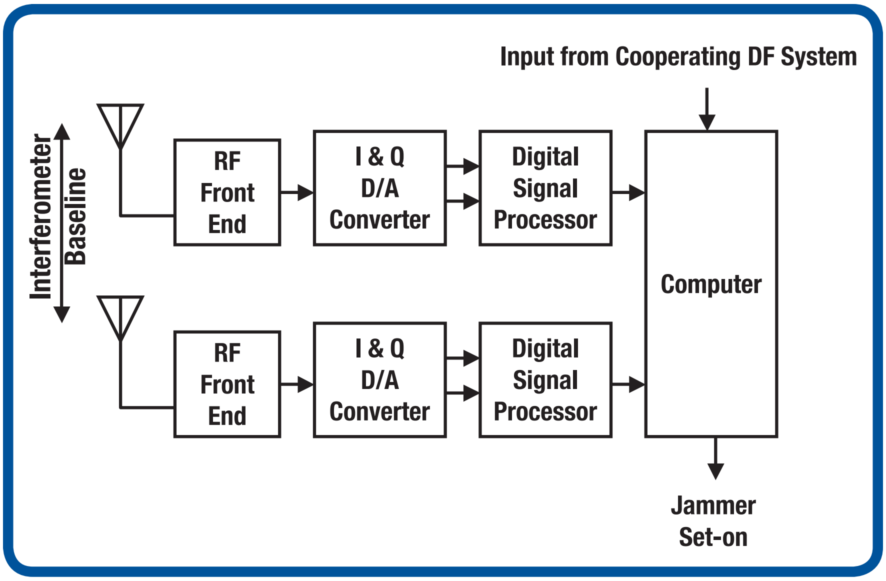

Figure 3: A follower jammer must determine the frequency & location of all signals present in the environment.

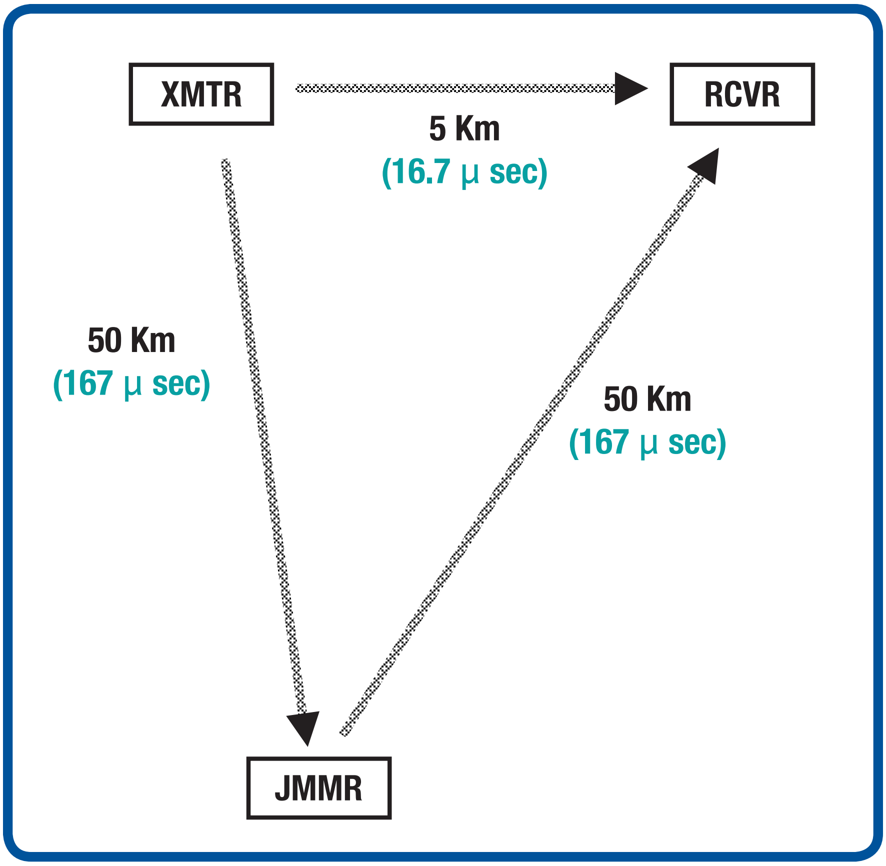

Figure 4: Follower jammer effectiveness can be severely impacted by propagation delays.

Slow Hop vs. Fast Hop

All of the above described techniques are appropriate for slow hoppers. However, fast hoppers (with hops per bit) are not vulnerable to follower jamming. In any reasonable tactical situation, the propagation delay will make analysis and set-on impractical. Thus, fast hopping must be jammed using barrage, partial band or swept spot jamming.

What's Next

Next month, we will discuss chirp signal jamming. For your comments and suggestions, Dave Adamy can be reached at dave@lynxpub.com.

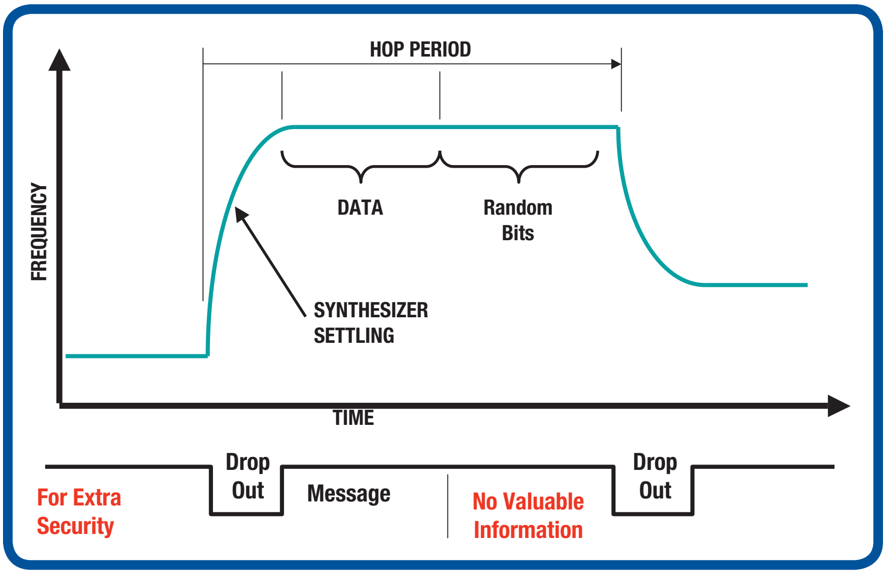

Figure 5: For extra anti-jam capability, signal data can be front loaded in the hop period.

INSIDE THE GOLDEN GATE CHAPTER EW MUSEUM


Display of AN/ALR-67 radar warning system.

Members of the Golden Gate Chapter museum committee in front of the USS Hornet Museum. From left to right: Carol Maiers, Bob Maiers, Debbie Scopelite, Dr. John Grighsby, Bob Simmen, David Grigsby, Tom Conway and Mike Licata (not pictured: Bob Hiller).

In late January, the AOC Golden Gate Chapter completed the move-in and set-up of museum quality displays of recent past and modern examples of EW equipment in Ready Room No. 3 of the USS Hornet, CV-12, permanently moored at Alameda, CA.

The museum features 10 transparent display cases mounted on wooden stands along the walls of the room, showing passive components from production systems including ER-142, AN/APR-25, APR-36, ALR-46/69, ALR-67 and APR-39A, plus active systems TRIM-7 and TRIM-9 and the X-band jammer from an SR-71.

Additionally, a large enclosed display case in the center of the room presents a variety of subassemblies and components including triplexers, antennas and field programmable gate arrays (FPGAs), as well as representative AOC paraphernalia (coffee cups, decals, etc.) and certificates and plaques awarded to the Golden Gate Chapter over the years.

The display is on loan to the USS Hornet Museum, and is thought to be the most complete and easily accessible presentation of EW apparatus and historical information available anywhere on the west coast.

The principal sponsor of the exhibit is the Northrop Grumman Corporation with several other EW suppliers also contributing to the support of the exhibit. Anyone else wishing to be listed as a contributor should contact the chapter.


Overall view of the exhibit in Ready Room No. 3.


Members of the Golden Gate Chapter museum committee inside Ready Room No. 3. From left to right: Tom Conway, Bob Simmen, Dr. John Grigsby, Mike Licata, David Grigsby, Debbie Scopelite, Bob Hiller and Bob Maiers.

AOC AND IO

Dominating the electromagnetic spectrum (EMS) has never been more important or more challenging than today.

All EW's are familiar with the multi-dimensional analogy of a game of chess between us and our adversary as we adopt a strategy to win by anticipating our adversaries' moves.

Our real world conflicts involve the player's minds (the cognitive), the medium (the EMS) and the message.

As the discussion unfolds as to how EW must be funded, a CYBER command is stood up - the formerly inclusive umbrella of Information Operations continues to evolve.

Stay tuned for the next edition of *JED* to read how the AOC's Information Operations Institute recommends that IO should evolve and mature.

SAVE THE WHALE UPDATE: ON US SOIL

A big step occurred May 26 in the initiative to transport one of the last remaining "Electronic Whales," a Douglas EA-3B aircraft, from a US Naval Station in Rota, Spain, to the USS Alabama Museum in Mobile, AL. To move the aircraft from the USS Wasp it previously had been traveling on to a US Naval Station in Norfolk, VA, the aircraft was strapped to a crane and hoisted from the USS Wasp to be hooked onto a tow tractor – all under rainy skies.

Capt Keith May of Norfolk Operations said the USS Wasp crew was thanked for its large contribution to the "Save the Whale" effort with mementos from the A-3 Association, the group of individuals behind the transport of the aircraft, and that several news stations were on-site to publicize the event.

The Electronic Whale gained its fame as an EW version of the US Navy's A-3 Skywarrior until 1992, when it was retired. The next step in its journey will be temporary storage at the Naval Station's Chambers Field until a realistic, affordable option is determined for moving it to the Gulf of Mexico and onto Mobile. The effort continues to need donations to help with transporting it on a waterways shipment to the Gulf and recruiting local Norfolk volunteers to prepare the aircraft for shipment. To make a donation, go to the AOC website at www.crows.org and download a "Save the Whale" donation form.

Pictured (left to right): Dean Robert Henry, College of Engineering and Physical Sciences; Bill Thomson, GSR; Tom Perkins, GSR; Bill Lenz, GSR; Steve Yushak, GSR Scholarship Chairman; and Dean Joe Klewicki of the Mechanical Engineering Department. Luke Gregory, the recipient of the Granite State's Tony Grieco Electronic Defense Scholarship, was not able to attend due to a military duty commitment.

GRANITE ROOST AWARDS SCHOLARSHIPS

During the University of New Hampshire College of Engineering and Physical Sciences Scholarship Awards Ceremony in Durham, New Hampshire in May, Luke Gregory was awarded the 2009 Tony Grieco Electronic Defense Scholarship by representatives of the Granite State Roost.

The Tony Grieco Electronic Defense Scholarship is offered by the Granite State Roost to a University of New Hampshire junior or senior majoring in engineering or science. The scholarship is named after the Department of Defense's former Deputy Director for Electronic Warfare, Tony Grieco, who retired after 40 years of service.

CHESAPEAKE BAY ROOST AND PATRIOT ROOST AWARD SCHOLARSHIPS

For its May luncheon, which took place May 7 at the National Electronic Museum in Linthicum, MD, the AOC's Chesapeake Bay Roost hosted its 23rd Annual Scholars Dinner and Awards Ceremony and gave out scholarship awards to 10 young individuals. The scholarships, jointly sponsored by Chesapeake Bay Roost and the AOC's Patriot Roost, recognized each awardee's interest in and goal to pursue the study of electronic warfare (EW)-related disciplines on a college level.

As part of the luncheon, guests heard from a group of speakers representing technical, educational and military fields. Each speaker spoke on the same topic, "The Value of Education," sharing experiences and anecdotes with the audience.

Chesapeake Bay Roost luncheons occur from September to May. To learn about the Roost and all of its activities, contact Chapter President John Hawkins at hawkinsje@comcast.net.

Pictured above are the recipients of the scholarship awards presented by the AOC Chesapeake Bay Roost with additional support from the Patriots Roost.

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SMALL (10-49 Employees)	$500	10
CONSULTANT (1-9 Employees)	$300	5

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