April 2009
Vol. 32 • No. 4

The AOC Electronic Warfare Publication
www.crows.org

JED

The Journal of Electronic Defense

LETHAL SEAD

Also in this issue:

Airborne SIGINT Forecast
RF Power Sources for IED Jammers

Thousands of rotary and fixed wing pilots rely on our advanced situational awareness, threat warning and ECM suites. Our EW team digs deep, not just to meet the specs, but to find the best solution to every problem. And the result? Systems that exceed expectations and deliver in a conflict's defining moment. Missions succeed, and pilots come home. To learn more, just visit us at **itt.com/victor.**

In the conflict's defining moment, be defined as the victor.

ITT

Engineered for life

Communications • Sensing & Surveillance • Space • Advanced Engineering & Integrated Services

THINK OUTSIDE THE BOX...

THINK KOR!

KOR Electronics offers unique system level solutions to our customer's challenges in:

- Leading Edge Systems Engineering
- Electronic Warfare (EW) Techniques
- Intelligent Communications Jamming
- Complex Waveform Generation and Analysis
- Digital Receiver Data Conversion
- Radar Environment Simulation
- Digital Radio Frequency Memory (DRFM)
- Signals Intelligence
- Net-Centric Warfare
- RF/Microwave Frequency Conversion
- High Fidelity Signal Modulation
- Software Systems with Data Manipulation

Exploiting the Digital RF Domain

Visit KOR at Booth 115,
45th Annual AOC Int'l Symposium and Convention

KOR ELECTRONICS

714.898.8200 **korelectronics.com**

KOR Electronics, 10855 **Business Center Drive, Building A, Cypress CA** 90630

Cover photo courtesy US Department of Defense.

News

Features

Departments

MAN-PORTABLE AIRCRAFT SURVIVABILITY EQUIPMENT SYSTEM TRAINER (MAST)

TRAINING EXPERTS DELIVER WINNING SOLUTION.

After-action review.

Leaders in defense training, AAI and its team of EW experts are designing the most cost-effective and advanced next-generation aircraft survivability equipment trainer. The team's MAST will enable aircrews to develop defensive skills against surface-to-air missile threats and build confidence in combat environments.

The team is already operating MAST successfully, combining an economical COTS-based architecture with established technologies. The trainer consistently delivers precise stimulation of missile warning systems, replicates the visual effects of SAM missiles, and provides comprehensive after-action video for continuing skills development.

AAI, a premier producer and integrator of EW test and training systems, is partnered with ESL Defence and Inter-Coastal Electronics (ICE). ESL is recognized for world-class EO/IR simulation capabilities. ICE is a top designer of networked telemetry and data acquisition equipment that interface with the Multiple Integrated Laser Engagement System, Air-Ground Engagement System, and Tactical Engagement System.

To learn more, e-mail us at EO_IR@aaicorp.com.

AAI®

TEXTRON Systems

INNOVATION THAT WORKS.®

aaicorp.com

KOSOVO, 10 YEARS LATER

This month, *JED* looks at the future of the lethal suppression of enemy air defenses (SEAD) mission in an article by Glenn Goodman. Since its beginnings during the Vietnam War, the lethal SEAD mission has mainly relied on two essential components – rapid emitter location and precision response. Those two components have evolved significantly in the decades since Vietnam. Today's SEAD aircraft use networked ESM systems that can perform precision emitter targeting in a matter of seconds. On the response side, the victim radar can be taken out with an anti-radiation missile (ARM) or a GPS-guided weapon, such as a JSOW or a JDAM.

In the coming years, every F-22 and every JSF will be, in effect, a Wild Weasel – a stealthy one that can attack hostile radars with minimal risk. Radar operators won't know if the targets they see are legitimate (F-16s, F-18s, etc.) or decoys (MALD, ITALD, etc.). The odds are that they won't be on the air long enough to figure it out. I have no doubt that radar manufacturers will eventually develop technologies and tactics to close the gap opened by emerging lethal SEAD capabilities. But for the next decade or two, I would not underwrite any life insurance policies for enemy radar operators.

The strange thing is that 10 years ago this month, the US was in the midst of learning some very tough lessons about lethal SEAD. At the time, NATO was conducting air strikes against targets in Serbia (what was left of the Federal Republic of Yugoslavia) during the Kosovo Conflict. You'll recall that the Serb radar operators mostly stayed off the air throughout the conflict. The net effect was that NATO was unable to destroy most of the Serb air defenses during the first weeks of the operation for lack of opportunity. With many of the Serb radars and SAM batteries still operational (or at least not destroyed), NATO commanders realized that they could not effectively advance the air campaign from the SEAD phase to the strike phase. There were not enough EW capabilities (lethal SEAD aircraft, support jamming aircraft and advanced self-protection systems) to allow large-scale air strikes in a potentially dangerous threat environment. As the result, the air campaign lacked the necessary "punch" that NATO commanders had planned and the operation dragged on for 10 weeks.

The importance of SEAD (both lethal and non-lethal) is perhaps the most enduring EW lesson from the Kosovo Conflict. After the war, the US Air Force boosted its lethal SEAD fleet by creating more F-16CJ aircraft and giving them new targeting capabilities. The US Navy became more serious about developing the Advanced Anti-Radiation Guided Missile (AARGM), and it re-affirmed its decision to modernize its support jamming fleet. These are all positive developments for EW.

Unfortunately, another lesson stemming from Kosovo is re-learned too often. That lesson is, EW is poorly understood by most senior military leaders, and it is poorly resourced as a result. I'd like to see the day when we can stop learning that lesson.

– John Knowles

The AOC Electronic Warfare Publication www.crows.org
JED The Journal of Electronic Defense

APRIL 2009 • Vol. 32, No. 4

Subscription Information: Please contact Glorianne O'Neilin at (703) 549-1600 or e-mail oneilin@crows.org.

The Journal of Electronic Defense is published for the AOC by

naylor

Naylor, LLC
5950 NW 1st Place
Gainesville, FL 32607
Phone: (800) 369-6220 • Fax: (352) 331-3525
www.naylor.com

PUBLISHED APRIL 2009/JED-M0409/8398

NORTHROP GRUMMAN

DEFINING THE FUTURE™

A modular approach to breakthrough thinking.

ELECTRONIC WARFARE. It is now possible to accelerate legacy electronic warfare systems ahead a full generation with a straightforward modular upgrade. Next Generation EW technologies from Northrop Grumman employ open architecture and digital building blocks to deliver maximum flexibility, accelerating combat capabilities. By mixing and matching components, fighting capacities are mission customized. With over fifty years of experience, backed by legendary support, Northrop Grumman delivers critical performance advantages in complex frequency environments.

www.northropgrumman.com

APRIL

Directed Energy Systems Symposium
April 6-10
Monterey, CA
www.deps.org

Navy EW Integration and Improvement Program
April 7-9
San Diego, CA
www.crows.org

Emerging EW Technologies Conference
April 14-16
Atlanta, GA
www.crows.org

Latin America Aero & Defence (LAAD) 09
April 14-17
Riocentro, Rio de Janeiro, Brazil
www.laadexpo.com

FiestaCrow 2009
April 19-23
San Antonio, TX
www.bmcaoc.org

InfowarCon 2009
April 23-24
Washington, DC
www.infowarcon.com

IDEF 2009
April 27-30
Istanbul, Turkey
www.kallman.com

MAY

AAAA Annual Convention
May 3-6
Nashville, TN
www.quad-a.org

Navy League Sea-Air-Space Exposition
May 4-6
National Harbor, MD
www.seaairspace.org

C4ISR Symposium
May 5-7
San Diego, CA
www.afcea.org

2nd Annual EW Gaps and Capabilities Conference
May 5-7
Crane, IN
www.crows.org

IMDEX Asia
May 12-14
Singapore
www.imdexasia.com

Joint Warfighting Conference and Exposition
May 12-14
Virginia Beach, VA
www.afcea.org

AOC/Shephard EW 2009
May 13-15
London, UK
www.shephard.co.uk

JUNE

NSA SIGINT Development Conference
June 3-4
Ft. Meade, MD
www.fbcinc.com

36th Annual EW Symposium
June 9-11
NAS Whidbey Island, WA
Clearance: Secret/US only
www.whidbeycrows.org

Paris Air Show
June 15-21
Le Bourget, France
www.paris-air-show.com

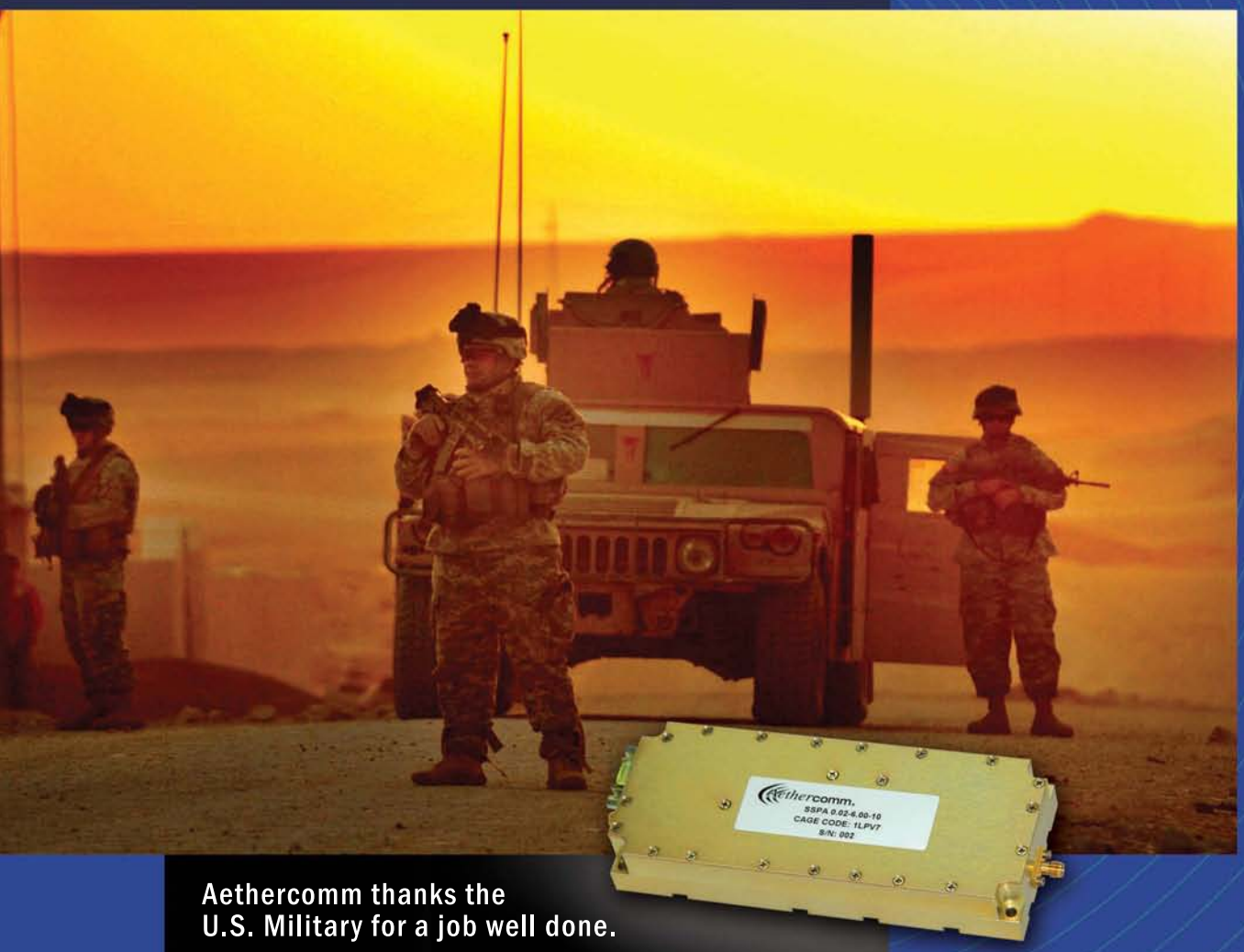
Emerging EW Technologies Conference
June 16-18
GTRI, Atlanta, GA
www.crows.org

55th MSS Tri-Service Radar Symposium
June 22-26
Boulder, CO
www.gatech.edu

For more information on AOC conferences, visit www.crows.org.

Aethercomm salutes our armed forces!

Another industry first from Aethercomm:
a 20 MHz to 6000 MHz 10 Watt
RF amplifier in a single module!



Aethercomm thanks the U.S. Military for a job well done.

We design & manufacture RF amplifiers and systems used for Force Protection and other life saving missions. Aethercomm products are combat proven and operate in the harshest environments on the earth.

Featured Product : SSPA 0.020-6.000-10

- *GaN technology*
- *20 MHz to 6000 MHz bandwidth*
- *10 Watts PSat output power typical*
- *50 dB small signal gain typical*
- *28 Vdc operation*
- *+/- 3 dB gain flatness typical*
- *-40C to +85C base plate operation*
- *2.5" (w) x 6.4" (l) x 1.0" (h)*

Applications:

- *EW Jamming*
- *Broadband Communications*
- *Test and Measurement*

Contact Aethercomm with your RF amplifier requirements.

BSI REGISTERED
ISO 9001:2000
FM 89386

Tel 760.598.4340
Fax 760.598.4342
sales@aethercomm.com
www.aethercomm.com

Aethercomm®

APRIL

Radar Countermeasures
April 1-3
Shrivenham, Swindon, UK
www.cranfield.ac.uk

Directed Energy 101
April 6
Monterey, CA
www.deps.org

Laser-Induced Sensor Effects
April 6
Monterey, CA
Clearance: Secret
www.deps.org

Modeling and Simulation of Antennas
April 14-16
Atlanta, GA
www.pe.gatech.edu

Directed IR Countermeasures: Technology, Modeling and Testing
April 21-23
Atlanta, GA
www.pe.gatech.edu

Basic RF EW Concepts
April 21-24
Atlanta, GA
www.pe.gatech.edu

Adaptive Array Radar Processing
April 28-May 1
Atlanta, GA
www.pe.gatech.edu

Aircraft Combat Survivability Short Course
April 28-May 1
Monterey, CA
Clearance: Secret/US Only
www.bahdayton.com/surviac/shortcourse/

MAY

Fundamentals of EW Course
May 4-8
Alexandria, VA
www.crows.org

Phased Array Antennas for Radar and Communications
May 5-7
Huntsville, AL
www.pe.gatech.edu

UAV Operations and Technology Integration
May 11-12
Shrivenham, Swindon, UK
www.cranfield.ac.uk

Multi-Target Tracking and Multi-Sensor Data Fusion
May 12-14
Beltsville, MD
www.aticourses.com

IR Countermeasures
May 12-15
Atlanta, GA
www.pe.gatech.edu

JUNE

Digital Signal Processing System Design
June 1-4
Beltsville, MD
www.aticourses.com

Basic RF EW Concepts
June 9-12
Atlanta, GA
www.pe.gatech.edu

An Introduction to Command and Control Concepts, Systems and Test & Evaluation
June 16-18
Atlanta, GA
www.pe.gatech.edu

JULY

Developing RF Prototype Hardware
July 21-23
Atlanta, GA
www.pe.gatech.edu

AUGUST

Fundamentals of Airborne Electronic Combat Test and Evaluation
August 10-14
Atlanta, GA
www.pe.gatech.edu

For more information about AOC courses or to register, visit www.crows.org.

HERLEY
Industries, Inc.

Multi-Spectral Test & Evaluation

ESM
- RSS8000

Radar
- RES/RTG
- Chameleon
- DRFM

EW Ranges
- MERTS

MAW
- PTS8000

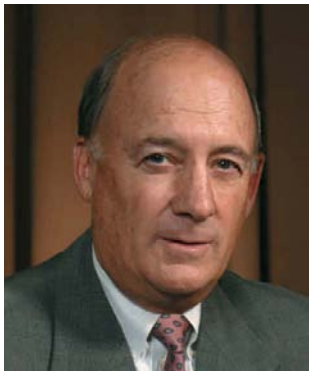
For the Lab and the Range

Herley - Micro Systems
17252 Armstrong Ave., Suite B, Irvine, CA 92614, USA
Tel: +1-949-251-0690 **Fax:** +1-949-251-0813
RFSimulation@Herley.com
www.Herley-MSI.com

EW Simulation Technology Ltd
B9 Armstrong Mall, Southwood Business Park, Farnborough, Hants, GU10 4DZ, UK
Tel: + 44 (0) 1252 512951 **Fax:** +44 (0) 1252 512428
www.ewst.co.uk

MICRO SYSTEMS, INC.
a HERLEY company

EWST
A HERLEY COMPANY



DATABASES: AN IMPORTANT PIECE OF THE PIE

What is database support for electronic warfare (EW)? Support is a word that most database analysts and managers would not like me to use in the context of a discussion on EW. From their point of view, these professionals are part of the team that makes EW systems work as well as they do. However, from an operator's point of view, it may be considered only one of the logistics groups that supply a commodity for the development and sustainment of the EW system that he or she operates. In addition, the database analysts and managers are not always considered a true member of the EW system acquisition team, but rather a group that is from another discipline (intelligence) and funded outside of the EW acquisition process.

Some might argue this point, but in the recent past the acquisition and test/development teams responsible for fifth-generation fighter aircraft realized deep in their program that the RF "database" of information required for all of the EW systems on these platforms was not adequate to operate the system as envisioned. Over time, this problem mostly was resolved, but not without consternation, long hours from database managers and analysts and, of course, program/funding adjustments. I bring this up because many EW acquisition managers (including export customers) do not always put database support in the major requirements list and often find themselves lacking all of the data required to make their EW systems operate as advertised and/or expected. I cannot count the number of times I have added a database support amendment to an FMS (Foreign Military Sale) case or a proviso in a DCS (direct commercial sale) license because it was a requirement that the program manager (both a US and/or international manager) did not think about in program development.

This Old Crow believes it is time that database support (is there a more appropriate term?) should be given a higher priority when program managers plan the development or purchase of an EW system. By way of example, in the United States, the Electronic Warfare Integrated Reprogramming Database (EWIRDB), the main Department of Defense (DOD) product used for initial development and programming of EW systems, is a living document. A dedicated team of database managers and analysts keeps information on more than 2,300 radars updated on a daily basis. Other nations maintain their own EW databases. Every EW system developer should make sure that databases are funded as an integral part of his or her programs. For the international customer purchasing EW systems from another government or directly through a commercial supplier, it is important to determine if database support is addressed in your case or license. If not, you should ask why. Database support is an important piece of the pie for EW systems development and for the logistical tail required to keep the EW system working to protect pilots, sailors, marines and soldiers in harm's way.

– Kermit Quick

foto: AERONAUTICA MILITARE - "Troupe Azzurra".

GREAT PERFORMANCES.

SMALL "ITEMS".

DESIGN AND PRODUCTION OF ELECTRONIC DEFENCE SYSTEMS.

elt
ELETTRONICA
mind is the first defence

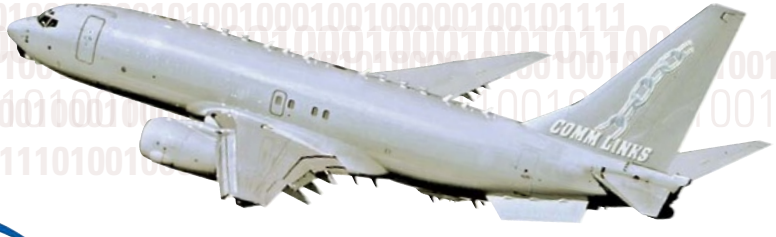
See the Light...

CCS Cosite Communication Solutions

Carefully designed communications links may fall short – interference eats away at your link margin. Co-sited transmitters emit broadband noise, your receiver is overloaded with out of band signals, and even rusty bolt effects result in unintended interference in your system. Can you hear? Are you being heard?

Pole/Zero can analyze your system and apply its vast database of knowledge and extensive line of range-restoring solutions. Selective agile filters and high dynamic range amplifiers, in carefully chosen configurations, clear the interference haze. For HF to microwave, transmit, receive, duplex, multicoupled, airborne, ground, maritime, SINCGARS, HAVEQUICK, SATURN, custom systems…

Recover your range – clear the haze by contacting one of our cosite communications engineers today!



POLE ZERO
CMP
A DOVER COMPANY

513.870.9060
fax 513.870.9064
www.polezero.com

DIRCM SYSTEM DEBUTS ON USMC HELICOPTERS

The first operational flight of a US Marine Corps CH-53E Super Stallion helicopter equipped with a laser-based directional infrared countermeasures (DIRCM) system for protection against shoulder-launched IR-guided missiles occurred in the Al Anbar Province of western Iraq January 18. The helicopter belonged to Marine Heavy Helicopter Squadron 466 of the 3rd Marine Air Wing from Camp Pendleton, CA. Navy CAPT Paul Overstreet, Commander of the Advanced Tactical Aircraft Protection Systems Program Office (PMA-272) at Naval Air Systems Command, NAS Patuxent River, MD, told *JED* that three of the large CH-53Es fitted with the AAQ-24 DIRCM system were following in Iraq. Additional CH-53Es were being outfitted with the DIRCM kits at a rate of three per month at MCAS New River, NC, and MCAS Miramar, CA, and then shipped to Iraq aboard Air Force C-5 transports.

The Navy and Marine Corps call their DIRCM system, built by Northrop Grumman's Defensive Systems Division (Rolling Meadows, IL), the AAQ-24(V)25 Department of the Navy Large Aircraft IRCM (DoN LAIRCM) system. The Marine Corps' CH-53Es receiving the DoN LAIRCM systems are the first US military aircraft to be outfitted with the new two-color IR missile warning system (MWS). (The Air Force version of LAIRCM uses the ultra-violet-based AAR-54, but it soon will be upgraded to the two-color IR MWS.) Overstreet said the DoN LAIRCM systems on the CH-53Es in Iraq had proven to be very effective and had suffered no operational failures. The two-color IR MWS was providing highly desirable low false-alarm rates, he said.

Last fall, PMA-272 conducted an early operational assessment of DoN LAIRCM before buying the first 32 systems and starting to field them on CH-53Es bound for Iraq. A two-month full operational test of the system on the CH-53E started early last month at Patuxent River and China Lake, CA, and, if successful, will lead to a full-rate production decision, he said. The program is on schedule to achieve an initial operational capability with 12 CH-53Es outfitted by the end of May.

Marine Corps CH-46E and CH-53D helicopters also are slated to receive the DoN LAIRCM system after the CH-53Es. Development testing on the CH-46E to validate the DoN LAIRCM installation will begin this summer and on the CH-53D in September. The Corps plans to install DoN LAIRCM on a total of 156 helicopters (split between the CH-46E, CH-53D and CH-53E), Overstreet said. Each of them will have two laser jam heads (one on each side of the aircraft) and five warning sensors. The DoN LAIRCM system with the two-color IR MWS sensors, which also can trigger the dispensing of expendable flare decoys, is the most advanced DIRCM system in the world, he said, and greatly enhances the survivability of the CH-53E.

PMA-272 plans to develop a more advanced MWS for Marine Corps and Navy rotary-wing aircraft called the Joint and Allied Threat Awareness System (JATAS), which ultimately will replace the two-color IR MWS. Industry bids were submitted last month. NAVAIR anticipates awarding a 16-month Technology Development contract to each of two companies late this summer, and then will down-select to a single company for an Engineering and Manufacturing Development phase in FY2011.

The lead platform for JATAS is the Marine Corps' new MV-22 Osprey tiltrotor aircraft, which currently counters shoulder-fired IR missile threats using the AAR-47 UV MWS built by ATK to trigger flare dispensing. The latest AAR-47B(V)2 version, installed on the MV-22 and being retrofitted on Marine and Navy AH-1, UH-1 and H-60 helicopters equipped with the AAR-47A(V)2, embeds a laser warning detector in each sensor head and offers improved clutter detection and reduced false alarms.

These helicopters are too small to be fitted with the DoN LAIRCM system but ultimately will receive the JATAS MWS. The MV-22 can accommodate the DoN LAIRCM, but the Marine Corps leadership decided to give priority to installing it first on the low-and-slow-flying CH-53s and CH-46s, Overstreet said. The MV-22 is less vulnerable to IR missile threats

Georgia Tech Research Institute | AOC

Emerging EW Technologies Conference
NEW DATE: June 16-18, 2009
GTRI, Atlanta, GA

Register Now—Limited Seating!

Sessions and Topics:

- Threats
- Disruptive EW
- EW Aspects of Directed Energy Technology
- Networked EW
- IRArray Based Missile Systems – An Evolving Threat
- Evolving EW Technology
- Experts from research labs, DoD, and industry!

Visit the AOC website for more information.

EW Modeling and Simulation Conference
July 28 - 31, 2009
Nellis AFB & The Rio Hotel
Las Vegas, NV

Multiple aspects addressed in modeling/simulation:

- Training
- Exercise
- Planning
- Analytical
- R&D

JEPAC presentations on live-fly exercises results and way-ahead for Joint Modeling/ Simulation

July 28/29 sessions open for world-wide attendees!

AOC hosted special events:
July 28—Golf at Rio Seco
July 28—Reception at Rio
July 29—Reception at Rio

AOC
ELECTRONIC WARFARE CAPABILITY GAPS & ENABLING TECHNOLOGIES
MAY 5-7, 2009
CRANE, IN

EW Capability Gaps & Enabling Technologies

Don't miss the conference that was lauded as "Best EW Conference Attended" by last year's attendees!

Conference kick-off with an informational brief on FSA.

Registration is online.

This conference met capacity last year so sign-up early to guarantee your seat!

Upcoming AOC Conferences:

Space Protection, **August 27-29**
Kirtland AFB, NM

Passive Covert Radar
September 15-17
Syracuse, NY

World Wide EW Infrastructure
October 6-8
GTRI, Atlanta, GA

Low Probability of Intercept, ELINT/ SIGINT
November 17-19
Naval Post Graduate School, Monterey, CA

Interested in sponsoring a conference?
Contact Kent Barker at 703-445-7798
or email barker@crows.org

Single conference sponsorship or conference packages available!

For more information visit www.myaoc.org.

because it flies higher and faster than the -53s and -46s.

As a follow-on to JATAS, PMA-272 had planned a development program for a lighter, miniaturized Assault DIRCM system for the MV-22 that also would fit on all of the small USMC/Navy helicopters. However, as a result of a decision by John Young, the Under Secretary of Defense for Acquisition, Technology and Logistics, the Navy and Army are dividing up responsibilities for future rotary-wing IRCM development. PMA-272 will develop missile warning systems such as JATAS for both services, while the Army's Program Executive Office for Intelligence, Electronic Warfare & Sensors (PEO IEW&S) at Fort Monmouth, NJ, will develop the smaller DIRCM systems that both services need, he said. – *G. Goodman*

US ARMY PROCURES NEW SIGINT SYSTEM

The US Army has selected General Dynamics C4 Systems (Scottsdale, AZ) to supply an improved follow-on to its current Humvee-mounted Prophet Spiral 1 electronic support signals-intelligence (SIGINT) system called Prophet Enhanced (PE). Prophet is the Army's principal ground-based tactical communications-intelligence (COMINT) sensor, providing force protection and intelligence support to brigade combat teams and armored cavalry regiments.

PE involves a retrofit of the existing Prophet Spiral 1 ES system in the form of an A-kit (installation kit with mounting hardware, cables, etc.) and a B-kit (sensors, antennas and associated hardware and software) for the M1165 up-armored Humvee, as well as the Cougar 6x6 Mine-Resistant Ambush-Protected (MRAP) armored vehicle. Each of the wheeled vehicles also will carry a man-pack configuration of PE. In addition, the B-kit will be removable to provide a dismounted capability, and will feature wide-band satellite communications. Prophet already can detect line-of-sight signals and provide direction-finding on the move, a first for a tactical SIGINT system.

A key feature of PE is that it will feature an open-system architecture that can be rapidly adapted through software upgrades – rather than by adding a new hardware box to the vehicle – to keep pace with the changing threat signals of interest resulting from the communications products commercially available today. The Army wants the ability to readily incorporate new software applications into PE developed by US intelligence agencies or industry vendors that counter particular signal sets.

General Dynamics was awarded an initial $70.8 million for 37 B-kits and 19 A-kits, but the company could receive up to $866 million under the six-year, indefinite delivery-indefinite quantity (ID/IQ) contract. Its principal subcontractors are L-3 Linkabit and Northrop Grumman. To expedite fielding, the first PE systems delivered will undergo limited testing and then will be deployed rapidly overseas as early as six months after contract award. Other PE systems will undergo more extensive testing this summer, leading to a First Unit Equipped milestone late this year or early next year.

The Prophet Spiral 1 ES sensor system is built by L-3 Linkabit (San Diego, CA). The Army ordered 126 systems, and deliveries began in 2007. The service also has 22 trailer-mounted Prophet electron-

ic attack (EA) jamming variants, built by General Dynamics. A PE capability beyond the baseline system that is desired by the Army is an EA subsystem integrated on the Humvee or Cougar PE vehicle itself instead of being trailer-mounted. The Prophet program is managed by the Army's Program Executive Office for Intelligence, Electronic Warfare & Sensors at Fort Monmouth, NJ. – *G. Goodman*

US NAVY RELEASES SEWIP RFP

US Naval Sea Systems Command (NAVSEA) released a request for proposals (RFP) February 27 for development and production of the SLQ-32X(V) Surface Electronic Warfare Improvement Program (SEWIP) Block 2 system. The scope of work encompasses Preliminary Design, Engineering and Manufacturing Development and Low-Rate Initial Production of SEWIP Block 2 forward-fit, back-fit and shore-based configurations. Bids are due April 24. The Navy plans to award a single industry contract this fall.

SEWIP Block 2 is the largest Navy surface ship EW acquisition program in many years, so capturing the contract is a high priority for the key industry competitors. BAE Systems is teamed with General Dynamics AIS, and Lockheed Martin-Syracuse with ITT Reconnaissance and Surveillance Systems (formerly EDO). Northrop Grumman Electronic Systems and SLQ-32 manufacturer Raytheon EW Systems are the other two expected bidders.

The SLQ-32(V) electronic support measures (ESM) system, introduced into the fleet in the early 1980s, is the Navy's primary soft-kill EW air defense system. It provides early warning and

USMC EYES UNMANNED JAMMER AS PROWLER REPLACEMENT

The US Marine Corps (USMC) is considering a new class of unmanned aerial systems (UAS) to help replace its fleet of EA-6B Prowlers, it revealed in February at the Association for Unmanned Vehicle Systems International's (AUVSI) Unmanned Systems Program Review. The announcement, made by Maj. Thomas Heffern, the service's UAS capabilities officer, follows several years of plans that the F-35B Joint Strike Fighter (JSF) be fitted with next-generation jammer pods and used as a replacement.

The USMC is looking at the possibility of a future Tier-III UAS, newly classified as the "Group 4" aircraft, which could support its airborne electronic attack mission. Despite its early consideration of a handful of candidates, including Bell Helicopter's Eagle Eye tiltrotor and Boeing's A160 Hummingbird aircraft, the service still is looking for a UAS with 14 to 30 hours of endurance, a notional radius of 350 to 450 miles and enough capability to haul a 1,500-lb. payload, plus possibly a future cargo lift system.

It still is undecided if the Group 4 aircraft mainly will be used for vertical takeoffs and landings or short, low-altitude operations, but the USMC has made clear that in addition to its EW role, the aircraft also will have intelligence, surveillance, reconnaissance and target acquisition (ISR)/TA functions. – *M. Kunkel*

classification of detected radar-based threats, particularly radar-guided anti-ship cruise missiles. About half of the fleet's SLQ-32s, predominantly those on larger ship classes, also have an active radar jamming capability. SEWIP Block 2 will be the first major hardware upgrade to key portions of the SLQ-32 ESM system, specifically its receiver/antenna group and combat system interface, effectively creating a new-generation shipboard EW system with much greater capability. The new digital receiver will use advanced signal processing techniques to passively detect and identify more radio-frequency emitters at longer ranges and provide more precise angle-of-arrival information on detected threat signals.

A key requirement for SEWIP Block 2 is that it features a non-proprietary open-systems architecture with industry standards-based interfaces, facilitating technology insertion through quick and inexpensive software and hardware upgrades over time to keep pace with emerging threats and incorporate technology advances. SEWIP Block 2 also will provide a modular enterprise EW solution that is common and scalable across various ship classes.

The SEWIP Block 2 forward-fit configuration will be designed for installation on the planned CVN-78 next-generation aircraft carrier and DDG-1000 guided-missile destroyer classes of ships. It will include four antenna arrays that are integral with the hull structure, according to the RFP. The back-fit configuration will be installed on existing DDG-51 Aegis destroyers. It will use two antenna enclosures and co-locate two antennas and supporting electronics within each enclosure.

The Navy has pursued a low-risk evolutionary series of enhancements to its SLQ-32s under SEWIP. The initial series of SEWIP Block 1 upgrades, layered on top of the SLQ-32's 1970s-vintage ESM technology, has included the addition of a modern signal-processing computer and some adjunct stand-alone sensor systems.

The NAVSEA point of contact is John Butto at (202) 781-2594, e-mail john.butto@navy.mil. The SEWIP program is managed by the Navy's Program Executive Office for Integrated Warfare Systems, co-located with NAVSEA at the Washington DC Navy Yard. – *G. Goodman*

IN BRIEF

ITT (Clifton, NJ) announced March 10 that it won a $317 million, follow-on contract from the US Navy for 4,501 CREW 2.1 Vehicle Receiver Jammers (CVRJs), which help protect soldiers against detonating improvised explosive devices (IEDs). The order, part of a $1.7 billion contract for as many as 25,000 CVRJ deliveries, comes after the delivery of 12,000 systems already. The jammers will be used by the US Marine Corps.

✪ ✪ ✪

Herley Industries (Lancaster, PA) has won a pair of contracts to deliver imtegrated microwave assemblies for EW systems on a US Navy electronic attack aircraft. The company's Herley New England subsidiary in Woburn, MA, received an $8.2 milion award. Herley CTI (Whippany, NJ) received a $2.3 million award.

BAE Systems (Nashua, NH) won a $7.9 million contract from the US Navy to provide Quick Reaction Dismounted Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (CREW) systems in support of the Global War on Terror (GWOT). The contract includes options that would boost its worth to $32.5 million. The systems are slated for completion in February 2010, and most work will take place in Iraq, as well as Rockville, MD, and Nashua, NH.

ITT Electronic Systems (Clifton, NJ) received an $8.6 million follow-on contract from the US Navy for the ALQ-214 Engineering Change Proposal (ECP), which is focused on modifying the ALQ-214, a radio frequency (RF) countermeasures system on F/A-18 E/F aircraft. Work mostly will take place in Clifton, with some work in Hillsboro, OR, and Chandler, AZ, and will finish by December 2009.

LaBarge Inc. (St. Louis, MO) was awarded a $1.7 million follow-on contract from Northrop Grumman (Los Angeles, CA) for electronic assemblies for ALQ-135 radar jammer systems on F-15 aircraft. Originally assigned in 2005, the contract calls for work to be performed at LaBarge's Tulsa, OK, facility for completion by December 2009.

Chesapeake Technology International Corp. (California, MD) was selected for a $9.9 million contract by the US Navy to provide engineering, technical and program services for communications jamming and receiver operational flight program simulations for EA-6B, EA-18G and other electronic attack (EA) aircraft. The simulations are slated for design, development, integration, testing and distribution among US Navy fleets. Work will occur in California, MD; Cherry Point, NC; Point Mugu, CA; Whidbey Island, WA; China Lake, CA; Patuxent River, MD; Iwakuni, Japan; and Yuma, AZ; with plans to finish by February 2014.

The **US Army** issued a request for information (RFI) about upgrades to the Duke VLQ-12(V)2, a Counter Radio-Controlled Improvised Explosive Device (RCIED) Electronic Warfare (CREW) system. Currently, the Army is only seeking information, not proposals, but it anticipates awarding a five-year contract for the upgrades in August 2009. The point of contact is Asif Damji at (732) 427-1458.

Raytheon (Goleta, CA) was awarded a $9.9 million follow-on contract from the US Navy February 27 for development, production and engineering support to the ALR-67(V)3 radar warning receiver (RWR) on F/A-18E/F Super Hornet aircraft. For a two-year performance time, Raytheon will lend its services to the Navy's Tactical Aircraft Electronic Warfare (EW) Integrated Product Team.

The perfect synthesis of low noise, speed, and wide bandwidth

- Wide bandwidth: 10 MHz to 40.96 GHz
- Step sizes: down to 1Hz
- 1-Hz full-band coherent switching
- Low phase noise: -120 dBc/Hz, typical at 10-kHz offset at 10 GHz
- Harmonic filters
- 200-ns switching speed available
- Industry-standard BCD programming
- Locks to an external or internal reference
- Modulation options: FM, Pulse, I&Q
- Four FM modes
- Digital frequency sweep
- Digital attenuator option
- Touch screen front-panel display
- Low-profile chassis or compact modular package configurations
- 2U height configurations available
- IEEE-488, GPIB & Ethernet capability
- Universal AC Supply

HERLEY-CTI

Series DS Direct Synthesizer

With ultra-low phase noise that rivals premium fixed-frequency sources, the DS Series offers very fast switching, extremely broad bandwidth in a single unit, and step sizes down to 1 Hz. Get the performance, speed, and flexibility you need for radar, RCS, EW, simulators, automatic test equipment, and frequency-agile equipment. Plus, 1-Hz coherent switching allows improved signature measurements.

For direct synthesizers, count on Herley for performance, reliability, service, and delivery.

For more information or to speak to a marketing representative, call 973-884-2580. Or e-mail us at sales@herley-cti.com.

Frequency Range (MHz)	Phase Noise (dBc/Hz)				
	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
10 GHz	-90	-110	-120	-120	-130
18 GHz	-84	-104	-114	-114	-124
40 GHz	-77	-97	-107	-107	-117

HERLEY Industries, Inc.

Proven Microwave Performance

www.herley.com

Herley-CTI, 9 Whippany Rd, Whippany, NJ 07981 • Telephone: 973-884-2580
FAX: 973-887-6245 • www.herley.com • sales@herley-cti.com

washington report

NEXT-GENERATION JAMMER ON TRACK

Naval Air Systems Command (NAVAIR) plans to release a request for proposals (RFP) for follow-on Next-Generation Jammer (NGJ) Technology Maturation studies, following the completion in July of six-month, system-level trade studies by four industry teams. The competitors conducting the ongoing studies are BAE Systems-Cobham, ITT-Boeing, Northrop Grumman and Raytheon.

The NGJ program aims to provide a replacement for the ALQ-99 Tactical Jamming System employed by the Navy's EA-6B Prowlers and the new EA-18G Growler. The NGJ is slated to become operational in 2018 and provide a significant enhancement to the EA-18G's jamming capabilities – including greater jamming power to counter longer-range air defense systems – at a reduced operations and sustainment cost. The program is managed by the EA-6B/Airborne Electronic Attack (AEA) Program Office (PMA-234) at NAVAIR (NAS Patuxent River, MD).

CAPT Steve Kochman, who heads PMA-234, told *JED* that multiple nine-month Technology Maturation contracts would be awarded in March 2010. They will lead to a Milestone A decision by Pentagon officials allowing the start of a Technology Development phase. This phase will see the award of multiple contracts to demonstrate mature NGJ technologies in system-level prototypes. A Milestone B decision to enter an Engineering and Manufacturing Development phase with a single contractor would follow in FY2013.

A required NGJ Analysis of Alternatives (AoA) also is underway that will be completed in FY2010 prior to the Milestone A decision. Conducted by a government-industry Integrated Product Team, it entails a detailed evaluation of options to meet the NGJ requirements, including incrementally upgrading the existing ALQ-99 jamming pods instead of developing an entirely new replacement for them, and their prospective costs.

The Office of Naval Research (ONR), under its Next-Generation AEA Enabling Capability project in support of the NGJ program, awarded 10 companies initial one-year Phase 0 study contracts in November 2007 to identify the critical NGJ technologies requiring further development. ONR plans to award a second round of contracts this year. The remaining years of the NGAEA project will focus on maturing selected components, such as beam-formers and exciters, Kochman said, that could be integrated into NGJ subsystem designs.

A key design challenge for a new NGJ external jamming pod is meeting power-generation and cooling requirements. The ALQ-99 uses a nose-mounted, externally bladed ram-air turbine to provide power. It precludes putting electronic equipment in the front end of the pod, the ideal location for antennas, and it increases aerodynamic drag. Two companies, working for several years under NAVAIR Small Business Innovative Research (SBIR) contracts, have developed innovative design configurations that allow the turbine to be located internally and provide active cooling for electronic equipment. These would allow jamming equipment to be located in the forward end of the pod. The two companies are CFD Research Corporation (Huntsville, AL) and Mainstream Engineering Corp. (Rockledge, FL). "Their efforts are starting to pay off," Kochman said. "Right now, I see them as the primary players investing in this particular technology. Their SBIR work is in Phase 2 and will lead to a subsequent phase with prototype demonstrations. We will expect our prime contractors to integrate those capabilities into their designs."

The Marine Corps hopes the NGJ program will provide a new external jamming pod or internal jamming system for its planned F-35B Joint Strike Fighter (JSF) to replace its EA-6Bs, which it plans to keep in service until 2018-2020 – six to eight years longer than the Navy. "It's really important what the F-35's concept of operations is," Kochman said. "How would you employ the NGJ from an F-35? The Marine Corps has been tasked to work with the other services to lead an analysis of that F-35 CONOPS and to feed it into the AoA." Another desirable outcome of the NGJ program is a scalable jamming system, a version of which could be carried on an unmanned aerial vehicle, he said.

Kochman added that his program office is working on integrating a jamming package on the Navy's turbojet-powered Improved Tactical Air-Launched Decoy (ITALD), 400 to 500 of which are in its inventory. He said ITALD-J would complement the Air Force's new Miniature Air-Launched Decoy-Jammer (MALD-J), which is slated for fielding in late 2012.
– *G. Goodman*

The goal is to become battle-hardened before the battle ever starts. At Northrop Grumman, our electronic warfare (EW) simulation products are as vivid as the real thing. Specializing in RF and IR threat simulators, we enable pilots and shipboard operators to locate, identify, and counter enemy missiles, employing the tactics they'll need to survive in actual combat. We also help the military test and evaluate new EW systems, as well as train EW systems operators. With over 30 years of leadership in this field, Northrop Grumman is able to offer full EW solutions at affordable prices. So, when the battle starts and the threats are real, there won't be any surprises.

www.northropgrumman.com

world report

AUSTRALIA MAY BUY EA-18 "GROWLER LITE"

The Royal Australian Air Force (RAAF) has exercised a $35 million option in its F/A-18E/F contract with Boeing which will enable it to upgrade part of its Super Hornet fleet to the Growler configuration. The decision, announced in late February, calls for Boeing to modify 12 of the 24 Super Hornets the RAAF has ordered from Boeing to be modified to accept ESM and EA upgrades in the future.

Boeing is offering a version of the EA-18G Growler, dubbed Growler Lite, which would provide an ESM-only capability. The US Navy version of the Growler uses the ALQ-218 ESM system from Northrop Grumman. This is presumably what the RAAF would buy. The Growler Lite configuration does not include ALQ-99 jamming pods, although the RAAF could eventually buy these pods if and when they are retired from US Navy service. Another option open to the RAAF is to buy support-jamming pods from another source, assuming the US grants permission and the integration cost is not prohibitive. Elisra of Israel and Elettronica of Italy are marketing support-jamming pods for strike aircraft.

While much has been made of the RAAF's Growler Lite decision, it is in the very early stages and will most likely be an incrementally acquired capability. The RAAF can wait until 2010 to decide whether or not it wants to buy the ALQ-218 ESM systems that it would need for the Growler Lite configuration. It would then consider its options for acquiring electronic attack systems. – *M. Kunkel and J. Knowles*

IN BRIEF

- **BAE Systems Australia** (Adelaide, Australia) confirmed March 11 the successful flight test of its Electronic Warfare Self-Protection (EWSP) system, or "Echidna," for the Australian Army's UH-60 Black Hawk and CH-47 Chinook helicopters. The system, which has radar warning and missile warning receivers and a countermeasures dispensing system, plus options for additional sensors and countermeasures for larger platforms, was tested in a pod mounted on a Lear jet. More flight tests are scheduled next month.
- **India's** Defence Research and Development Organisation (DRDO) and Anna University, also of India, signed a Memorandum of Understanding (MoU) in late February to make official their joint research and development of combat vehicles and systems. The two groups have worked previously on developing combat vehicles, but the agreement formalized their five-year goal to produce 12 vehicles for the India-built Arjun main battle tank (MBT) program, which will include laser warning systems, automatic target tracking systems and other defensive aids.
- **ITT Electronic Systems** (Clifton, NJ) has received a $99.8 million contract to deliver ALQ-211(V)4 Advanced Integrated Defensive Electronic Warfare Systems (AIDEWS) and countermeasures dispensing systems for the Turkish Air Force's 30 new F-16 Block 50M aircraft. The three-year contract, made through US Foreign Military Sales (FMS) channels, calls for the company to produce, customize and install the systems beginning in 2010. Poland, Oman, Chile and Pakistan have also ordered the AIDEWS for their F-16s
- **Raytheon** (Goleta, CA) was awarded a $9.9 million contract to supply products and engineering services for its ALR-67(V)3 digital radar warning receiver (RWR) on F/A-18 A-F aircraft owned by the US Navy, Canada, Australia and Switzerland. Most of the contract work, negotiated through Foreign Military Sales (FMS) channels, will go toward the US Navy, with 15 percent to each of the international users. Work will take place in Goleta; Point Mugu, CA; and China Lake, CA; and is scheduled for completion by February 2011.
- **Bharat Electronics Ltd. (BEL)** (Hyderabad, India) and Hyderabad-based Astra Microwave Products Ltd. Corporation, in a Memorandum of Understanding (MoU) in late February, agreed to jointly launch a company that designs and develops microwave components and subsystems for weapons systems, including radars and electronic warfare (EW) systems, for Indian and international customers. Astra Microwave manufactures radio-frequency (RF) and microwave components for defense applications.
- **Elettronica S.p.A.** (Bologna, Italy) and Global Force Capital (Abu Dhabi, UAE) announced in late February their plans to build a gold and silver refinery in Abu Dhabi. Slated to be the largest dual refinery in the region, the facility will cost $18.3 million. It represents Elettronica's efforts to meet its offset obligations in its defense equipment dealings with the UAE Armed Forces, and was encouraged by UAE's Offset Program Bureau, which aims to diminish the supply-demand gap for gold and silver in the region. Global Force Capitol Chairman Khalid Ahmed Al Mansoor will own 51 percent of the refinery, with Elettronica and other investors owning the rest.

2009 InfowarCon™

InfowarCon 2009 is just days away!

The most important Information Operations conference of 2009! Register Today!

April 23–24

Gaylord National Resort and Convention Center
National Harbor, MD

REASONS WHY YOU SHOULD ATTEND THIS EVENT

- Network with IO Professionals
- Learn from the greatest minds in your field from around the world
- Improve your ability to do your job
- Discuss shaping the future; catch up on the latest developments, discussions, problems and efforts
- Observe a raucous hacking competition

Thursday, April 23

- Keynote: LTG Thomas Metz, IO: *The Great Enabler*
- The Future of IO
- SC in a Global Information Environment
- Cyberwar - 2008 Russian invasion of Georgia
- Innovation beyond the Pillars
- The New Arab Media
- CNA/CND Live Fire Exercise

Friday, April 24

- Keynote: Former Undersecretary of State for Public Diplomacy and Public Affairs, James Glassman, *"Can a 'Conversation' Win the War on Terror?"*
- IO: A Warfighter's Perspective
- US Cybersecurity: Where's Next?
- The Media and Information Dispersal in Afghanistan
- Chinese Information Warfare

To honor and help educate our nation's warriors, uniformed US and allied military members are invited to participate FREE in InfowarCon 2009.

Register in advance by April 10 or register on-site.

www.InfowarCon.com

or call (703) 549-1600

Lethal SEAD

By Glenn Goodman

US Navy and US Air Force pursue different paths to counter SAM threats

Suppression of enemy air defenses (SEAD) has long been a critical mission essential to US and allied air superiority and all that springs from it. Even in an era of low-observable aircraft, SEAD is an essential means of reducing aircraft vulnerability to surface-to-air missile (SAM) defenses. Going back to the Vietnam War, SEAD has aimed primarily at countering radar-guided threats to US Air Force (USAF) and Navy attack aircraft to allow them to penetrate heavily defended areas to reach their targets, reducing aircraft losses.

Non-lethal means of SEAD have included the use of support jamming aircraft, such as the Navy's EA-6B Prowler, to protect packages of strike aircraft by temporarily blinding enemy early-warning, SAM and anti-aircraft artillery (AAA) radars. Lethal SEAD largely has entailed using dedicated strike aircraft to try to destroy these radars permanently in advance of attack aircraft by launching air-to-surface, anti-radiation homing (ARH) missiles. These missiles passively guide themselves by following a radar's radio-frequency emissions back to their source and actually hitting the radar dish or array itself. Successful SEAD also is achieved if enemy SAM radar operators choose to stay off the air for fear of being targeted by anti-radiation missiles.

During the extensive air campaigns mounted by coalition forces in Operations Desert Storm, Allied Force and Iraqi Freedom, stealthy Air Force F-117 fighters and B-2 bombers and Navy ship-launched Tomahawk cruise missiles (as well as Army Apache attack helicopters in some instances) actually conducted the initial lethal SEAD missions by attacking some key air defense command-and-control centers or early-warning acquisition radars. Lethal SEAD fighter aircraft subsequently fired large numbers of AGM-88 High-Speed Anti-Radiation Missiles (HARMs), particularly at SAM control radars.

During Operation Allied Force in 1999, for example, Navy, Air Force and allied aircraft launched more than 1,000 HARMs against Serbian air defense radars. During Operation Iraqi Freedom in March 2003, they fired more than 400 HARMs. US aircraft also have fired tactical air-launched decoys from stand-off ranges to stimulate enemy air defense radars to start emitting in advance of HARM-equipped aircraft. SEAD missions, including non-lethal jamming by EA-6Bs and Air Force EC-130H Compass Call aircraft, were crucial in neutralizing

the SAM threats posed to non-stealthy attack aircraft in these air campaigns by Soviet-style integrated air defense systems (IADS).

The Navy and Air Force now are following different paths to maintain the lethal SEAD capabilities of their fighter aircraft. HARMs and upgraded HARM derivatives still figure prominently in the plans of both services as they seek to overcome the ARH missile's major drawback – its loss of guidance if an enemy radar stops transmitting. As a result,

the two services are pursuing separate programs to give HARM a capability to attack non-radiating radar systems accurately. This would give the missile what the services call a true destruction of enemy air defenses (DEAD or "deed') capability.

The Navy plans to add new multimode guidance capabilities to a sizeable portion of its HARM inventory in the form of the AGM-88E Advanced Anti-Radiation Guided Missile (AARGM), now in low-rate production. This modification program for existing HARMs will allow the supersonic missile to destroy air defense units even when they employ radar shutdown tactics, as well as nontraditional non-emitting targets.

The Air Force has not participated in the AARGM program. It is pursuing a less extensive, lower-cost HARM guidance upgrade called the HARM DEAD Attack Module (HDAM) that it hopes to begin funding in FY2010. It also will allow HARM to strike non-radiating targets accurately. Another thrust of the Air Force's lethal SEAD strategy involves networking receivers or other sensors on multiple aircraft to rapidly pinpoint the location of mobile SAM radars for targeting before they relocate.

The advent of global positioning system (GPS)-guided bombs, such as the Joint Direct Attack Munition (JDAM), has given any strike aircraft the ability to destroy or damage – with five-meter accuracy – an air defense site whose coordinates are known. But JDAMs have a range of only five to 15 miles, making non-stealthy launch aircraft vulnerable to SAMs and AAA. GPS-guided air-to-surface missiles, such as the Navy-Air Force Joint Stand-off Weapon (JSOW) and the Navy's Standoff Land-Attack Missile-Expanded Response (SLAM-ER), can be launched from outside of the lethal range of most SAMs to attack stationary air defense targets. However, unlike the supersonic HARM, they have the disadvantage of long flight times during which an air defense system might shut down and relocate.

EXPANDING HARM'S CAPABILITIES

The AGM-88 HARM, built by Raytheon Missile Systems (Tucson, AZ), is the primary lethal SEAD air-to-surface stand-off weapon used by both Navy and Air Force tactical aircraft since 1984. The 800-pound missile, no longer in production, is nearly 14 feet long and 10 inches in diameter. Its warhead weighs 150 pounds. The fire-and-forget HARM's unclassified range is more than 30 miles.

HARM can be fired "blind" in a long-range preemptive mode in the direction of threat radars before locking on to one. More often, fighter aircraft use HARM's ARH seeker before the missile is launched to detect and identify enemy radar emitters and the bearing to them. Threat emission characteristics and directional data from the aircraft's radar warning receiver also can complement the HARM seeker's target information.

The Navy, which developed HARM, has an inventory of more than 5,000 of the missiles; the Air Force also has several thousand. Navy HARMs are fired by EA-6B Prowlers and single-seat F/A-18C and two-seat F/A-18D Hornets. The Air Force's HARMs are only fired by single-

seat F-16CJ Block 50 aircraft, which are dedicated to the lethal SEAD mission.

The Air Force retired its vaunted but aging F-4G Wild Weasel dedicated lethal SEAD aircraft in the mid-1990s and shifted the mission to new single-seat F-16CJ Block 50 aircraft fitted with the external ASQ-213 HARM Targeting System (HTS) pod built by Raytheon Missile Systems. The F-16/HTS combination became operational in 1994. The Air Force has an inventory of more than 250 HTS pods, which have been upgraded over time.

The latest Release 7 (R7) pod features a new digital receiver and a GPS receiver, in addition to redesigned software. The Air Force has been upgrading all of its HTS pods to the R7 configuration, which Raytheon began developing in 2001 under the F-16 Smart Targeting and Identification via Networked Geolocation (STING) program. The R7 installation on the F-16CJ involves moving the pod to the aircraft's left inlet hardpoint, allowing simultaneous carriage of HTS and the Sniper electro-optical/infrared targeting pod built by Lockheed Martin. Together, the two systems enable the F-16CJ to engage emitters via GPS-guided munitions.

R7 has provided a new lethal SEAD capability to precisely geolocate SAM radars in seconds, before they move, via cooperative multi-aircraft targeting algorithms originally developed under the Defense Advanced Research Projects Agency's (DARPA) Advanced Tactical Targeting Technology (AT3) program. Raytheon's (Goleta, CA) AT3 involves networking multiple receivers on three or more F-16CJs to exchange time and frequency difference of arrival information on threat emissions and essentially triangulate the precise location of the emitter.

A similar Air Force technology program for rapidly pinpointing the locations of mobile air defense emitters is called Network-Centric Collaborative Targeting (NCCT), developed by L-3 Communications' ComCept division (Rockwall, TX). Its advanced algorithms translate dissimilar sensor data on the same emitter supplied by networked intelligence, surveillance and reconnaissance (ISR) aircraft into a common language and correlate the data within minutes to reduce the target location error. NCCT has been fielded on Air Force RC-135 Rivet Joint signals intelligence (SIGINT) aircraft and will be installed on Air Force Compass Call jamming aircraft beginning this year.

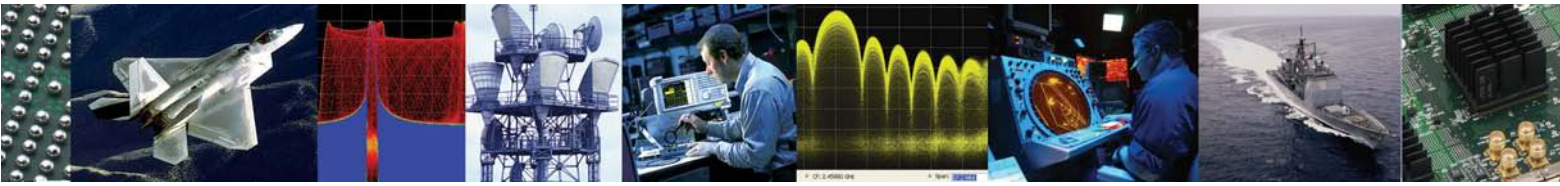
THE NAVY'S HARM UPGRADE

The Navy's AARGM, developed by ATK's Advanced Weapons Division (Woodland Hills, CA), is a cooperative development program with the Italian Air Force (Aeronautica Militare). It entered low-rate initial production (LRIP) at ATK last December with the award of a $55 million contract by US Naval Air Systems Command.

AARGM retains the HARM's warhead, wings, fins and rocket motor. The HARM control section is upgraded with a GPS/inertial navigation system (GPS/INS), and its front-end seeker section is completely replaced. The new multi-mode seeker section features a more sensitive ARH seeker with a digital receiver, and an active millimeter-wave (MMW)-radar seeker. The latter is used for terminal guidance when a target radar shuts down after the AARGM is launched.

Navy CAPT Larry Egbert, who heads the Direct and Time-Sensitive Strike Program Office (PMA-242) at Naval Air Systems Command, Patuxent River, MD, told *JED*, "The improved ARH passive receiver features greater emitter detection range and expanded threat coverage. It provides very accurate emitter geolocation information to the missile prior to launch and during flight. AARGM's guidance algorithms fuse inputs from the ARH, GPS and MMW radar seeker to find and destroy air defense units even when they employ countermeasures such as the shutdown tactics. When a threat radar stops emitting, the GPS/INS keeps the missile heading toward the radar's last known position. Then the MMW seeker kicks in and actively searches to find the non-emitting enemy radar autonomously." He said that the MMW seeker draws on a library of threat system characteristics to identify a target.

Egbert noted, "With the introduction of the GPS/INS, AARGM can be used as a precision point-to-point weapon. It amounts to a first-generation high-speed strike weapon for attacking non-emitting, time-sensitive, high-value targets.



need more bandwidth?
focused on EW, SIGINT or radar systems?

maxtek delivers:

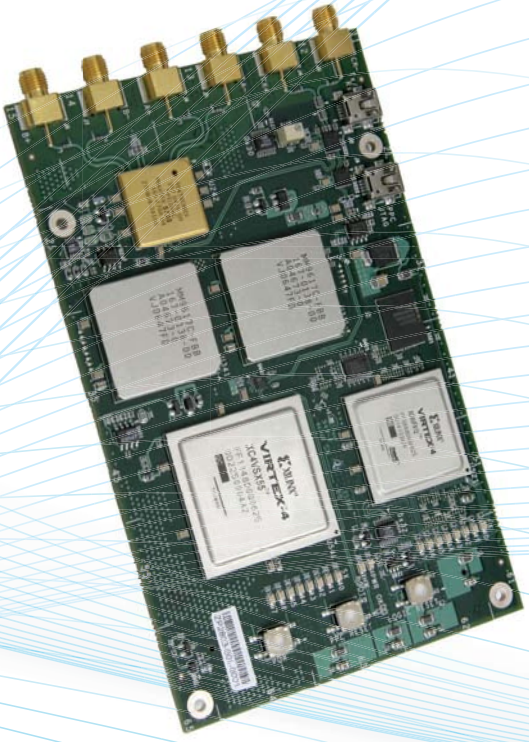
6.25 GHz analog bandwidth & 12.5 GS/s digitizers
9.0 GHz analog bandwidth & 12.0 GS/s DACs

Incorporating Tektronix IC technology to enable:

Ultra-wide-band sampling
Direct digital up- and down-conversion
Digital demodulation and channelization
Broad direct frequency synthesis

Digitizer and DAC reference designs enable immediate prototyping and proof-of-concept demonstrations

Maxtek-engineered custom solutions available to achieve demanding form factor, cost and performance requirements



For more information:

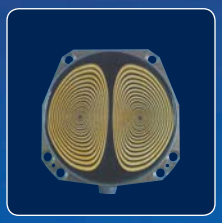
www.maxtek.com/jed.html
technology@maxtek.com
800.462.9835

real-time. faster. proven.

maxtek
A Tektronix Company

The whole is far greater than the sum of its parts

Cobham Microwave Systems consists of these groups: Sensor & Antenna Systems, Active Microwave Sub-systems, and Passive Microwave Sub-systems. For added assurance, all our products, from the smallest MMIC components to the largest antenna subsystems, are designed, manufactured, tested and inspected to meet the most stringent customer specifications.



Electronic Warfare / *Ground & Mobile Communications* / *Homeland Security* / *Search & Surveillance*

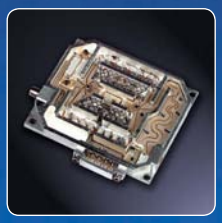
THE POWER OF INTEGR

Atlantic Positioning Systems *Atlantic Microwave* *Continental Microwave*

ATLANTIC POSITIONING SYSTEMS www.atlanticpositioners.com 727.299.0150 ATLANTIC MICROWAVE www.atlanticmicrowave.com 978.779.6963
M/A-COM www.macom.com North America 800.366.2266 Europe +44 0 1908.574200 Asia / Pacific +81.44.844.8296 NURAD www.nurad.com 410.





Radar / *Force Protection* / *Smart Munitions & Missiles* / *Satellite Communication* / *Space* / *Overhaul & Repair*

ATION WORKING FOR YOU

Kevlin *Lansdale* *M/A-COM* *Nurad* *REMEC Defense & Space* *Sivers Lab AB*

COBHAM

www.cobhamdes.com

CONTINENTAL MICROWAVE www.contmicro.com 603.775.5200 KEVLIN www.kevlin.com 978.557.2400 LANSDALE www.cobhamdes.com 215.996.2000
542.1700 REMEC DEFENSE & SPACE www.remecrds.com 858.560.1301 SIVERS LAB AB www.siverslab.se +46 8 477 6811

It doesn't have a very big warhead, but it's a Mach 2 missile that can get to a target in a hurry if its GPS coordinates are known. AARGM's real improvement in destroying nontraditional targets is when the GPS is coupled with the MMW radar. This will make AARGM a point-to-area weapon, allowing it to be used when a target's exact location may not be known or when the target is mobile and likely to leave a known location."

Another plus for AARGM is that, with the MMW seeker, the target is no longer just the emitting antenna itself as with ARH guidance alone. Aimpoint selection extends to other parts of the air defense system, such as control vans and SAM launchers, he noted.

The AARGM upgrade embeds an Integrated Broadcast Service receiver in the missile's seeker section that receives real-time intelligence threat updates. These are fed to the cockpit, cuing the aircrew to emitter locations and helping it correlate target information prior to missile launch. In addition, AARGM transmits a Weapon Impact Assessment message just prior to detonation that provides missile and target position information for battle damage assessment purposes.

Friendly-fire incidents and collateral damage have been concerns with existing HARMs. During coalition air operations over Bosnia and Serbia in the 1990s, HARM occasionally locked on to a distant friendly or civilian radar by accident after its target emitter shut down and the missile sought to acquire another emitter. In addition, during the Kosovo campaign, Serb forces often deliberately positioned SAM batteries near schools, hospitals or churches. To minimize these concerns, AARGM can be programmed to stay out of geographic avoidance zones and to only engage targets within prescribed impact zones.

AARGM entered the system development and demonstration (SDD) phase in 2003. Versions of the missile logged seven successful live-fire tests prior to SDD in advanced technology demonstrations. AARGM subsequently completed four SDD and two Operational Assessment shots successfully through last August in advance of LRIP approval.

Prior to a full-rate production decision, AARGM will undergo a nine-month independent Navy Operational Evaluation (OPEVAL) that will begin this summer. It will include 11 live firings of production-representative missiles. The Navy plans to convert 1,750 of its HARMs to AARGMs. An initial operational capability (IOC) on F/A-18C/D Hornets is slated to occur in the last quarter of 2010, Egbert said. AARGM also will be fielded on Navy F/A-18E/F Super Hornets and EA-18G Growlers beginning in 2012, as well as on Italian Tornado ECR (Electronic Combat/Reconnaissance) aircraft. The Navy will not phase out its legacy HARMs as AARGMs enter service but will retain a combination of both, he said.

The Hornet is the lead platform for AARGM. The integration efforts for the Super Hornet and the Growler – a Super Hornet derivative slated to replace the EA-6B Prowler – have begun and are occurring simultaneously. AARGM does not fit internally on the F-35 Joint Strike Fighter (JSF), Egbert said, but external carriage on the JSF is a long-term AARGM program objective.

The Italian industry subcontractors to ATK on the AARGM program are MBDA, Marconi and Vitrocisett. As this issue went to press, the US and Italian governments were negotiating the details of a memorandum of understanding (MoU) for the production phase of the program, including the number of AARGM conversion kits that Italy will buy to upgrade its HARMs. Separate industry discussions regarding potential work shares are underway. Germany and other HARM user countries have expressed interest in AARGM, but nothing is yet firm, Egbert said. Nations operating F/A-18s also are potential customers. AARGM's average procurement cost over the life of the program for the Navy's 1,750 missile buy is roughly $500,000 per missile, he said. Production for other customers would reduce this cost.

"It became clear in the air operations in which HARMs have been used that the missile is vulnerable to radar shutdowns," Egbert said. "So, over time, the Navy has made an investment to expand HARM's capability beyond just suppression – creating a sanctuary for strike aircraft for a minimal amount of time – to taking out a radar permanently. That's a capability that we need and that AARGM provides."

USAF HARM PLANS

The Air Force's prospective HDAM upgrade for its HARMs, developed by Raytheon, adds GPS/INS to the missile's control section, like the Navy's AARGM, but retains the existing seeker section

Precision Warfare

Combat-proven air power solutions for mission success.

In combat, lives depend on equipment performance. Raytheon solutions have earned a trust from the warfighter that is based on mission assurance, delivering proven performance in the most demanding conditions. As the world leader in the design, development and production of a complete range of missile systems, Raytheon provides combat-proven precision warfare solutions that offer superior reliability, dependability and capability. It's performance with NoDoubt™, mission after mission, flight after flight.

AIM-9 **AMRAAM** **JSOW** **HARM** **HDAM** **Paveway™** **Maverick** **MALD™**

www.raytheon.com

Raytheon

Customer Success Is Our Mission

with its ARH receiver. This less ambitious HARM upgrade would allow the missile to strike non-radiating targets with GPS accuracy, including radars that shut down as HARM homes in on their emissions, as well as non-air-defense high-value targets whose coordinates are known. Like AARGM, HDAM can limit the missile to striking targets within a specific geographic area, minimizing the possibility of fratricide and collateral damage.

Last September, a Raytheon Missile Systems official said his company was completing cost-reduction measures that would allow it to offer the HDAM upgrade to the US military "for far less than $100,000 per unit in 2008 dollars."

HDAM began in the mid-1990s as a Navy program with Italian and German participation called the HARM Precision Navigation Upgrade. Five of six test firings were successful, but the Navy canceled the program as it shifted to developing the more extensive AARGM upgrade with ATK. Raytheon continued funding HDAM out of its own pocket. Under a Cooperative Research and Development Agreement (CRADA) with the Air Force, Raytheon conducted three successful live HDAM firings from an F-16 in 2006 at the Navy's China Lake, CA, test range. These tests demonstrated HDAM's ability to engage non-radiating emitters and to ignore radar sources outside of its restricted impact zone.

The Air Force is interested in HDAM as a low-cost upgrade for its large inventory of HARMs. HDAM was on the service's unfunded priority list in its FY08 and FY09 budget requests, but appeared to have a good chance of receiving initial funding in the forthcoming USAF FY10 budget request. One recent positive indicator was the January release of a request for information (RFI) by the service's Air Armament Center at Eglin AFB, FL. It asked interested companies to state their capabilities to deliver 500 HDAM modification kits for AGM-88C HARMs, beginning within 18 months of contract award. The RFI, which prominently credited Raytheon's HDAM development effort under the CRADA, likely set the stage to award the company a sole-source contract in FY10. A Raytheon representative told *JED* that 2,400 Air Force AGM-88C HARMs are "ready for immediate modification."

The Air Force also is negotiating a "Replacement-Exchange-in-Kind" (REIK) program with Raytheon under which the company would refurbish older, excess HARMs from the service's inventory and sell them to international customers with a "tip-to-tail" warranty for less than half their original cost. In return, the Air Force would get credits for the missiles sold to overseas customers that it could apply to orders of HDAM kits from Raytheon. The Air Force and Raytheon have a similar program underway for excess Maverick air-to-surface missiles.

Although he couldn't reveal the funding details of his service's unreleased FY10 budget request, Col Robert Schwarze, the chief of Air Force EW and Cyber Requirements at the Pentagon, confirmed to *JED* that the two thrusts that the Air Force plans to pursue for its HARM inventory are HDAM upgrades and the REIK program.

THE "STEALTH" FACTOR

Air Force leaders appear to believe that lethal SEAD missions will become less essential once the service has retired its non-stealthy aircraft and replaced them with large numbers of fifth-generation low-observable fighters such as the F-22 and the F-35 by 2025 to 2030. As the Air Force HDAM RFI states, "These HARM modifications are required to address the force structure gap until sufficient numbers of fifth-generation aircraft and advanced weapons are fielded to assume the SEAD role."

The stealthy F-22, F-35 and B-2 aircraft are expected to remain virtually undetectable by SAM radars for many years to come, and may only be vulnerable to long-range early-warning and ground-control-intercept radars operating in the low frequency bands. These radars, if they remain stationary, could be destroyed using long-range, subsonic, precision-guided missiles, such as the new Joint Air-to-Surface Stand-off Missile (JASSM), a stealthy cruise missile. The jamming variant of the Air Force's expendable Miniature Air-Launched Decoy (MALD-J), to be initially fielded in late 2012, will fly close to enemy air defenses and also could help counter these radars as a non-lethal SEAD asset.

It is likely that the Air Force and Navy, within 10 to 15 years, will begin to field stealthy, fighter-size, unmanned combat air vehicles (UCAVs). They could be fitted with a jammer or air-to-surface weapons (or ultimately a high-power-microwave or other type of directed-energy weapon rather than guided bombs or missiles). This type of unmanned aircraft likely represents the future for lethal and non-lethal SEAD.

In the meantime, CAPT Egbert told *JED*, "I think that there will continue to be a need in the foreseeable future for an anti-radiation homing missile to do SEAD missions instead of relying on GPS-only weapons. We will have pop-up air defense threats that we may not have information on, so I believe that a supersonic HARM type of weapon will be required for some time to come."

WERLATONE

SOPHISTICATED APPLICATIONS

- JAMMING
- COMMUNICATIONS
- CO-SITE MANAGEMENT

REQUIRE,

SOPHISTICATED SOLUTIONS

- MORE POWER
- GREATER BANDWIDTH
- LESS LOSS
- SMALLER PACKAGES

- POWER COMBINERS/DIVIDERS
- 90° HYBRID COUPLERS
- 0°/180° HYBRID JUNCTIONS
- DIRECTIONAL COUPLERS

DESIGNED TO MEET THE MOST STRINGENT OPERATING CONDITIONS.

Werlatone, Inc.
2095 Route 22
PO Box 47
Brewster, NY 10509
T. 845.279.6187
F. 845.279.7404
sales@werlatone.com

www.werlatone.com

Manned Airborne SIGINT: US Market Forecast

By Dr. David L. Rockwell

The coming months are a crucial period for the manned signals intelligence (SIGINT) market, with major upgrades in the works and all three services planning the next generation of their primary intelligence platforms. The US Army has contracted for a total SIGINT system replacement for its primary Guardrail reconnaissance aircraft, and also is back on track with development plans for the next generation Aerial Common Sensor (ACS), due to enter service after the middle of the next decade. The Navy is spending hundreds of millions of dollars on upgrades for its EP-3E Aries II SIGINT aircraft fleet, with somewhat less definite plans for a next generation system, the EP-X. Finally, despite Global Hawk and its Airborne SIGINT Payload (ASIP), the US Air Force's (USAF) RC-135 series (Rivet Joint, Cobra Ball and Combat Sent) not only will continue to receive major funding and continuing upgrades, but the UK Royal Air Force (RAF) may even buy three new aircraft to become its own primary airborne SIGINT system. Just as many hope for a new surge of intelligence in world politics over the next decade, the largest air forces will be doing their best to provide airmen with better electronic intelligence (ELINT).

The manned SIGINT market has been overshadowed by the rapid growth of the unmanned SIGINT market over the past several years (see "UAVs: Growing Fast beyond COMINT" on Page 42). The UAV SIGINT market will grow from **$457 million** in FY09 to **$1.2 billion** in FY18, but the manned airborne SIGINT market will remain larger in total funding every year for at least the next decade.

ARMY: GUARDRAIL & ARL

The AN/USD-9(V) Guardrail has been the US Army's primary airborne SIGINT program since the 1970s. It is based on Raytheon's Beech RC-12 aircraft, with systems integration by the ESL business unit of Northrop Grumman Mission Systems (Sacramento, CA). Production of new Guardrail aircraft ended in 2000, but the Guardrail Common Sensor (GRCS) has seen a number of system upgrades and improvements. More than 50 Guardrail aircraft have been built, with about 45 still in service. The Guardrail's SIGINT payload is remotely controlled, with data processed by ground operators in the Guardrail Ground Baseline (GGB) ground station.

The Army's earlier Airborne Reconnaissance Low (ARL) also is a militarized commercial aircraft, this time based on

RDT&E+Procurement (FY09 $ Millions)	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	Total (FY09-18)
Guardrail & ARL	172	184	216	298	392	386	382	378	155	113	2,676
ACS	92	140	200	160	182	180	210	215	280	375	2,034
EP-3E	142	236	148	146	122	114	128	132	138	156	1,462
EP-X	36	40	54	44	46	98	102	110	108	114	752
RC-135	158	158	146	212	212	194	154	138	148	170	1,690
Other	209	215	258	256	255	280	290	292	302	286	2,643
Total	**809**	**973**	**1,022**	**1,116**	**1,209**	**1,252**	**1,266**	**1,265**	**1,131**	**1,214**	**11,257**

the DeHavilland DHC-7. ARL comes in two configurations, the ARL-C with a complete COMINT sensor package, and the ARL-M (Multi-INT) that combines COMINT with synthetic aperture radar (SAR) and electro-optic/infrared (EO/IR) imagery capabilities. Overall, there are eight DHC-7/ARL aircraft in service (two -Cs and six -Ms).

Guardrail and ARL originally were to be replaced this decade by the Aerial Common Sensor (ACS), but since the ACS was cancelled and then restructured in 2006, GRCS and ARL have been receiving massive new funding transferred from ACS and other Army funding lines.

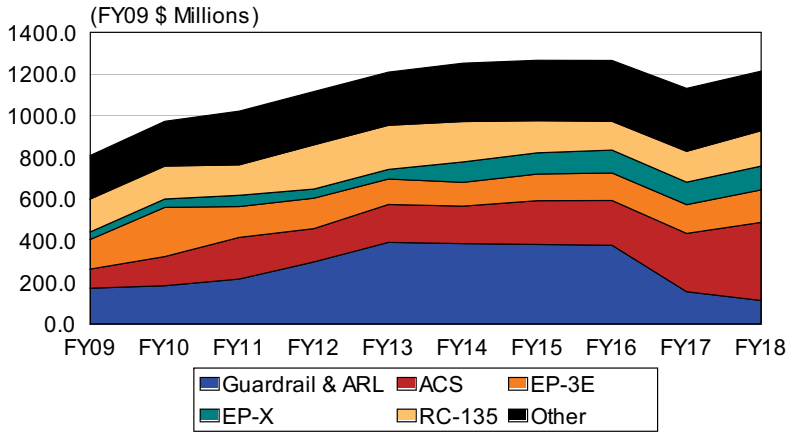
First, in late 2006 the Army awarded a $42 million contract to Lockheed Martin Systems Integration (Owego, NY) to develop CHALS-C (Communications High Accuracy Location Subsystems-Compact), with 40 systems to be delivered by 2009. CHALS-C has better interoperability with other COMINT assets and increased processing speed to allow detecting multiple simultaneous signals on different frequencies.

Then, in September 2007, the Army announced the Guardrail Modernization System Integration (GMSI) program to upgrade 33 Guardrail aircraft (29 operational and four training) to a new RC-12N1 standard. The potential value of the five-year, indefinite delivery/indefinite quantity (ID/IQ) contract with one five-year option was announced as $462 million, but Teal Group believes that the actual value eventually will be much higher. The operational Guardrail inventory includes seven RC-12Ks, 11 RC-12Ns, nine RC-12Ps, three RC-12Qs, three RC-12Hs and six RC-12Ds, as well as four RC-12Ns for training. Older RC-12D and H aircraft will be retired under the GMSI program, with the newer aircraft to be gutted before receiving a common GMSI system. The first new RC-12N1 aircraft are to be fielded in 2010.

In late 2007, the Army that decided the core of the RC-12N1 GMSI would consist of the Enhanced Situational Awareness (ESA) capability, based on a two-chassis derivative of Northrop Grumman's Global Hawk ASIP. It will include signals classification and recognition (SCAR) software and a network-centric sustainable architecture, as well as associated ground-based sensor con-

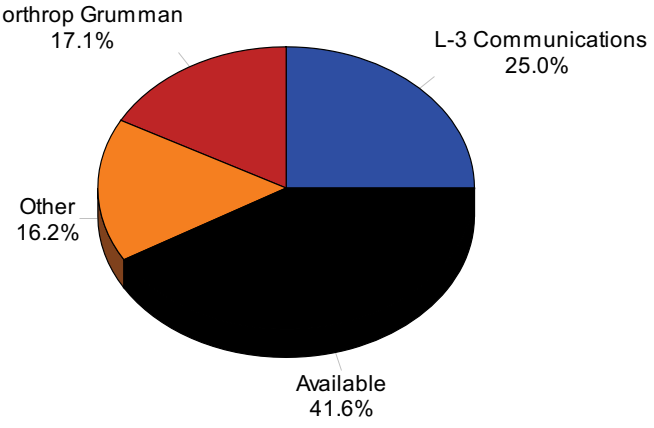
Manned SIGINT Funding Forecast

RDT&E+Procurement Available to the U.S.



Manned SIGINT Market Share

RDT&E+Procurement Available to the U.S.



(FY09-FY18)

trol and signals exploitation software tools. In February 2008, a prototype ASIP system for Guardrail flew for the first time.

Guardrail platforms also have received a new high-band COMINT sensor developed by Argon ST (Fairfax, VA) and another "special signals" upgrade to intercept non-traditional signals of interest in Afghanistan and Iraq. The Guardian Eagle signal exploitation upgrade package includes Delta Wing, a government-furnished system, and X-MIDAS (X-windows Multi-user Interactive Development and Analysis System) from Zeta Associates (Fairfax, VA).

In October 2008, the Army reported that it had successfully fielded GGB 2.0 hardware and software to Army military intelligence battalions, standardizing Guardrail ground processing stations across the Army. GGB 2.0, developed by Northrop, L-3 Communications, and CACI Technologies, is the initial step toward migrating Guardrail into the Army's network-centric Distributed Common Ground System (DCGS). The new GGB sends SIGINT data to DCGS, but is not yet an embedded node. The ACS initially also will use GGB ground stations.

These many upgrades indicate the attention and funding now devoted to Guardrail, which will continue as the Army's primary airborne SIGINT system for at least another decade, with upgrade and support funding certain to exceed $1 billion. Guardrail truly has taken over from ACS, at least in the near-term.

The slightly larger Airborne Reconnaissance Low (ARL) aircraft has long been Guardrail's poor sister in terms of funding and attention, but it, too, now will receive significant upgrades. In mid-2008, the Army planned to convert at least one of its two ARL-C aircraft to full ARL-M capability, and all ARL-Ms will receive COMINT, EO/IR and SAR upgrades. The total upgrade value is reported as about $200 million.

The Army plans to install a scaled-up version of BAE Systems' Tactical SIGINT Payload (TSP) – originally developed for tactical UAVs – on ARL over the next three years. The system will provide extended COMINT frequency coverage, a remote operation facility, multi-level security functionality, an easily modified system architecture to meet emerging threats and connectivity to the DCGS-Army enterprise, including two full-motion video downlinks per aircraft (something much sought after from UAVs).

ACS

The ACS program was intended to replace both the ARL and Guardrail for US Army SIGINT/SAR/EO/IR surveillance and reconnaissance. The Army planned to buy 38 aircraft, with the entire program worth several billion dollars. The US Navy also planned to buy 19-20 ACS aircraft, as a replacement for its EP-3E Aries II SIGINT aircraft.

Then, in January 2006, the Army and Navy terminated ACS, as the Embraer ERJ-145 aircraft was determined to be too small to carry all of the payloads that the services required. In August 2008, the Army released a new ACS plan. The Army is specifying some equipment, such as Northrop Grumman's ASIP SIGINT system, but the platform and SAR/ground moving target indication (GMTI) radar payload are open to competition. Aside from the baseline ASIP, other SIGINT sensors also are being competed, with companies such as Argon ST and Applied Signal Technology (Sunnyvale, CA) chasing these portions of the program. Three teams, led by Northrop Grumman, Raytheon and Lockheed Martin, respectively, are expected to bid for the program. A six-year system development and demonstration (SDD) contract is planned for award later in 2009, with development likely to be worth as much as $1.5 billion or more. The program acquisition value is estimated by the ACS program manager, COL Robert Carpenter, as $6 billion to $9 billion for 38 aircraft. Initial operational capability (IOC) is not expected before 2016.

In early 2009, ACS plans were for a manned business jet platform of less than 100,000 lbs., able to fly at 45,000 feet for eight hours on station. ACS will carry a crew of four to operate sensors, as well as a pilot and co-pilot. Unlike Guardrail and future SIGINT UAVs, whose sensor data all will be processed on the ground, ACS will process data, provide C4I, and even cue and operate UAVs from onboard.

This new onboard operation plan also has influenced the sensors to be carried. Increment 1 will provide COMINT via a variant of Northrop Grumman's ASIP. It also will provide SAR imagery with GMTI, from another already-developed radar (to be competitively selected, but Lockheed Martin's new Phoenix Eye SAR for the ARL has been suggested as a possibility). Increment 2 will add an ELINT capability to ASIP, and the far-off Increment 4 theoretically will add "modular sensors."

ACS operators are to be provided with four DCGS-A compatible workstations aloft, with an Increment 1 baseline capability for Level 0.1 fusion (correlation), battle command, data processing, report development and dissemination. Communications will include a 45 Mb/s wideband air-to-air datalink and an up to 274 Mb/s wideband air-to-ground datalink. ACS also will have both Ku-band (12.5-18 GHz) commercial and Ka-band (26.5-40 GHz) Wideband Gap-filler Satellite Communications systems, with data rates of

ITT's Electronic Signals Intelligence (ELINT) is, as the name suggests, intelligent. It sees beyond horizons. Collects radar signals. Catalogues each source. And archives these for future use. Then, as a new radar signal is encountered, ITT's Electronic Support Measures (ESM) kicks in, tapping into the archive to compare it to known sources. ITT's Radar ESM/ELINT system is contained in a small footprint and is compatible with all types of combat management systems. Each time ITT's Radar ESM/ELINT system is turned on, threats are identified and lives are saved. Learn more at **ittrss.com**.

Take-off. Detect. Identify. Defeat. Repeat.

ITT

Engineered for life

Communications • Sensing & Surveillance • Space • Advanced Engineering & Integrated Services

between 2-20 Mb/s and two narrowband satellite communications terminals, six V/UHF radios, the Army's Multi-role Common Datalink and Link 16. Blue Force Tracking will be accessed for combat identification of ground troops. ACS initially will use GGB ground stations.

NAVY: EP-3

The US Navy's primary manned SIGINT aircraft is the EP-3E Aries II, based on the P-3 Orion platform and in service for more than 30 years. The Navy's EP-3E inventory totals 16 aircraft, with 12 EP-3Es operational at any one time. Originally scheduled for retirement from 2014 to 2017, this aircraft's service life now will be extended, with substantial upgrades, following the 2006 cancellation of the follow-on ACS/EP-X.

All EP-3Es recently have completed the Sensor System Improvement Program (SSIP) upgrade, adding new tactical communications, automated ELINT/electronic support measures (ESM) and special-signal processing and exploitation systems. In late 2008, Spiral 1 of a further three-spiral upgrade – the Joint SIGINT avionics family modernization (JMOD) program – also was completed. Development of JMOD Spiral 3 upgrades will continue for another decade, to keep pace with evolving COMINT and ELINT requirements. JMOD systems include the "Story Book" COMINT signal acquisition/processing/data fusion capability, the "Story Classic" low-band search/acquisition subsystem, the "Story Finder" radar-band digital server, the "Story Maker" data fusion capability and the "Story Teller" data manipulation/correlation/communications capability.

EP-X

After the collapse of the joint ACS acquisition in 2006, the Navy decided to go its own way and it initiated the EP-X program. This will see the development of a manned, armed SIGINT aircraft to act in concert with the Navy's next generation of maritime patrol and intelligence, surveillance, and reconnaissance (ISR) platforms, the Boeing P-8A Multimission Maritime Aircraft (MMA) and Northrop Grumman's Global Hawk-based Broad Area Maritime Surveillance (BAMS) UAV.

The EP-X eventually will replace the EP-3E as the Navy's primary manned SIGINT collector, but it is expected to add capabilities as well, including EO/IR and SAR sensors, and a targeting capability. In February 2008, the Navy issued three five-month, $1.25 million concept-refinement contracts to Boeing, Lockheed Martin, and Northrop Grumman. A series of development contracts and down-selects are planned until SDD in 2012. The Navy could buy up to 26 EP-X aircraft, but Teal Group estimates that it is more likely to acquire closer to 20. Production is unlikely to begin until the 2018-2020 timeframe, with a tentative IOC date of 2017 or 2019 that is almost certain to slide to the right. As SDD will not occur for at least four years, it is safe to expect many changes in requirements.

The Navy expects to award three 13-month Broad Agency Announcement (BAA) contracts in the coming months, with Boeing, Lockheed Martin, and Northrop Grumman all expected to participate. The Navy then could down-select to two Technology Development contracts in 2010, before down-selecting to a single contractor team for SDD in 2012.

AIR FORCE: RC-135

The USAF's primary manned SIGINT platform for the past several decades has been the RC-135. Versions include Rivet Joint (RC-135V/W), Combat Sent (RC-135U), and Cobra Ball (RC-135S), with development and integration managed by the USAF Big Safari Program (645th Aeronautical Systems Group). Some funding is publicly declared, but other funding and many program details are classified.

Planned RC-135 developments include the procurement, fielding, and logistical support for three distinct Rivet Joint baseline configurations (baselines 8, 9 and 10) and two distinct configurations (baselines 3 and 4) for Combat Sent and Cobra Ball. The current Rivet Joint baseline 8 with Network Centric Collaborative Targeting (NCCT), operational since 2007, is able to support tactical and strategic operations and is able to monitor devices from cell phones to air defense radars. Funding increased in FY08 to FY10 to reflect new USAF SIGINT Capabilities Working Group (SCWG) priorities. There will be extensive utilization of commercial-off-the-shelf (COTS) solutions, intended to reduce needed manufacturing sources integration efforts. Upgrades will focus on an evolutionary acquisition approach to field incremental capability improvements.

Rivet Joint will receive the majority of USAF RC-135 funding (more than 80 percent in the near term), with ongoing development of a steerable beam antenna, aperture tiles, demodulator and compressive receiver, ultra wideband capability, and advanced HF capabilities and interferometry. Bistatic radar development is planned. Current Combat Sent/Cobra Ball developments include improved low band capabilities, with Combat Sent antenna upgrades planned to begin in FY10.

In early 2008, the UK indicated that it likely would retire its three Nimrod R.1 SIGINT aircraft early next decade, following the loss of a similar-vintage Nimrod MR.2 over Afghanistan in September 2006, probably due to a fuel fire.

RDT&E+Procurement (FY09 $ Millions)	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	Total (FY09-18)
L-3 Communications	268	362	265	316	292	269	251	242	256	292	**2,814**
Northrop Grumman	88	88	128	210	308	308	316	320	105	59	**1,930**
Other	161	175	198	189	177	186	190	187	190	176	**1,828**
Available	292	348	431	401	432	489	509	516	580	687	**4,685**


WE HAVE ONE WORD FOR THE CREWS OF THE RC-135:
CONGRATULATIONS.
L-3 congratulates the dedicated crews and maintainers of the RC-135 Rivet Joint for nearly 40 years of extraordinary service.
L3
AM&M > SPECIALIZED PRODUCTS > C3ISR > GOVERNMENT SERVICES
Integrated Systems
L-3com.com

Project Helix had been planned as a £400 million upgrade to the R.1, to maintain capabilities until 2025, but Helix now probably will be cancelled. Instead, the UK was considering its options, the most likely of which was thought to be the lease or "joint-pool" operation of two or three Rivet Joint aircraft.

While there is some resistance to Rivet Joint within the RAF, due to the USAF's more automated SIGINT methods and the Nimrod's "finer grain" tactical SIGINT emphasis, Rivet Joint appears to be the most affordable option.

In October 2008, according to the US Department of Defense's (DOD) Defense Security Co-operation Agency (DSCA), the UK RAF "requested a possible sale to convert three US Air Force (USAF) KC135R aircraft into RC-135V/W Rivet Joint aircraft" at a cost of $1.07 billion (if all options are exercised), with L-3 Communications (Greenville, TX) as the prime contractor. The new RC-135V/W request is believed to cover the "joint-pool" RAF operation of USAF-owned aircraft, which sources claim could be ready within 24 months of contracting (Teal Group finds this estimate to be optimistic). The RAF would like to replace its Nimrod R.1s in 2011 to 2013, at about the same time as it retires the Nimrod MR.2 maritime patrol aircraft (although it still is totally rebuilding nine Nimrod MRA.4s to replace the MR.2s). However, no final decision has been made and, with the current recession, the UK may not have the money even for leased R.1 replacements.

MARKETS: WIDE OPEN

With the two most high-profile new manned SIGINT programs (ACS and EP-X) still not contracted for development, it is obvious that there are great market opportunities. But with the increasingly COTS and open-architecture nature of the increasingly C4I-driven SIGINT market, there are even more opportunities hidden in the tens or hundreds of millions of dollars of new upgrades being contracted every year. Teal Group's "market share pie chart" shows 41.6 percent of funding over the next decade as still uncontracted and available. Much of this likely will be won by the big guys, especially L-3 Communications (EP-3E and RC-135 systems prime) and Northrop Grumman (ASIP prime), but much will be won by smaller firms. Hidden in Teal Group's "Other" wedge are strong showings by BAE Systems, Raytheon, and Lockheed Martin, but there is no dominance of the airborne SIGINT market by just a few defense contractors, as there is in many defense electronics markets. There will be great opportunities here.

Dr. David L. Rockwell is Senior Electronics Analyst for Teal Group Corp., a provider of aerospace and defense competitive intelligence based in Fairfax, VA. Please send comments or questions to drockwell@tealgroup.com.

UAVS: GROWING FAST BEYOND COMINT

Ever since the end of the 1991 Gulf War, UAVs have been in strong demand. Today's major COMINT and ELINT programs will soon equip all scales of UAVs, from the Global Hawk Airborne Signals Intelligence Program (ASIP) to (eventually) micro-scale COMINT receivers on mini- and micro-UAVs. Teal Group forecasts steady RDT&E and procurement funding.

By far the largest program over the next decade will be Northrop Grumman's ASIP. On Global Hawks, Predators and Reapers (and also manned U-2 and Guardrail aircraft), ASIP will be the first major UAV SIGINT program providing a capability equivalent to manned platforms. Funded at a quarter of a billion dollars per year already (UAV component), it will ramp up to more than a half billion dollars annually by the middle of the decade, with production in full swing for all three major US endurance UAVs.

Tactical UAV programs will remain smaller, with the Army's BAE Systems Tactical SIGINT Payload (TSP) to be only a moderate program in terms of funding. On the other hand, UAV SIGINT RDT&E will remain high throughout our forecast period, and this should provide knock-on technology benefits for other SIGINT programs.

With ASIP entering production now, whether or not it also is chosen for the Army's Sky Warrior, Northrop Grumman will dominate the near-term UAV SIGINT market with at least 51 percent of funding over the next 10 years. BAE Systems should keep a steady small share with TSP, at least 10 percent, but expect Northrop to shrink ASIP components further to offer competition for small UAVs as well. More opportunities probably will be available as subcontractors than as UAV SIGINT primes.

The US Navy's BAMS and the US Coast Guard's future endurance UAV are still essentially available, but Northrop Grumman certainly will be the favored competitor for these programs, unless a company can offer a breakthrough advantage for maritime applications.

The best future opportunities likely will come for mini/micro/nano-UAVs, which do not yet carry highly capable SIGINT receivers. In any case, there still is a lot of funding available (at least 35 percent), so there will be great opportunities in this fast-growing market – from $457 million in FY09 to $1.2 billion in FY18, an 11 percent CAGR. – *D. Rockwell*

RDT&E+Procurement (FY09 $ Millions)	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	Total (FY09-18)
GH/Pred ASIP	244	319	316	345	431	466	485	517	527	540	**4,190**
Other Endurance	63	72	94	114	116	144	152	212	236	257	**1,460**
TSP	14	18	34	33	50	73	84	78	76	82	**542**
Other Tactical	98	94	94	108	114	118	142	148	170	182	**1,268**
Available Int'l	38	48	64	64	70	88	86	100	104	108	**770**
Total	**457**	**551**	**602**	**664**	**781**	**889**	**949**	**1,055**	**1,113**	**1,169**	**8,230**

GaN Amplifiers: Boosting the Power behind Communications Jammers

By John Knowles

When remote-controlled improvised explosive devices (IEDs) began to appear in Iraq back in 2003 to 2004, it wasn't just the US Army and US Marine Corps that were caught flat-footed. The US electronic warfare (EW) industry also was unprepared to meet this threat. Up until this time, jamming in the communications frequencies usually was performed by large, dedicated EW platforms, like the USMC's Marine EW Support System (MEWSS) vehicle, the US Air Force's EC-130H Compass Call aircraft or the US Navy's EA-6B Prowler aircraft. There were some smaller mobile and stationary, "hand emplaced" jammers in use as well. Almost all of these devices, however, were designed to jam communications at distances typically measured in miles. US forces did not perceive a need for small, relatively low-power, wideband communications jammers that would, in effect, create a 30- to 150-ft. jamming "bubble" around a vehicle or soldier. This requirement evolved rapidly, however, once IEDs appeared in large numbers in Iraq, and soon afterward in Afghanistan.

As urgent requirements for IED jammers began to emerge in 2004 and 2005, it created a wide open market for the US defense industry. No US company was manufacturing IED jammers before Operation Iraqi Freedom in 2003. Over the next five years, more than 40 companies (most of them from outside the traditional EW market) would offer IED jammer solutions. With the US Army and US Marine Corps buying thousands of IED jammers per year beginning around 2005, there has been a lot of emphasis on the developing supply chain that would turn out IED jammer components and subsystems quickly and efficiently.

A critical component of any IED jammer is, of course, the power amplifier. Until the market for IED jammers emerged, there was a very limited demand for small, rugged and efficient broadband high-power amplifiers. For power amplifier manufacturers, however, this changed almost overnight. Fortunately, reliable amplifier technology was available.

NEW TECHNOLOGY

For IED jammer applications, many power amplifier manufacturers rely on Gallium Nitride (GaN) transistor technology. GaN devices offer significantly better performance compared with Gallium Arsenide (GaAs), laterally diffused metal oxide semiconductor (LDMOS) and vertical diffusion metal-oxide semiconductor (VDMOS) transistors. The advantages of GaN are described in this quote from Milmega (Isle of Wight, UK) in a September 2008 *Microwave Journal* article: "The inherent properties of GaN have a number of advantages to offer the amplifier designer. A major one is that the transistor structure enables the development of a product that allows operation into high VSWR loads, including short and open circuits, without the need for protective circuits or isolators. The higher gains of GaN transistors, compared to those of competing technologies, reduce both the overall transistor count and the number of combining stages required. Operation from high voltages results in a less complex power supply design, an important feature in determining the overall reliability of an amplifier structure."

Today, a number of amplifier manufacturers produce GaN devices for IED and general communications jamming applications. Aethercomm Inc. (Carlsbad, CA) makes a range of GaN power amplifiers that operate from +28Vdc and +50Vdc power supplies. Among its newest products are the SSPA 0.020-1.000-30-28V and SSPA 0.020-1.000-30-48V. Both amplifiers cover the 20- to 1,000-MHz range with a typical gain of 50 dB. The SSPA 0.020-1.000-30-28V offers an

POWER AMPLIFIERS

designed and built to withstand

EXTREME ENVIRONMENTAL CONDITIONS

High Performance GaN Modules

BBM2E3KKO (SKU 1094)
20 - 520 MHz, 100 Watts

BBM3K5KKO (SKU 1143)
500 - 2500 MHz, 100 Watts

BBM5K8CHM (SKU 1131)
2500 - 6000 MHz, 50 Watts

Compact, scalable amplifier modules that can be utilized in base stations, test equipment, P, L & S-band radar, man-portable communications and counter-communications systems.

ISO 9001 : 2000
ANAB ACCREDITED
Registered Company

EMPOWER
RF SYSTEMS, INC.

316 West Florence Ave., Inglewood, CA 90301 USA,
Phone: 1(310) 412-8100, Fax: 1(310) 412-9232,
Web: www.EmpowerRF.com

- EW / Jamming
- Military Communication
- Wireless Communication
- Broadcasting
- Commercial

average P3dB of 20-45 W at room temperature and operates from a +28Vdc input voltage, while the SSPA 0.020-1.000-30-48V features a typical P3dB of 30-45 W and operates from a +48Vdc input voltage. For broader jamming applications, the SSPA 0.020-6.000-10 covers from 20 MHz to 6 GHz with a typical saturated output power of 5-10 W. The company also offers a higher power amplifier, the SSPA 0.1-0.8-125, which covers the 100- to 800-MHz range with a P3dB of 125 W at room temperature.

Empower RF Systems Inc. (Inglewood, CA) is another company that manufactures a line of broadband GaN amplifiers. In December 2008, Empower introduced the BBM3K5KK0, a 500- to 2,500-MHz amplifier designed for mobile jamming applications. The 10 x 5 x 1-inch, 2.5-lb. device features a 50 dB gain and a power output up to 100 W. The company also has released the BBM2E3KK0, which provides 100 W of power over 20-520 MHz, and the BBM5K8CHM, which generates 50 W over 2,500-6,000 MHz.

BC Systems (Setauket, NY) is leveraging its experience as a manufacturer of power supplies to set itself apart from its competition. The company's ability to manufacture power supplies and power amplifiers side-by-side enables it to seamlessly match the two, providing optimal noise mitigation, according to the company. "Practically speaking, the performance of the amplifier is only as good as its power source allows it to be," the company said in a May 2007 article in *Microwave Product Digest*. Problems, such as spectral re-growth and supply noise, can be managed by designing the power supply and the power amplifier to work together. The company's Advanced RF Amplifier Division manufactures the BCPA-500-2550-80, a 500- to 2550-MHz, 80-W GaN amplifier for jamming applications. Another GaN device, the BCPA-2500-6000-35, provides 35 W of output power over the 2.5- to 6-GHz range.

Microwave Amps Ltd. (Bristol, UK) has added a GaN amplifier range to its portfolio. The AM6 series is designed for jamming applications. The series includes the AM6-20-500-50-50, a 20- to 500-MHz, 100-W device featuring 50 dB gain performance. The AM6-20-500-55-55 offers similar frequency coverage with output power levels up to 300 W. For wideband jamming applications, the company manufactures the AM6-0.5-2.5-48-48, which covers 500-2,500 MHz, with output power levels up to 60 W. Other amplifiers in the series cover the 2.5- to 4-GHz range (40 W and 50 W), the 4- to 6-GHz range (40 W and 50 W) and the 2.5- to 6-GHz range (40 W).

Spectrum Microwave (Palm Bay, FL) last year introduced its QB-900 series of small, lightweight surface-mount amplifiers. Designed for jamming applications, the series features the QB-904 (4 W with 35 dB gain), the QB-910 (0.5 W with 27 dB gain) and QB-909 medium-gain (17 dB gain) devices, each operating over the 2- to 6-GHz region.

Comtech PST (Melville, NY) manufactures a range of power GaN and LDMOS amplifiers for various applications, including EW. Its BM series includes amplifiers that cover the 20- to 6,000-MHz frequency range at output power levels ranging from 10 W to 200 W.

CAP Wireless (Newbury Park, CA) makes a broad range of GaN amplifiers tailored to EW applications. The company's SS7497 is a 20- to 2,500-MHz device that provides 25 W of output power and 52 dB gain (typical). Another example is the CS5497, a 2- to 6-GHz, 20-W amplifier that the company introduced last year. It operates off of a 28Vdc power source and features an integrated blanking mode with low-power consumption that enables it to generate less heat and reduces power requirements, according to the company.

HIGH-POWER COMMS JAMMERS

While the influx of IED jammer programs has driven new players into the EW market, there are still a number of companies manufacturing amplifiers for dedicated, high-power communications jamming platforms. Herley Power Amplifier Systems (Farmingdale, NY) makes a series of rack-mountable power amplifiers for communications electronic attack systems, such as the CICADA jammer manufactured by MRCM. The company's amplifier products cover the 1.5-MHz to 3-GHz range, with power levels from 50 W to 10 kW. One example is the Ultra Wideband High-Power Amplifier, with 500 W output over the 20- to 500-MHz range. The system is configured in four 19-inch rack-mountable chassis.

AR Modular RF (Bothell, WA) makes a range of power amplifiers for jamming applications from 10 to 2,700 MHz at power levels from 12 to 3,000 W. Its KAW1080 is a 10 KHz- to 1,000-MHz device that provides up to 25 W of output power and a typical gain of 45 dB. The 19-inch rack-mount unit is 7 inches tall and 18 inches deep and weighs 31 lb.

Ophir RF (Los Angeles, CA) has developed a product line of lightweight, broadband 50-W broadband amplifier modules suited for jamming applications. The 5303006A covers the 20- to 500-MHz frequency range; the 5303099 covers the 20- to 1,000-MHz range; the 5303084 covers the 500- to 3,000-MHz range; and the 5303096 covers the 800- to 2,500-MHz range. Each features 48 dB gain (typical).

THE FUTURE OF SOLID-STATE

With a strong foothold in the IED jammer market, GaN transistor technology is poised to reach beyond 6 GHz and propel broadband solid-state amplifiers into the EW frequency ranges (up to 18 GHz) normally served by traveling wave tubes. The Defense Advanced Research Projects Agency (DARPA) is supporting several efforts aimed at further developing GaN technology with a goal of improving the reliability of GaN transistors and lowering the manufacturing costs.

In 2007, BAE Systems EIS (Nashua, NH) received an $8 million contract from the US Army's Intelligence and Information Warfare Directorate (I2WD) and DARPA to develop a 160-W power amplifier based on GaN technology. The GaN amplifier would be used for EW, radar and communications applications. The contract, awarded through DARPA's Disruptive Manufacturing Technology Program, is scheduled to wrap up in 2010 with the demonstration of the 160-W amplifier. BAE's teammates on the program are Rohm and Haas (Blacksburg, VA) and the University of Colorado (Boulder, CO). Efforts such as these bode well for the future of solid-state amplifiers and could lead to their use across a range of RF countermeasures applications.

Crane Roost

By Marianne Kunkel

It is hard to believe that an AOC chapter with such rapid growth and obvious enthusiasm began just a little more than 10 years ago. The AOC's Crane Roost, located in Crane, IN, near the US Navy's Naval Surface Warfare Center's Crane Division (NSWC Crane), saw its membership double in 2007 and again in 2008. This year, as the chapter's members gear up for the 2nd Annual EW Capability Gaps and Enabling Technologies Conference May 5-7, they expect to draw even more members to the chapter. This month, JED *shines a spotlight on the Crane Roost, highlighting its history, its people and its goals.*

Chartered in 1995, the Crane Roost was the brainchild of Tony Brees, an AOC leader at Northrop Grumman Corp.'s Rolling Meadows, IL, facility. There were 15 to 20 founding members, the majority of whom were electronic warfare (EW) engineers at NSCW Crane. By 2004, under the presidency of Rob Walker, the chapter grew to more than 40 members. In 2007, this number rose to about 70. Currently, the chapter holds 205 members and approximately two-thirds of these are Department of Defense (DOD) civilians.

The Crane Roost has been lauded for its speedy growth in recent years, winning the AOC's Small Chapter Membership Growth Award in 2007 and 2008 and the Overall Chapter Membership Growth Award in 2008.

Going forward, Crane Roost President Jim Hearn has set his sights on growing the talent pool of radio frequency (RF) and EW professionals in southern Indiana, and recruiting these individuals into the chapter. A veteran of the EW/information operations (IO) community since 1978, Hearn has worked as a support contractor for NSWC Crane for 15 years and participated in such projects as EA-6B ICAP III and SLQ-32 system upgrades. At present, he is a program manager for the NSWC Crane Platform and Launch Systems Division.

"Our No. 1 priority with the meetings that we hold is to have people come in and talk about EW, including AEA [Airborne Electronic Attack], the SEWIP [Surface EW Improvement Program], Counter Radio Controlled Improvised Explosive Device [IED] EW or other EW projects," said Hearn. One of the chapter's latest goals is to seek establishment of a higher education center to bring EW courses to young engineers. Explained Hearn, "We'll tell them, 'This is AOC training – this is what we can do. But in the AOC, the cost of the courses is much lower.'"

The chapter also will attract attention during the 2nd Annual EW Capability Gaps and Enabling Technologies Conference, which it will cosponsor May 5-7 in Crane. The three-day, secret-level-only conference will feature discussions led by representatives from the EW industry and military about meeting capability gaps in the EW world.

Held in a building that fits no more than 300 people, last year's conference drew more out-of-state attendees than the chapter planned for. "We had to turn people away," said Hearn. Overall, the chapter considered the event a huge success. "I had people telling me that, outside of the large AOC conference, ours was the best EW conference they'd been to," Hearn said. He expects this year's turnout to be just as big – if not bigger – and chapter members have been busy in recent months creating an agenda, issuing calls for papers and sending invitations.

Involvement at conferences has been a top priority of the chapter's for the last few years. It sponsored the classified session at the 2005 American Society of Naval Engineers (ASNE) Conference and cosponsored the Indiana RF Alliance Integrated Circuits Workshop in Indianapolis in May 2008. Crane Roost members frequently give briefs and chair session tracks at the national AOC conference as well, said Hearn.

The chapter also is invested in supporting the NSWC Crane community. At the Team Crane Science Fair held each year in April, the Crane Roost gives away $200 and a plaque to the high school student with the best science project. It also has contributed to the RF Innovation Discovery Pilot Project, an intellectual property program designed to identify and give credit to innovations developed at NSWC Crane.

New this year, the chapter will get involved in the Hoosier Hope Scholarship, which presents high school students planning to attend state universities with $20,000 scholarships. The chapter currently is seeking to locate or develop a program for federal-matching funds for RF- and EW-related college degrees.

Spearheading the Crane Roost along with Jim Hearn are Carl Lohkamp, vice president; Larry White, treasurer; Julie Speaker, co-treasurer; Ted Markley, secretary; and Directors Tom McCann and Eric Wandel. Together, the team is focused on promoting awareness of EW in many spheres – government, industry, academia and the public. One of its goals, for example, is to seek adequate research and development funding for technologies on the EW Critical Technologies list. Another goal is to advocate for post-Global War on Terror (GWOT) EW applications, such as adapting EW for counterterrorism, counterdrug operations, humanitarian crises and low-level conflicts.

All in all, the Crane Roost is dedicated to being an unyielding advocate for EW, and is equally dedicated to bringing others who are passionate about EW into its community.

SHEPHARD AOC

EW ELECTRONIC WARFARE 2009

Brought to you by: SHEPHARD AOC

Conference and Exhibition

14-15 May, 2009

Novotel London West, London, UK

STRENGTHENING THE SHIELD

NOW IN ITS 14th YEAR

Courtesy of US Air Force
Photo by Staff Sgt. Aaron Allmon

KEYNOTE ADDRESS

Air Marshal Sir Christopher Moran KCB OBE MVO,
Commander in Chief Air Command, Designate, Royal Air Force, UK

OPENING ADDRESS

Air Commodore Sean Bell,
Director Equipment Capability, Theatre Airspace, Ministry of Defence, Royal Air Force, UK

Book online at **www.shepherd.co.uk**

Early Bird Rate Expires **18th March 2009**

VIP Dinner Partner: SELEX GALILEO A Finmeccanica Company

Supported by: SBAC

Member of: DMA

Media Partners: JED Military Embedded Systems, Aerospace Index, Ground Security Index, ASD-Network aerospace & defence network, epicos.com, DIGITAL battlespace, DEFENCE HELICOPTER

Exhibitors include: EADS, indra, L3 communications, NORTHROP GRUMMAN, RUAG Aerospace Defence Technology, SWE, TERMA

EW ELECTRONIC WARFARE 2009

STRENGTHENING THE SHIELD

In partnership with the Association of Old Crows, The Shephard Group is very pleased to announce London as the venue for EW 2009, the global Electronic Warfare conference and exhibition. This prestigious event is an opportunity for international leaders in EW from across defence, government, industry, science and technology, and academia, to meet to shape the future of this vital element of modern warfare and share their experiences. The conference will cover current and future operations, evolving concepts and strategies, experimentation and trials, and the acquisition and evolution of equipment capabilities across all lines of development.

Lessons identified from current operations coupled with new analysis and concepts are raising new possibilities and requirements for EW around the globe. Lessons about the importance of integrated EW in all services, once forgotten, have been relearned and rapidly addressed, but at a cost in terms of effectiveness and interoperability. The conference will enable debate on force development, interoperability and the integration of EW. Leading industry partners will demonstrate the latest technology and how innovative capability management will benefit governments, the military and their industrial partners.

Operational experience has also ensured that the importance of the electromagnetic operational areas has been recognised by NATO and many nations around the world. Experimentation and force development have demonstrated how this electromagnetic environment, and within it EW, work with the other operational environments of the land, sea, air and space, and the information environment. This interaction will feature strongly in EW 2009, with a focus on EW and new weapon systems. Effects-based spectrum operations covering electronic surveillance, electronic attack and electronic defence will feature throughout the conference along with NEC, ISR, communications and Navwar. The ability to conduct such spectrum operations while denying adversaries the same opportunity strengthens the shield, protecting friendly forces while sharpening the sword of increased weapon effects.

DELEGATE PACKAGE INCLUDES:

- Executive package with list of all attendees, speakers' biographies and presentation synopses, and online access to presentations after the conference
- FREE copy of Electronic Warfare Handbook 2009
- FREE one-year subscription to *Digital Battlespace* magazine
- FREE Military or Civil Helicopter wall chart
- UNLIMITED ACCESS to conference sessions and exhibition arena
- FREE copy of the *Journal of Electronic Defense (JED)*
- FREE INTERNET access
- Conference support to delegates
- High-quality catering during conference
- Superb exhibition space

WHO WILL BE ATTENDING EW 2009?

- International EW Leaders
- Front-line Forces
- Operational Commanders
- Operators and Planners
- Ministry of Defence Staffs
- Intelligence and Communication Branches
- Programme Managers
- Acquisition Personnel
- Logisticians
- Engineering Staff
- Global Industrial Leaders
- Over 30 Nationalities

...FROM THE FOLLOWING ORGANISATIONS

- Maritime, Land and Air Forces
- Headquarters
- Defence Ministries
- Defence EW Centre
- Joint EW Center
- Defence Spectrum Operations
- Integrated Project Teams
- Defence Laboratories
- Defence Test and Evaluation Organisations
- Industry Worldwide

WHO WILL BE EXHIBITING?

- Systems Integrators
- EW Systems Manufacturers
- EW Components Suppliers
- SIGINT System Manufacturers
- RF and IR Engineering Services Providers
- EW Training Companies
- Database Consultants
- EW Test Equipment Suppliers
- RF and IR Countermeasures Manufacturers
- IED Countermeasures Manufacturers
- Suppliers of Logistics Support
- Research Organisations

To book your delegate place at **Electronic Warfare**, please contact:
Kathy Burwood on **+44 (0)1753 727019** or email **kb@shephard.co.uk**

Conference and Exhibition
14 - 15 May 2009
Novotel London West,
London, UK

EXHIBITING AT ELECTRONIC WARFARE 2009

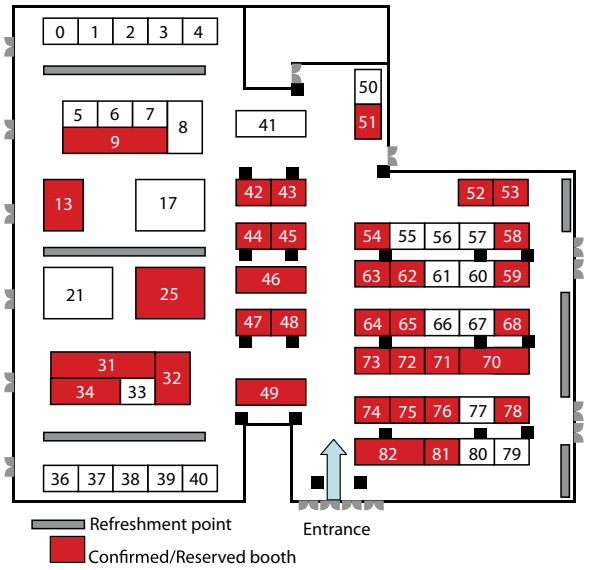
Electronic Warfare 2009 offers its valued exhibitors a number of additional benefits that will provide both your company and your exhibitions team with the quality customer service they deserve.

Exhibition booth package includes:

- Shell scheme (3m x 2m)
- Fascia ID sign
- One electrical socket
- Technical advice and support
- Two complimentary delegate places
- 25% discount off full conference rate for additional delegates

Booth size 3m x 2m - £2,690

Booth size 6m x 2m - £5,240



Confirmed 2009 Exhibitors

09 - Northrop Grumman Corporation
13 - EADS
25 - Selex Galileo
31 - Terma A/S
32 - SystemWare Europe Ltd
34 - Chemring Group
42 - Systematic
43 - Meggitt Avionics
44 - e2v
45 - Roke Manor Research
46 - L-3 TRL Technology
47 - Teledyne Defence Ltd
48 - KOR Electronics
49 - Abacus EW Consultancy Ltd
51 - AAI Corporation
52 - EONIC
53 - Enterprise Control Systems
54 - Tactical Technologies Inc (TTI)
58 - Ultra Electronics Telemus
59 - Annapolis Micro Systems AB
62 - MC Countermeasures Inc
63 - Times Microwave Systems UK
64 - MASS Consultants Ltd
65 - Rohde & Schwarz UK Ltd
68 - Synectics Surveillance Technology
70 - RUAG Aerospace
71 - Saab
72 - LS Telcom AG
73 - EW Simulation Technology
74 - Wallop Defence Systems
75 - Empower RF Systems Inc
76 - Maxtek Components Corp.
78 - Southwest Research Institute
81 - Microwave Marketing Ltd
82 - Indra

PARTNERSHIP OPPORTUNITIES AT ELECTRONIC WARFARE 2009

In addition to being directly identified with this prestigious conference and exhibition, partnership enables your company to enhance its visibility, brand awareness and reputation among the most senior representatives from the electronic warfare community, whilst enabling you to engage an industry-focussed audience in a relaxed atmosphere of goodwill.

Partnered by:

- VIP Dinner SELEX GALILEO A Finmeccanica Company

Remaining Partnership Opportunities include:

- Official Drinks Reception Day 1
- Lunch Breaks Day 1 and Day 2
- Refreshment Breaks Day 1 and Day 2
- Delegate Lanyards
- Delegate Folders
- Delegate Bags
- Delegate Gifts
- Internet Area
- Event Guide

VENUE INFORMATION

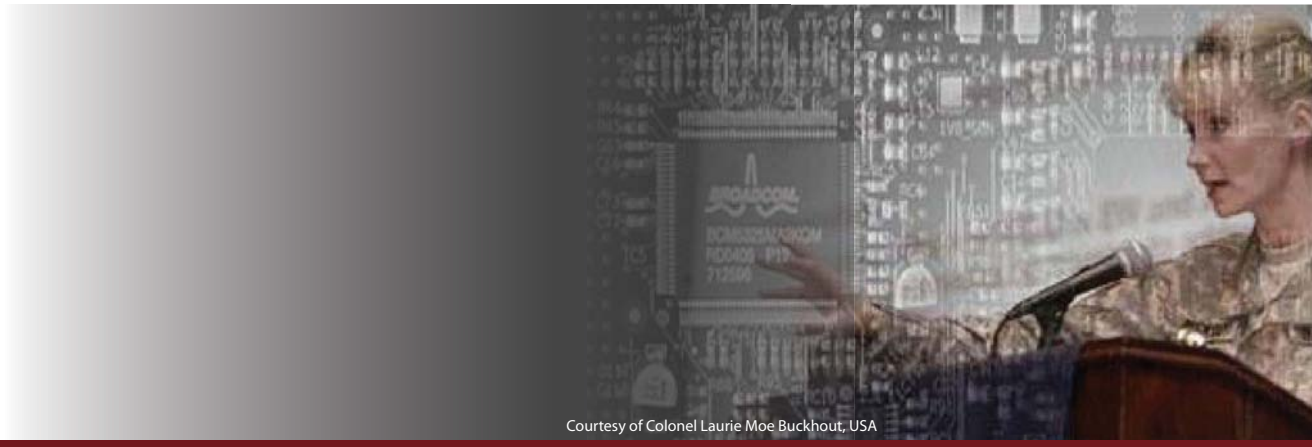
Novotel London West
One Shortlands
W6 8DR
London, UK
Tel: +44 (0)208 741 1555 **Fax:** +44 (0)208 741 2120
Web: www.novotellondonwest.co.uk

For further information on sponsoring or exhibiting, please contact:
Ana Stratton on **+44 (0)1753 727008** or email **ams@shephard.co.uk**

Conference Programme Day One – Thursday 14 May 2009

Programme may be subject to change

08.00 - 09.00 – REFRESHMENTS AND EXHIBITION	
09.00	CHAIRMAN'S OPENING REMARKS **Wing Commander David Kitching RAF (Ret'd)**, Director and Executive Officer AOC UK Chapter, UK
09.10	WELCOME **John Clifford OBE**, President, AOC UK Chapter, UK **Alexander Giles**, CEO, The Shephard Group, UK
09.20	KEYNOTE ADDRESS **Air Marshal Sir Christopher Moran KCB OBE MVO**, Commander in Chief Air Command, Designate, Royal Air Force, UK
09.45	OPENING ADDRESS – LAND/AIR INTEGRATION AND THE EW CHALLENGE **Air Commodore Sean Bell**, Director Equipment Capability, Theatre Airspace, Ministry of Defence, Royal Air Force, UK
10.15 - 10.45 – REFRESHMENTS AND EXHIBITION	
SESSION ONE – EW AND THE LAND BATTLE	
10.45	OPERATIONAL EXPERIENCE OF ELECTRONIC WARFARE **Invited**, 14 Signals Regiment (EW), and Y Squadron Royal Marines, UK
11.10	DELIVERING CAPABILITY TO THE ARMY **Dr Richard Wittstruck PhD**, Chief System Engineer, US Army Acquisition Support Center, US Army, USA
11.35	US ARMY EW – THE STORY SO FAR **Colonel Laurie Moe Buckhout**, Chief, Electronic Warfare Division, US Army, USA
12.00	SCIENTIST AT WAR – AIR PLATFORM PROTECTION **Sam Wells OBE**, Scientist, Defence Science and Technology Laboratory, UK
12.30 - 14.00 – LUNCH AND EXHIBITION	
SESSION TWO – INTERNATIONAL AND NATO EW	
14.00	EW IN INDIA **Dr UK Revankar PhD**, Head of Indian Defence Aeronautical Establishment, Bangalore, India
14.25	NATO JEWCS **Captain (RN) Ken Taylor**, Director, NATO Joint EW Core Staff, Royal Navy, UK
14.50	EXPERIMENTATION AND NATO TRANSFORMATION – DEFENCE AGAINST TERRORISM **Hauptmann Herbert Hopp**, Chairman, NATO SIGINT/EW Working Group, German Air Force, Germany
15.15	***TBC***, Industry Representative
15.40 - 16.10 – REFRESHMENTS AND EXHIBITION	
SESSION THREE – EW DEVELOPMENT	
16.10	***TBC***, Industry Representative
16.35	KEY TO OPERATIONAL SUCCESS – TRAINING THE FORCE **Wing Commander "PJ" Wallace**, Commanding Officer, Royal Air Force Spadeadam, Royal Air Force, UK
17.00	OPEN FORUM
17.15 - 18.45 – DRINKS RECEPTION	

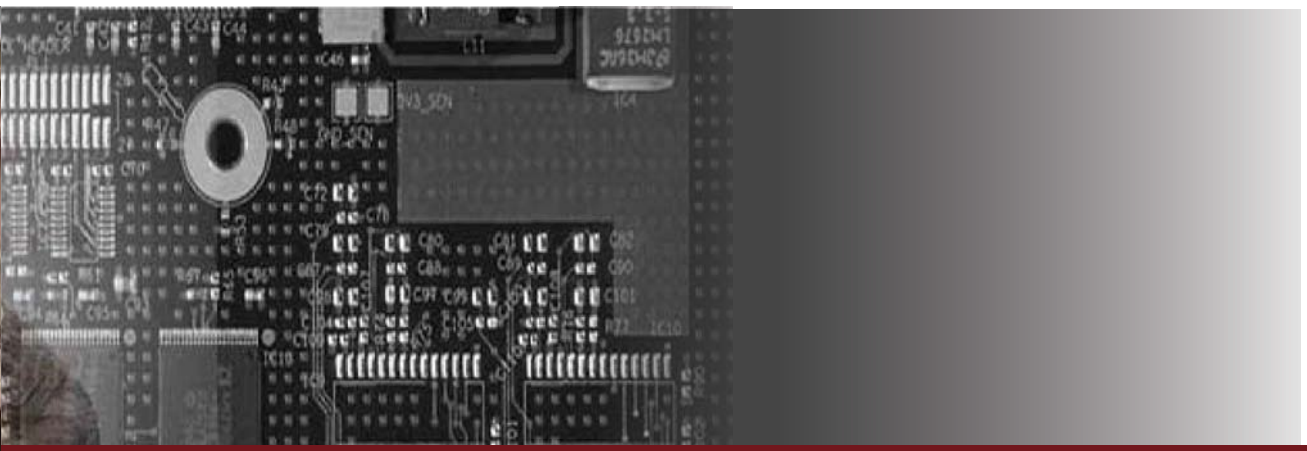


Courtesy of Colonel Laurie Moe Buckhout, USA

Conference Programme Day Two – Friday 15 May 2009

Programme may be subject to change

08.00 - 09.00 – REFRESHMENTS AND EXHIBITION	
SESSION FOUR – EW IN THE 21st CENTURY	
09.00	CHAIRMAN'S OPENING REMARKS **Wing Commander David Kitching RAF (Ret'd)**, Director and Executive Officer, AOC UK Chapter, UK
09.10	KEYNOTE ADDRESS - CHALLENGES AND OPPORTUNITIES OF THE 21st CENTURY **Andrew Brookes**, Senior Defence Analyst, International Institute for Strategic Studies, UK
09.35	OPENING ADDRESS - THE UK TRADE AND INVESTMENT DEFENCE AND SECURITY ORGANISATION **Air Vice-Marshal Nigel D A Maddox, CBE MBA**, Senior Military Adviser, UKTI DSO, UK
10.00	OPEN FORUM DISCUSSION
10.15 - 10.45 – REFRESHMENTS AND EXHIBITION	
SESSION FIVE – CAPABILITY DEVELOPMENT	
10.45	COUNTERING RF AND IR THREATS TO AIR PLATFORMS **Dr Jim Wickes PhD**, Air Platform Protection, Defence Science and Technology Laboratory, UK
11.10	EVOLUTION OF JOINT EW **Colonel Denney Marshall III**, Director, Joint EW Center, USA
11.35	NAVAL EW CAPABILITY **Steve Hyde**, Integrated Project Team Leader, Naval EW, Ministry of Defence, UK
12.00	USAF EW LIFE CYCLE MANAGEMENT/FMS **Colonel Stan VanderWerf, USAF**, Co-Chair USAF EW Life Cycle Management Group, Robins AFB, USA
12.30 - 14.00 – LUNCH AND EXHIBITION	
SESSION SIX – THE ELECTROMAGNETIC ENVIRONMENT	
14.00	DISTRIBUTED CAPABILITY FOR BATTLESPACE DOMINANCE **Dr Peter S. Sapaty PhD**, Director of Distributed Simulation and Control, Institute of Mathematical Machines and Systems, National Academy of Sciences, Ukraine
14.25	SPECTRUM MANAGEMENT – CHALLENGES AND OPPORTUNITIES **Jim Nixon**, Branch Head, Policy, Defence Spectrum Management CBM J6, Ministry of Defence, Main Building, UK
14.50	BATTLESPACE SPECTRUM MANAGEMENT **Tessa Mulhall**, Branch Head, Electromagnetic Environment Effects, Blandford Camp, UK
15.15	***TBC***, Industry Representative
15.35	***TBC***, Industry Representative
15.55	CHAIRMAN'S CLOSING REMARKS **Wing Commander David Kitching RAF (Ret'd)**, Director and Executive Officer, AOC UK Chapter, UK
	FAREWELL **John Clifford OBE**, President, AOC UK Chapter, UK
16.00 - 16.30 – REFRESHMENTS AND EXHIBITION FAREWELL – **Alexander Giles**, CEO, The Shephard Group, UK, and Invitation to EW 2010 Germany	
16.30 – CONFERENCE CLOSE	



For more information visit www.shephard.co.uk/events

Communication Jamming *(continued)*

By Dave Adamy

After last month's brief discussion of cell phone networks, we now will consider some cell phone jamming situations. We will use the propagation formulas discussed in the July and August 2007 *JEDs* and the jamming-to-signal ratio (J/S) formulas discussed in the December 2008 *JED*.

Because any propagation loss model might be appropriate to any link, it is necessary when approaching a communication jamming problem first to determine the appropriate loss model for each of the links involved. Since cell phones and cell towers are near the ground, the uplink (i.e., cell phone to tower) and the downlink (i.e., tower to cell phone) either will be "line of sight" or "two-ray," depending on the range, frequency and antenna heights. This also applies to the link from a jammer (regardless of its location) to the cell phone or to the cell tower. Thus, the first step in analyzing cell phone jamming is to determine the Fresnel zone (FZ) distances for the cell phone and jamming links. Then the J/S can be calculated.

We will consider four cases – jamming from the ground and from the air against the uplink and the downlink. In each of these cases, the cell system is operating at 800 MHz and we are jamming the whole RF channel. If the cell system is analog, this will jam one signal. If the system is digital, this will jam all user channels using this RF channel. To jam only one user channel in a digital system, it is necessary to limit the jamming to the appropriate time slot (for GSM systems) or apply the code for one user (for CDMA systems).

UPLINK JAMMING FROM THE GROUND

As shown in **Figure 1**, the cell phone is 1 meter from the ground and 2 km from a 30-meter high cell tower. The cell phone has a maximum effective radiated power (ERP) of 1 Watt. The jammer is 4 km from the cell tower, 3 meters above the ground and generates 100 Watts ERP.

Because the uplink goes from the cell phone to the tower, we must jam the link receiver, which is in the tower. The cell phone transmit power can be reduced to as little as 6 milliwatts, providing only the amount of power needed for adequate signal-to-noise ratio (SNR) in the tower receiver. However, we can assume that our jamming will cause very low SNR in the jammed link, so the cell phone would remain at its maximum power during jamming.

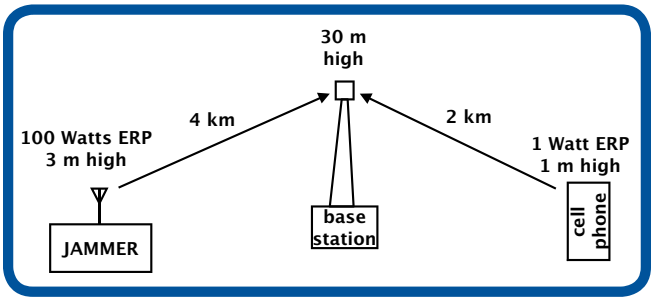


Figure 1: Jamming a cell phone uplink requires broadcasting to the cell tower.

First, let's calculate the FZ distance for the cell phone and jamming links using the following formula:

$$FZ = (h_T \times h_R \times F)/24{,}000$$

where FZ = the FZ distance (in km)
h_T = the transmitter height (in meters)
h_R = the receiver height (in meters)
F = the link frequency (in MHz)

The FZ distance for the cell phone to tower link is

$$FZ = (1 \times 30 \times 800) / 24{,}000 = 1 \text{ km}$$

The cell phone is 2 km from the tower, which is greater than the FZ distance, so two-ray propagation applies to the cell phone link.

For the jamming link:

$$FZ = (3 \times 30 \times 800) / 24{,}000 = 3 \text{ km}$$

Because the link distance is greater than the FZ distance, the propagation is two-ray.

As in all communication jamming, when the receiving antenna has approximately the same gain in all directions, the J/S is calculated from

$$J/S = ERP_J - ERP_S - LOSS_J + LOSS_S$$

where ERP_J = the ERP of the jammer (in dBm)
ERP = the ERP of the desired signal transmitter (indBm)
$LOSS_J$ = the loss from the jammer to the receiver (in dB)
$LOSS_S$ = the loss from the desired signal J = the ERP of the jammer (in dBm)

Converting the two ERP values to dBm is

100 Watts = 50 dBm and 1 Watt = 30 dBm

The loss from the jammer (two-ray propagation model) is

$$LOSS_J = 120 + 40 \log(4) - 20 \log(3) - 20 \log(30)$$
$$= 120 + 24 - 9.5 - 29.5 = 105 \text{ dB}$$

The loss from the cell phone to the tower (two-ray propagation model) is

$$LOSS_S = 120 + 40 \log(2) - 20 \log(1) - 20 \log(30)$$
$$= 120 + 12 - 0 - 29.5 = 102.5 \text{ dB}$$

So the J/S ratio is

$$J/S = 50\ dBm - 30\ dBm - 105\ dB + 102.5\ dB = 17.5\ dB$$

UPLINK JAMMING FROM THE AIR

As shown in **Figure 2**, the cell phone link is the same as in the previous case, but now the 100-Watt jammer is in an aircraft flying at a 2,000-meter altitude 15 km from the cell tower.

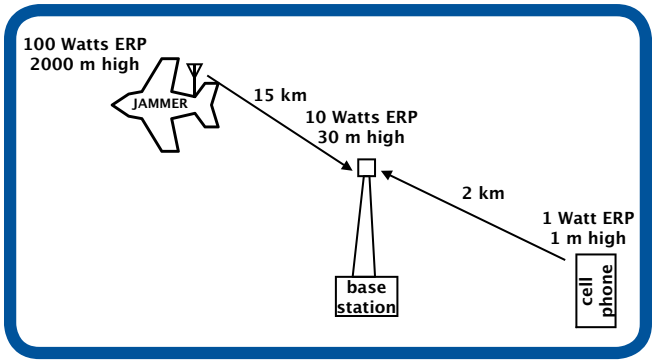


Figure 2: An airborne uplink jammer can achieve good J/S even at long range because of its elevation.

The cell phone tower link is the same, but we must calculate the FZ distance for the jammer-to-tower link.

$$FZ = (2{,}000 \times 30 \times 800) / 24{,}000 = 2{,}000\ km$$

The jammer-to-tower link is much shorter than the FZ, so it definitely uses line-of-sight propagation. The jamming link loss is then

$$LOSS_J = 32.4 + 20 \log(d) + 20 \log(F)$$

where d = link distance (in km)
F = operating frequency (in MHz)

$$LOSS_J = 32.4 + 23.5 + 58.1 = 114\ dB$$

The other link values (ERP_S, ERP_J and $LOSS_S$) are the same, so J/S is calculated as

$$J/S = 50\ dBm - 30\ dBm - 114\ dB + 102.5\ dB = 8.5\ dB$$

It is interesting to note that if the jammer were 3 meters from the ground, rather than 2,000 meters, the J/S would be 14 dB less.

DOWNLINK JAMMING FROM THE GROUND

This problem is shown in **Figure 3**. The 30-meter-high cell tower ERP is 10 Watts, the 1-meter-high cell phone is 2 km from the tower and the 100-Watt, 3-meter-high jammer is 1 km from the cell phone.

Because we are jamming the downlink, the jamming link is from the jammer to the phone. The FZ calculation for the downlink is the same as for the uplink above (i.e., 1 km), so the downlink uses two-ray propagation. The jammer FZ is

$$FZ = (3 \times 1 \times 800) / 24{,}000 = 100\ meters$$

The phone link is longer than the FZ, so it uses two-ray propagation. The jamming link loss is

$$LOSS_J = 120 + 40 \log(1) - 20 \log(3) - 20 \log(1) = 120 + 0 - 9.5 - 0 = 110.5\ dB$$

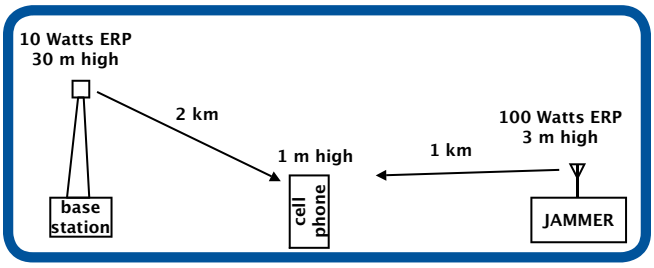


Figure 3: A downlink jammer broadcasts to the cell phone and must overcome the high power of the cell tower transmitter.

The 10-Watt ERP from the tower is 40 dBm. The other parameters (ERP_J and $LOSS_S$) are the same as for the uplink jamming from the ground case, so the J/S ratio is

$$J/S = 50 - 30 - 110.5 + 102.5 = 12\ dB$$

DOWNLINK JAMMING FROM THE AIR

The jammer now is at 2,000 meters and 15 km from the receiver, as shown in **Figure 4**. The jamming link FZ is

$$FZ = (2{,}000 \times 1 \times 800) / 24{,}000 = 66.7\ km$$

This is greater than the jamming link distance, so the jammer link is line-of-sight and has the same loss as for the uplink jamming from the air case.

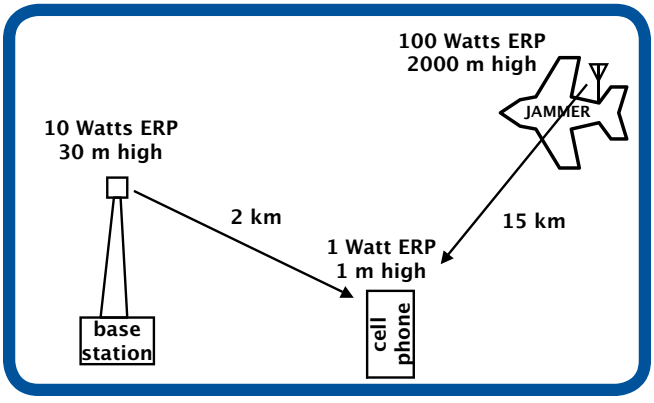


Figure 4: An elevated downlink jammer at long range provides significantly more J/S than a ground jammer at the same range.

The cell phone downlink ERP is 10 Watts (40 dBm), but the other parameters (ERP_J and $LOSS_S$) are the same as the uplink jamming from the air case. Thus, the J/S is

$$J/S = 50\ dBm - 40\ dBm - 110.5\ dB + 102.5\ dB = 2\ dB$$

Again, the J/S would be 14 dB less if the jammer were 3 meters, rather than 2,000 meters, high.

WHAT'S NEXT

Next month, we will start a series on jamming LPI communication signals. For your comments and suggestions, Dave Adamy can be reached at dave@lynxpub.com.

LAST CHANCE: AOC AWARD AND BOARD OF DIRECTOR NOMINATIONS

It's your last chance to nominate members for the AOC Board of Directors and to submit nominees for the AOC Annual Awards. Board of Directors nominations are due by close of business on April 10, 2009. Award nominations are due by April 15, 2009. Visit www.crows.org for nominations forms. Additional details are below:

BOARD OF DIRECTORS NOMINATIONS

Each year the AOC membership helps determine the future direction of the AOC by electing representatives to its Board of Directors. Nominations for the 2009 election are now being accepted.

This year's election slate will include the position of President, who will serve as Vice President in 2010 and as President in 2011. The AOC President appoints the Association's Secretary and Treasurer, presides over the Board of Directors and Executive Committee and appoints committee chairs. The President is also the AOC's primary spokesperson, visiting AOC chapters across the world and meeting with defense leaders. This is a significant but rewarding commitment.

The 2009 election slate will also include three At Large Director positions. At Large directors serve a three-year term. In addition, Regional Directors will be elected for three-year terms from the Central, Mid-Atlantic and Pacific Regions. This year, the Northern Pacific and Southern Pacific Regions will be combined into one region – the Pacific Region.

Nomination forms are available on the AOC website at www.crows.org or by contacting Carol Vann at the AOC. Nominations must be submitted to Ms. Vann by close of business on April 10, 2009.

For any questions or assistance, please contact: Carole Vann, AOC Election Coordinator, (703) 549-1600, e-mail: vann@crows.org

AOC AWARD NOMINATIONS

Any AOC Member can nominate an individual or organization for the AOC Annual Awards. AOC Awards recognize excellence in the EW community and are presented during the AOC Annual Convention, October 18-22 in Washington, DC.

Nominations are being accepted for the following awards:

- AOC Gold Medal Logistics Award
- Stanley Hall Business Development Award
- Clark Fiester C2 Warfare Award
- Communications Award
- Directed Energy Warfare Award
- EO/IR Award Offensive
- Executive Management Award
- Information Operations Award
- Integrated Product Team Award
- John Marks ISR Award
- International Achievement Award
- Joint Service Award (multiple)
- Joseph W. Kearney Pioneer Award
- Training Award
- Maintenance Award
- Program Management Award
- Business Management Award
- Defensive Information Warfare Award Modeling and Simulation Award
- Navigation Warfare Award
- Information Warfare Award
- Operations Award
- Psychological Operations Award
- Radio Frequency Award
- Research and Development Award
- Technical Analyst Award
- Technical Intelligence Analyst Award
- A. C. McMullin Test and Evaluation Award

INFOWARCON 2009: FREE FOR US AND ALLIED UNIFORMED MILITARY PERSONNEL

Don't miss this year's premier Information Operations event, hosted by the AOC's IO institute and National Defense University, Information Resources Management College, April 22-24 at the Gaylord National Hotel and Resort, National Harbor, MD.

InfowarCon 2009 examines the numerous theoretical and practical changes and uses of IO/IW, cyberwar, strategic communication and public diplomacy techniques and experiences learned in Iraq, Afghanistan, China and Georgia-Russia to predict the future of IO. Keynote speakers include LTG Thomas Metz, director JIEDDO, and James Glassman, former Undersecretary of State for Public Diplomacy and Public Affairs.

This year's event is FREE for active military personnel. For more information visit www.infowarcon.com or call the AOC: (703) 549-1600.

REFER A MEMBER...
GET A MEMBER GIFT

Recruit 5 new members and receive a five-member mug and $20 gift certificate redeemable for AOC merchandise.

Recruit 25 new members and receive a $50 gift certificate redeemable for AOC merchandise and a one-year AOC dues credit.

Recruit 50 new members and receive a $75 gift certificate redeemable for AOC merchandise and a two-year AOC dues credit.

Recruit 100 new members and receive free transportation to the AOC convention, free registration and a five-year AOC dues credit.

Your name as the recruiter must appear on the application for the membership to count toward your recruitment total.

MEMBERSHIP APPLICATION

Please return this form with your payment. Make checks payable to:

Association of Old Crows
1000 North Payne Street • Alexandria, VA 22315-1652
Phone: (703) 549-1600 • (888) OLD-CROW • Fax: (703) 549-2589
www.crows.org

U.S./International/Associate ❑ $45 (1yr) or ❑ $115 (3yr)

Undergraduate Student ❑ $15

Life ❑ $500

Retired (Over 62 yrs & retired) ❑ $15 (1yr)

AOC Educational Voluntary Contribution $_____

(Payment must be in U.S. Dollars) Total Amount Paid $_____

❑ VISA ❑ MC Expiration Date _____

Account # _____

Name _____

Address _____

City, State, Zip, Country _____

Phone _____ Fax _____

E-Mail _____

Signature _____ Date _____

I am a citizen of _____

Recruiter name _____

I. EMPLOYER TYPE (Check one)

❑ Army ❑ Navy ❑ Coast Guard ❑ Marines
❑ Air Force ❑ DoD Civilian ❑ Gov. Non DoD ❑ Industry
❑ Educator ❑ Other

II. PRINCIPAL JOB FUNCTION (Check one)

❑ Management, Corp. ❑ Management, General ❑ Engineering/R&D
❑ Operations ❑ Marketing/Sales ❑ Data Processing
❑ Procurement ❑ Production ❑ Engineering Support
❑ Training ❑ Testing/Simulation
❑ Other

III. YOUR ORGANIZATION'S PRODUCT/ SERVICE/APPLICATION (Check one)

❑ EW/C2W ❑ Avionics ❑ Intelligence
❑ C3 ❑ Computers ❑ Electronics
❑ Electro-Optics ❑ Communications ❑ Test/Diag. Equipment
❑ Logistics ❑ Consultant ❑ Components
❑ Information Warfare ❑ Other

IV. Age (Check one)

❑ 17-29 ❑ 30-49 ❑ 50 & over

Contributions or gifts to the AOC Educational Foundation are deductible as charitable contributions for federal income tax purposes. Dues payments to the AOC are deductible as an ordinary and necessary business expense; however, contributions or gifts to the AOC are not tax deductible. Membership dues include subscription to the Journal of Electronic Defense.

AOC Industry and Institute/University Members

SUSTAINING

Agilent Technologies
Argon ST
BAE SYSTEMS
The Boeing Company
Chemring Group Plc
Crane Aerospace & Electronics Group
Electronic Warfare Associates, Inc.
Elettronica, SpA
General Dynamics
ITT Industries, Inc.
Northrop Grumman Corporation
Raytheon Company
Rockwell Collins
Saab Avitronics
Thales Communications
Thales Aerospace Division

INSTITUTE/ UNIVERSITY

Georgia Tech Research Institute
Mercer Engineering Research Center

GROUP

AAI Corporation
Aculight Corporation
Advanced Concepts
Advanced Testing Technologies Inc
Aethercomm, Inc.
Air Scan Inc.
Akon, Inc.
Alion Science and Technology
AMPEX Data Systems
Anaren Microwave, Inc.
Annapolis Micro Systems, Inc.
Anritsu
Applied Signal Technology
ARINC, Inc.
Aselsan A.S.
ATDI
ATK Missile Systems Company
Avalon Electronics, Inc.
BC Power Systems
Blackhawk Management Corporation
Booz & Allen Hamilton
CACI International
Calhoun International
CAP Wireless, Inc.
Colsa Corporation
Comtech PST
CPI
Cubic Defense
Curtiss-Wright Controls Embedded Computing
CyberVillage Networkers Inc.
Dare Electronics Inc.
David H. Pollock Consultants, Inc.
dB Control
Defence R&D Canada
Defense Research Associates Inc.
DRS Codem Systems Inc.
DRS C3 Systems
DRS EW & Network Systems (Canada)
DRS Signal Recording Technologies
DRS Technologies Sustainment Systems
DRS Training and Control Systems, Inc.
Dynetics, Inc.
ELBIT Systems of America
Elcom Technologies, Inc.
Electro-Metrics
Elisra Electronic Systems, Ltd
EMCORE
EMS Technologies Inc.
Endwave Corp
EONIC B.V.
ESL Defence Limited
Esterline Defense Group
e2v
EWATER Solutions
EW Simulation Technology Ltd
EWA-Australia Pty Ltd.
Field Aviation Company Inc.
Filtronic Signal Solutions
Foster-Miller Inc.
Honeywell International
Hubner & Suher Inc
Impact Science & Technology
Innovationszentrum Fur Telekommunikation -stechnik GmbH
Instruments for Industry, Inc.
ITCN, Inc.
iVeia, LLC
IZT GmbH
Jabil Circuit
JB Management, Inc.
JT3, LLC
Keragis Corporation
KOR Electronics, Inc.
L-3 Communications
L-3 Communications-Applied Signal & Image Technology
L-3 Communications Cincinnati Electronics
L-3 Communications/ Randtron Antenna Systems
Lockheed Martin
Longmont Machining
Lorch Microwave
LNX
M/A-COM
MacAulay-Brown
Mass Consultants
MC Countermeasures, Inc.
MegaPhase
Micro-Coax, Inc.
Micro Systems
MiKES Microwave Electronic Systems Inc.
MITEQ, Inc.
The MITRE Corporation
Monteria, LLC
MRSL
Multiconsult Srl
My-konsult
New World Solutions, Inc.
Nurad Technologies, Inc
Ophir RF Inc.
Orion International Technologies
Overwatch Systems Ltd.
Phoenix International Systems, Inc.
Plath, GmbH
QUALCOMM
Rafael-Electronic Systems Div.
Research Associates of Syracuse, Inc.
Rheinmetall Air Defence AG
Rising Edge Technologies
Rohde & Schwarz GmbH & Co. KG
RUAG Holding
Sage Laboratories
Sage Management
Science Applications International Corporation
Scientific Research Corporation
SELEX Galileo
SELEX Sensors & Airborne Systems US Inc.
Siemens Schweiz AG
Sierra Nevada Corporation
Simulation Technologies
Sivers IMA AB
Soneticom, Inc.
SprayCool
SRCTec, Inc.
SRI International
Subsidium
Sunshine Aero Industries
SURVICE Engineering Co.
Symetrics Industries, LLC
Sypris Data Systems
Syracuse Research Corporation
Systematic Software Engineering
Systems & Processes Engineering Corp.
SystemWare Inc.
T. Bear Larson & Associates, Inc.
Tactical Technologies Inc.
Tadiran Electronic Systems Ltd.
Tech Resources, Inc.
Technology Management Inc.
TECOM Industries
Tektronix, Inc.
Teligy
TELEMUS
Teleplan AS
TERMA A/S
Thales Components Corp.
Thales Homeland Security
Times Microwave Systems
TINEX AS
TMD Technologies
TRAK Microwave
TRIASYS Technologies Corp.
TRU Corporation
Vigilance
Wavepoint Research, Inc.
Werlatone Inc.
xwave Solutions, Inc.

BECOME AN INDUSTRY OR INSTITUTE/UNIVERSITY MEMBER

Sign up now to become an industry or institute/university member and receive a discount on exhibit space at the AOC National Convention in Washington, DC. Exhibit space is selling quickly. For more information on industry membership visit our website at www.crows.org or contact Glorianne O'Neilin at oneilin@crows.org or (703) 549-1600.

AOC INDUSTRY OR INSTITUTE/UNIVERSITY MEMBER BENEFITS

- Opportunity to designate key employees for AOC membership
- Reduced rates for exhibit space at the AOC National Convention
- Free organization narrative annually in the *Journal of Electronic Defense (JED)*
- Names of industry members will appear in each issue of *JED*
- Sponsored members receive discount for courses, and technical symposia
- Strengthened industry/association/government coalition
- Nonpartisan government relations
- Highly ethical forum for free exchange of information
- Expanded participation in professional activities
- Valuable professional contacts.

INDUSTRY FEE SCHEDULE

(Company size determines fee except for sustaining members)

MEMBER TYPE	ANNUAL FEE	SPONSORED MEMBERS
SUSTAINING (ANY SIZE)	$3,000	30
INSTITUTE/UNIVERSITY	$1,500	25
LARGE (400+ Employees)	$1,500	22
MEDIUM (50-399 Employees)	$1,000	15
SMALL (10-49 Employees)	$500	10
CONSULTANT (1-9 Employees)	$300	5

JED, The Journal of Electronic Defense (ISSN 0192-429X), is published monthly by Naylor, LLC, for the Association of Old Crows, 1000 N. Payne St., Ste. 300, Alexandria, VA 22314-1652.

Periodicals postage paid at Alexandria, VA, and additional mailing offices. Subscriptions: *JED, The Journal of Electronic Defense*, is sent to AOC members and subscribers only. Subscription rates for paid subscribers are $160 per year in the US, $240 per year elsewhere; single copies and back issues (if available) $12 each in the US; $25 elsewhere.

POSTMASTER:
send address changes to
JED, The Journal of Electronic Defense,
c/o Association of Old Crows,
1000 N. Payne St., Ste. 300,
Alexandria, VA 22314-1652.

Subscription Information:
Glorianne O'Neilin
(703) 549-1600
oneilin@crows.org

JED Sales Offices

naylor

Naylor, LLC – Florida
5950 NW 1st Place
Gainesville, FL 32607
Toll Free (US): (800) 369-6220
Fax: (352) 331-3525

Sales Manager:
Melissa Zawada
Direct: +1 (352) 333-3407
melissaz@naylor.com

Project Manager:
Ray Goodwin
Direct: +1 (352) 333-3459
rgoodwin@naylor.com

Advertising Sales Representatives:
Shaun Greyling
Direct: (352) 333-3385
sgreylin@naylor

Erik Henson
Direct: (352) 333-3443
ehenson@naylor.com

Chris Zabel
Direct: (352) 333-3420
czabel@naylor.com

Naylor – Canada
100 Sutherland Ave.
Winnipeg, MB Canada R2W 3C7
Toll Free: (800) 665-2456
Fax: (204) 947-2047

Advertising Sales Representative:
Cheryll Oland
Direct: (204) 975-0451

Index of advertisers

Innovation … Delivered.

ATK's Advanced Anti-Radiation Guided Missile launches from a Navy F/A-18

AARGM: On target, on schedule. Affordable precision. Field tested. In Production.

www.atk.com

ATK