September 2009
Vol. 32, No. 9

The AOC Electronic Warfare Publication
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JED
The Journal of Electronic Defense

Defeating Threats to Large Aircraft

Also in this issue:
Threat Test Resource Gap

Periodical

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the view
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US NAVY CYBER – CAUTIOUS PESSIMISM

For the past month, I have been reading, hearing and generally trading information with anyone who can tell me anything about the US Navy's plans to establish its new Fleet Cyber Command (FLTCYBERCOM)/Commander Tenth Fleet (COMTENTHFLT) by October 1. I have read a "leaked" memo from the Chief of Naval Operations that has been making the rounds in various circles. It lays out a logical plan to establish FLTCYBERCOM, which will directly support the new US Cyber Command at Fort Meade. However, the memo also states that FLTCYBERCOM will serve as the Navy's…"central operational authority for networks, intelligence, cryptology/SIGINT, information operations, cyber, electronic warfare, and space in support of forces afloat and ashore…." It will also…"coordinate Navy's requirements for intelligence, information operations, networks, cryptology/SIGINT, and space capabilities." In its capacity as COMTENTHFLT, it will provide "…operational support to [Navy] commanders worldwide in the area of cyber, information and computer network operations, electronic warfare, and space."

On paper, this seems relatively straightforward. Then why the "cautious pessimism" on my part? Well, the EW community had a very difficult time establishing its relationship with the Cyber community. Back in the 2006-2007 timeframe, the US Air Force made a strong (and ultimately unsuccessful) play to subordinate EW under its Cyber concept. I have no doubt that the Air Force was only interested in selected pieces of EW, (i.e., electronic attack) and the resulting plan would have broken apart and weakened EW further in the Air Force. Cynical as it may sound, the idea was that computer network operations alone did not "own enough hard assets" to justify a major command. But the Air Force did have some assets (i.e., EC-130H Compass Call aircraft) that were politically weak and easily transferred to the new Air Force Cyber Command. Fortunately, the plan was shot down by the current Chief of Staff of the Air Force. Last year, the Army's Combined Arms Center also tried to "lash-up" EW and Cyber under its proposed Cyber-Electronics concept. Again, I have no doubt that it would have hindered the establishment of an effective EW capability in the Army. That idea, too, was ultimately rejected by the Army's leaders.

Now, the Navy is looking at EW and how it can support its new FLTCYBERCOM. On the one hand, I applaud the Navy leadership for recognizing that EW and Cyber need to work together at the operational level. On the other hand, I think the EW community should keep a close eye on exactly how the FLTCYBERCOM fashions its relationship with EW today and over the next few years. Is this an attempt to establish EW-Cyber synergy or the opening gambit of what will be a Cyber land-grab for Navy EW, taking the Growler and other assets with it? It is difficult to tell at this point, and past experience had left me wary of the Cyber community's "good intentions" toward EW. I hope that time will show my suspicions to be wrong and label me an unfair cynic. In the meantime, I will remain cautiously pessimistic.

– John Knowles

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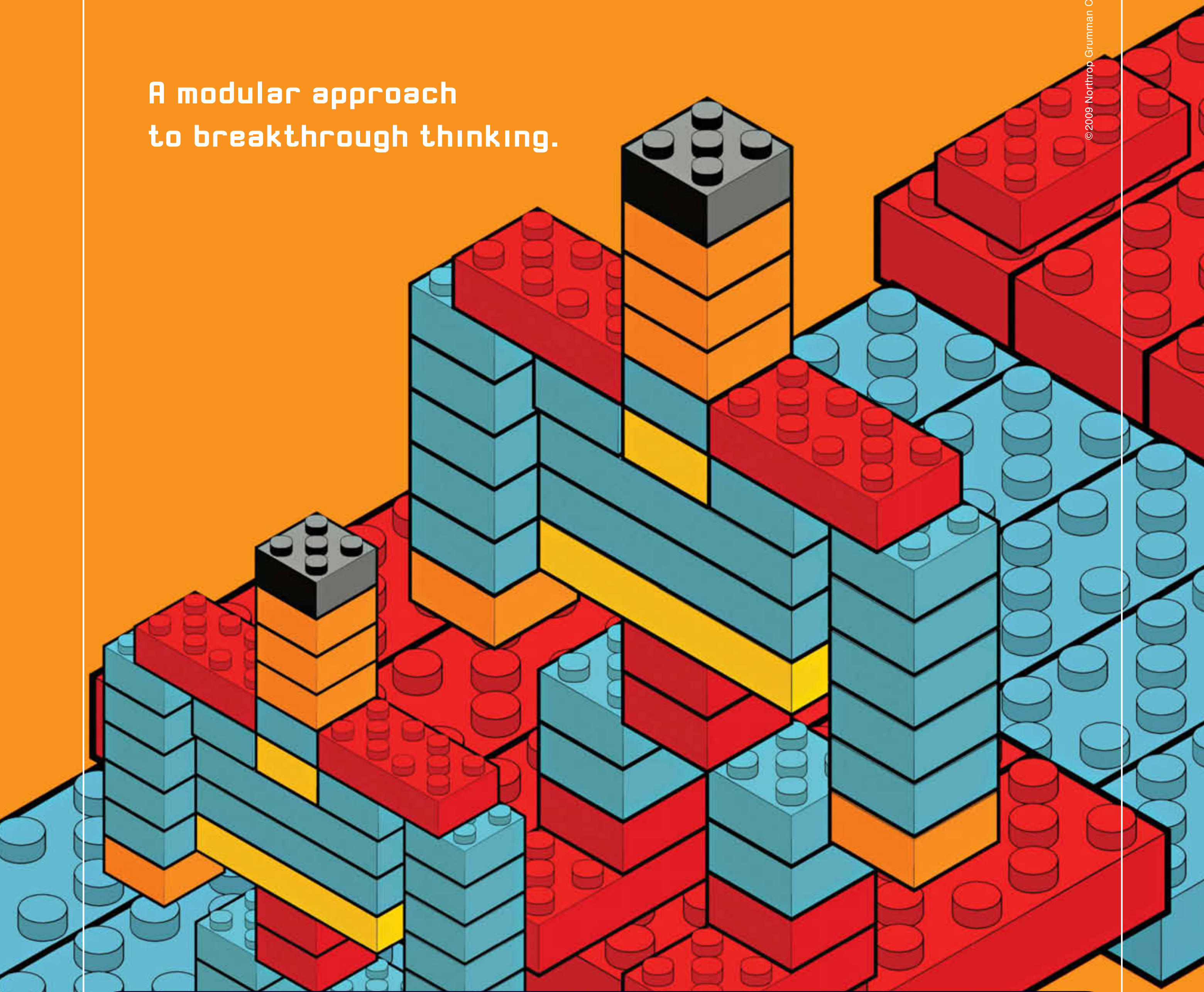

SEPTEMBER

DSEi
September 8-11
London, UK
www.dsei.co.uk

NGAUS Annual Conference and Exhibition
September 11-13
Nashville, TN
www.ngaus.org

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

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

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

Net-Centric Operations Conference
September 22
Newcastle, NH
www.crows.org

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

11th Defense Operational Applications Symposium
September 30-October 2
São Paulo, Brazil
www.sige.ita.br

OCTOBER

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

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

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

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

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

NOVEMBER

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

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

Aircraft Survivability Symposium 2009
November 3-6
Monterey, CA
Clearance: Secret/US only
www.ndia.org

AAAA ASE Symposium
November 9-11
Nashville, TN
www.quad-a.org

Dubai Airshow
November 15-19
Dubai, UAE
http://dubaiairshow.aero/

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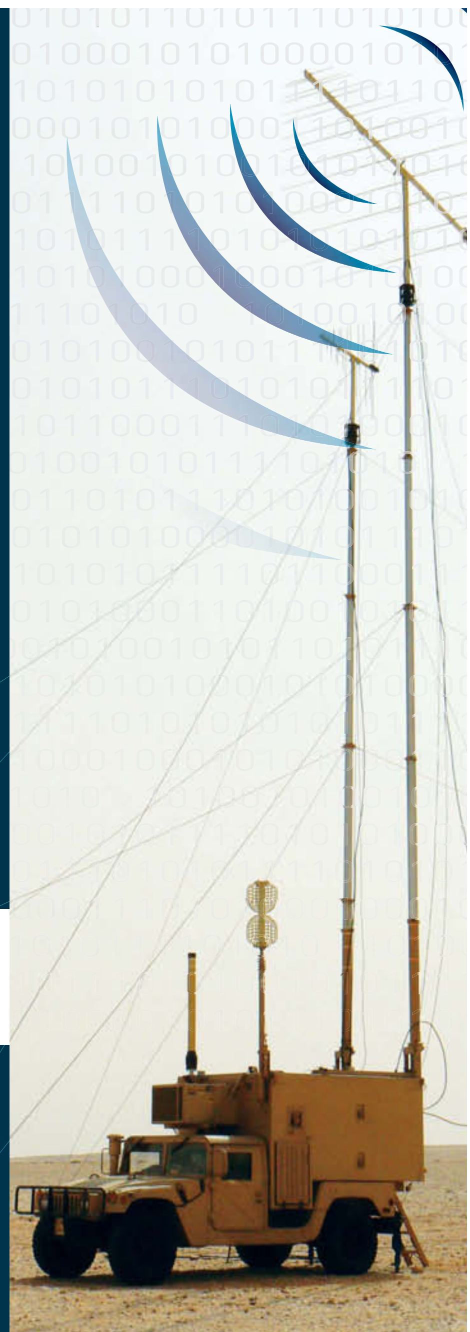

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Phased Array Antennas and Adaptive Techniques
September 15-17
Atlanta, GA
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Basic RF EW Concepts
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Digital Radio Frequency Memory (DRFM) Technology
September 22-24
Atlanta, GA
www.pe.gatech.edu

Principles of Radar Electronic Protection
September 29-October 1
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OCTOBER

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Radar Cross-section Reduction
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www.pe.gatech.edu

High Energy Laser Weapon Systems
October 26-30
Dayton, OH
www.deps.org

NOVEMBER

2009 UK MOD Air Platform Protection Seminar
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Bristol, UK
DESASP-RM1@mod.uk

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

Survivability
November 23-December 4
Shrivenham, UK
www.cranfield.ac.uk

DECEMBER

IR Countermeasures
December 1-4
Atlanta, GA
www.pe.gatech.edu

Senior Leader Information Operations Course
December 7-11
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message from the president

CONSOLIDATING OUR GAINS

The EW community has made some outstanding technology advances over the past several years that have significantly aided our warfighter's ability to take the fight to the enemy. I am proud of our Association and its members' role in those accomplishments, especially in protecting ground forces against IEDs and aircrews against IR-guided MANPADS. Senior defense leaders around the world are once again recognizing the value of EW as a force multiplier, and support for EW programs is exceptionally strong at the moment. All of these certainly are positive developments for EW.

However, we in the Association cannot sit back and pat ourselves on the back, as there are many underlying issues that continue to haunt the EW community. It would be imprudent to ignore these underlying issues simply because EW program budgets are relatively healthy at the moment. Our community still has much to accomplish in order to truly strengthen our discipline and ensure it does not slip backwards. Among areas where we need to concentrate our efforts are:

EW Leadership. Unfortunately, the rank of O-6 (or OF-5 in NATO terms) represents the apex of the EW career field. This often means that informed and consistent "EW advocacy" is reduced to a guarded anticipation that field-grade EW officers can successfully influence flag-rank officers, who are typically not well schooled in EW or spectrum control. EW needs to be led by flag-rank officers in every service who have come "up through the EW ranks" and who are empowered to manage EW requirements, programs and operations.

Training. Simply put, we need to begin to train the same way we intend to fight in the electromagnetic spectrum. If the combatant commander does not think seriously about spectrum control before his forces are deployed, then it is too late. Realistic training requires a realistic electromagnetic environment.

Science and Technology Investment. With more investment in EW science and technology programs, EW can deliver better electronic support, electronic protect and electronic attack capabilities that are more affordable than today's solutions. Without these new EW technologies, we cannot expect to control the spectrum in future operations.

I acknowledge that there are many more issues that need to be addressed in order to strengthen our discipline, and I strongly encourage you to raise those issues within your organizations and within our larger community by writing to the *Journal of Electronic Defense*. This Association has a wealth of experience and we should not be shy about raising our voices to gain the attention of those who make decisions about the future of EW. Next month I end my term as AOC President. However, I hope you will stand with others and with me as we continue to advocate for our discipline and ensure that this Association is doing its utmost to support our warriors today and in the future.

– Kermit Quick

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the monitor news

DARPA SOLICITS BIDS FOR "SURGICAL JAMMER"

The Strategic Technology Office at the Defense Research Projects Agency (DARPA) has issued a Broad Agency Announcement (BAA 09-65) for the Precision Electronic Warfare (PREW) program. DARPA wants to develop a highly surgical electronic attack capability that focuses energy from a distributed array of low-power jamming nodes (40 or more, according to the solicitation) to attack navigation and communications receivers while minimizing the effects on nearby friendly and neutral systems.

According to the BAA, the PREW system would use small, lightweight (notionally less than 5 lbs.), low cost nodes mounted on a slow moving or stationary aircraft or in advantageous ground positions. The nodes will be formed into an ad-hoc network and use precision timing techniques to collectively focus their low-power jamming energy on target locations as precise as "a city block corner" with minimal impact on the surrounding area. The desired frequency range is 200-2,700 MHz. Target systems are described in a classified index.

DARPA envisions the system will operate in one of two electronic attack modes: "point to an area" or "point to a spot." The "point to a spot" mode will rely on some type of passive or active beacon(s) near the target area (or within the network area) that would provide reference information on the target location. This closed-loop approach could use a beacon that is cooperative or one that is not aware it is serving this purpose.

The BAA also states, "Clock synchronization represents a significant challenge in this effort. Synchronization can be accomplished in various ways including round trip synchronization, full feedback, 1-bit feedback, location-based and retro-reflective techniques." Additionally, the PREW program "restricts the techniques to simple methods such as injecting wideband or narrowband energy into a digital receiver to disable communications. The effect need not be saturation of the receiver front end, but should reduce the communications or navigation receiver Quality of Service (QoS) to a useless level." DARPA envisions the system will have the following minimal set of organic capabilities: localization; intra-node communication link for coordination; command and control communication link; synchronization; processing for spatial and temporal jamming; and energy transmission. In terms of node design, two key design drivers are the number of target signals it can attack and the unit's size, weight, power and cost.

The BAA covers the first two of three anticipated program phases. During Phase 1, the contractor will develop and demonstrate "clock synchronization across the array, pointing accuracy, energy coherence at 10 km range and collateral interference minimization." Phase 2, which could be exercised as a contract option, will focus on designing an "airborne-based array node" and pointing the coherent energy from the array at the target area. The contractor also must demonstrate "low impact" to friendly receivers operating in the jamming frequency bands and outside the specific target area.

continued on page 17

GROWLER ENTERS SERVICE

The US Navy's new Boeing EA-18G Growler support jamming aircraft, following completion of its three-month Operational Evaluation and a subsequent test report, was declared operationally effective and suitable in late July and recommended for fleet introduction by the service's independent Operational Test and Evaluation Force. This clears the way for a full-rate production decision. The first EA-18G electronic attack squadron, VAQ-132, is scheduled to become operational this month. The Navy currently plans to buy 88 Growlers to replace all of its carrier-based EA-6B Prowlers by 2013. – *G. Goodman*

Phase 3 work, which could be solicited under a separate BAA, would cover development of a prototype system comprising airborne and ground-based nodes, and live demonstration of the array. DARPA envisions that an array could comprise up to 40 nodes, with some of them operating at distances up to 100 km from the target.

DARPA is hosting a PREW Proposers' Day in Arlington, VA, on September 9. Bids are due on October 13. The PREW technical point of contact is Neil Fox, Neil.Fox@darpa.mil. – *J. Knowles*

NEW ARMY SIGINT VEHICLE NEARS DEPLOYMENT

The US Army will begin taking deliveries next month of its new vehicle-mounted Prophet Enhanced signals-intelligence system, which could be fielded with units deploying overseas in early 2010. Prophet is the service's principal ground-based tactical communications-intelligence (COMINT) sensor. It detects, identifies and locates enemy communications emitters on the battlefield, performing stationary and on-the-move direction-finding. Prophet provides force protection and intelligence support to brigade combat teams, armored cavalry regiments and battlefield surveillance brigades.

The Army previously procured 126 up-armored Humvee-mounted Prophet Spiral 1 electronic-support sensor systems from L-3 Linkabit (San Diego, CA) in 2007, and about two-thirds of them have been delivered. At the request of its intelligence user community at Ft. Huachuca, AZ, the Army curtailed further orders of Spiral 1 systems in the spring of 2008 in favor of buying new Prophet Enhanced systems offering greater flexibility to keep pace with evolving threats.

Last February, General Dynamics C4 Systems (Scottsdale, AZ) won the six-year, indefinite-delivery/indefinite-quantity Prophet Enhanced (PE) production contract with a potential value of $866 million. To date, the Army has ordered an initial 37 PE systems – 19 housed in up-armored Humvees and 18 in the service's new blast-resistant Panther 6x6 wheeled Medium Mine-

continued on page 20

What's NEW at DLI Dielectric Laboratories

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In an effort to be at the forefront of the aerospace market, Dielectric Laboratories, Inc. (DLI) has been certified to the AS9100B standard. DLI was informed in March 2009 that the Quality Management System in place was found to be in compliance with the standard and was officially certified to ISO 9001-2000 & AS9100B.

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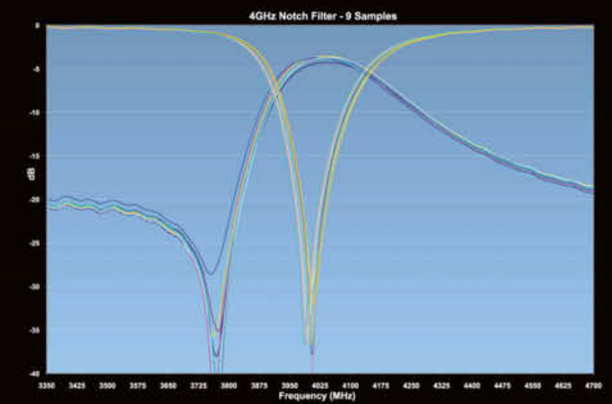

Notch Filter
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- Solder surface mount device

Typical Lowpass Filter
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- Typical size: .4 x .25 x .015 inches
- Chip and wire filter [mounted on PCB with epoxy or SMT]
- Designs possible from S to Ku band

Typical Highpass Filter
- Low loss in passband region [better than -2.0dB]
- Greater than -35dB attenuation in stopband
- Typical size: .3 x .2 x .015 inches
- Chip and wire filter [mounted to PCB with epoxy]
- Corner frequencies possible from 1GHz to 67GHz

L1/L2 GPS Notch Filters
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Protected Vehicle (MMPV), built by BAE Systems (York, PA). General Dynamics will deliver the first PE-equipped MMPVs to the Army next month. L-3 Linkabit and Northrop Grumman Information Technology (Chantilly, VA) are the company's principal subcontractors.

LTC James Ross, Product Manager-Prophet under the Program Executive Office for Intelligence, Electronic Warfare and Sensors at Ft. Monmouth, NJ, told *JED* that the Army plans to order at least 13, and perhaps 20, additional PE systems. The number of Prophet systems in the Army's inventory could ultimately total about 120 Spiral 1 and around 50 PE systems, he said, although the service's objective requirement is a total of 200. Army leaders haven't yet decided whether to upgrade Spiral 1s to the PE configuration – the likely course of action – or to replace them, Ross said.

Each brigade combat team will have two Prophet Spiral 1 or PE systems and one Prophet Control vehicle, each manned by three soldiers. The data from the Prophet sensor systems are passed to Prophet Control for processing and then forwarding to brigade intelligence elements.

A key design goal for PE is an open-system architecture that can be readily upgraded by incorporating new software applications – instead of adding a new hardware boxes to the vehicle – to keep pace with changing threat signals of interest. As Ross said, "We want to get to software-based capabilities, so we don't have to depend on pieces of hardware and don't have to say, 'Here's a new receiver or laptop; stick it in the vehicle and it provides this capability.' We would like to get to a laptop or two within the vehicle that operate on a server technology – which we are looking at – so we only have to upgrade software and the operator can have access to different capabilities without having to replace or add pieces of hardware."

He added, "We also want to get to a kitting strategy with modular components for Prophet Enhanced by which we could install it in the form of kits on different vehicles the Army might procure, with only limited design changes to the vehicles."

A major capability added in the PE configuration is satellite beyond-line-of-sight communications on the move, Ross said, which will be provided by the Army's new WIN-T (Warfighter Information Network-Tactical) communications system. "SATCOM on the move will give Prophet more autonomy, flexibility and mobility," he said, "because it will give us the [direct] connectivity back to the US that we need for some parts of our SIGINT mission." – *G. Goodman*

EP-X AOA MOVES FORWARD

Naval Air Systems Command (NAVAIR) announced its intention in August to release a request for information seeking materials useful for the execution of the Analysis of Alternatives (AoA) for the Electronic Patrol-X (EP-X) signals-intelligence aircraft program. Completion of an AoA is a required step in the DOD's acquisition process before a development program can enter the initial Technology Development phase.

NAVAIR tentatively planned to hold an Information Day meeting for interested RFI respondents on or about September 10-11 in the Metropolitan Washington, DC area or in Southern Maryland (near NAVAIR at NAS Patuxent River, MD.) On May 20, NAVAIR cancelled its EP-X pre-solicitation notice for a Broad Agency Announcement (BAA) phase that would have led to the award of three 13-month contracts for requirements analysis, system design concept development and risk reduction, ostensibly to wait for completion of the Office of the Secretary of Defense-directed AoA.

Following the BAA phase, NAVAIR plans to down-select to two contractors to complete the technology development phase of the program, then will down-select to a single contractor for the engineering and manufacturing development phase.

The EP-X is slated to replace the Navy's aging shore-based EP-3E Aries II turboprop SIGINT aircraft and also will carry a number of other intelligence, surveillance and reconnaissance (ISR) sensors, including electro-optical/infrared and radar, making it a multi-mission, multi-INT platform. The aircraft will provide tactical, theater and national-level SIGINT, ISR and targeting support to Navy carrier strike groups and to theater, combatant and national commanders. The solicitation number is Pre-RFI_EP-X; the NAVAIR point of contacts of contact are the EP-X AoA Technical Director, R.B. Shibe, at (301) 342-8309, e-mail robert.shibe@navy.mil, and the Information Day Lead, Natalie Whitman, at e-mail natalie.whitman@navy.mil.

The industry members of the AoA Integrated Product Team and subordinate AoA working groups are: Booz, Allen & Hamilton (McLean, VA); Johns Hopkins University Applied Physics Laboratory (Laurel MD); MANTECH (Lexington Park, MD); ARES Government Services (Arlington VA); AT&T Government Solutions (Lexington Park, MD); General Dynamics Advanced Information Systems (Mountain View, CA); Integrity Applications, Inc. (Chantilly, VA); MITRE (Lexington Park, MD); Center for Naval Analysis (Arlington, VA); and Technology Security Associates (Lexington Park, MD). – *G. Goodman*

CORRECTION

In the article, "The Top 20 EW Programs," (*JED*, August 2009, p. 35) the article incorrectly stated that the EA-6B Prowler is being retired. The US Navy is retiring its last Prowlers in 2012. But the US Marine Corps is planning to fly their Prowler aircraft through at least 2018. Also, in the July *JED*, on page 18, the article, "USMC EA-6B Training Squadron Planned", misidentified the USMC Prowler squadrons. They should have been listed as "VMAQ-1 through VMAQ-4." *JED* regrets the errors.

US NAVY TO RELEASE NEXT GENERATION JAMMER BAA

In late August, as this issue of *JED* went to press, the US Navy's EA-6B Program Office (PMA-234) was expected to issue a Next Generation Jammer (NGJ) Technology Maturation (TM) Broad Agency Announcement (BAA).

The Navy wants to develop the NGJ to replace the ALQ-99 jamming pods currently used on the EA-6B and EA-18G. The NGJ pods, which would be integrated onto to EA-18G and possibly F-35 aircraft, are slated to reach initial operational capability in 2018.

In advance of the NGJ program's engineering and development phase, the Navy wants to mature critical technology elements to Technology Readiness Level (TRL) 6 or higher and integrate them into a tactical jamming system concept design. The work performed during the TM phase will feed the follow-on technology demonstration (TD) phase, which will include laboratory and flight demonstrations. Transition to the TD phase is dependent on a successful Milestone A review.

According to the BAA, the NGJ TM phase will focus on two objectives. The first objective calls for the contractor(s) to provide a system-level concept demonstrator design. The second objective is to mature critical technology elements and subsystems that are required to support to concept demonstrator design.

Once the final NGJ TM BAA is issued, bidders will have 30 days to respond with their proposals. The BAA will be available at www.navair.navy.mil. The solicitation number is N00019-09-R-0238. The contracting point of contact is Ms. Robyn Warner, Robyn.Warner@navy.mil. – *J. Knowles*

IN BRIEF

Science Applications International Corp. (San Diego, CA) has won a $6.1 million contract from the Defense Advanced Research Projects Agency to develop RF signal location and identification technologies for the Retriever program. Under to the contract, which runs through May 2012, the company will develop a prototype system, demonstrate the system and then embed the system into "devices" for demonstration.

✪ ✪ ✪

KOR Electronics (Cypress, CA) was awarded a contract from a major international defense prime to upgrade a simulator developed in 2005. The new contract will extend the simulator's current features and provide the user with enhanced testing capabilities.

✪ ✪ ✪

Sierra Nevada Corp. (Sparks, NV) has received a $26 million contract from Naval Sea Systems Command (NAVSEA) for long lead material for 1,300 dismounted Joint Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (JCREW) systems. Work is scheduled for completion by December 2010.

✪ ✪ ✪

A demo of unmanned airborne medium power communications electronic attack (EA) capabilities was conducted July 27 jointly by a team of EA specialists and software/system engineers from **Chesapeake Technology International Corp.** (CTI) and **AeroMech Engineering, Inc.** (AME). The aircraft, which is a modification of AMEs Fury platform carried CTI's Thunderstorm EA system during the demonstration.

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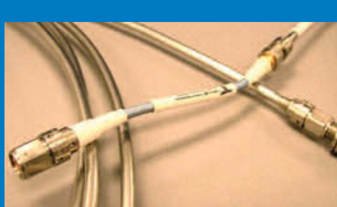

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HOUSE PASSES FY10 DEFENSE SPENDING BILL

Before breaking for the August recess on Capitol Hill, the US House of Representatives passed its version of the FY2010 Defense Appropriations Bill. The bill totals $636 billion (including funding for the Department of Energy), which is $10.2 billion more than FY2009 and $3.8 billion above the President's request.

The House supported most of the electronic warfare (EW) and signals intelligence (SIGINT) programs requested by the Pentagon, including $1.6 billion for EA-18G Growler procurement and $248.5 million for research and development of EW devices.

In the Air Force operation and maintenance portion of the bill, the House called special attention to the Air Force Electronic Warfare Simulator (AFEWES): "The Committee is aware of an Air Force effort to relocate the Air Force Electronic Warfare Evaluation Simulator (AFEWES) from Air Force Plant 4 to the Air Force Flight Test Center. Several government studies, including the 1995 Base Realignment and Closure Commission and a 1997 Government Accountability Office report, highlight the absence of a cost or capability rationale to justify this relocation. Therefore, the Committee directs that the Department shall not obligate or expend funds to relocate the AFEWES from Air Force Plant 4 until a comprehensive cost/benefit analysis, reviewed by the Government Accountability Office, is provided to the Congressional defense committees. Further, because the AFEWES specialized test capabilities are a vital element of our national defense posture, study findings should demonstrate the technical merits of any proposed relocation."

House appropriators were very aggressive with their funding plus-ups and cuts, and many EW programs were affected. The House cut $43 million from 10 EW and SIGINT programs, while adding $6 million to three others. The Committee was more generous with the research and development lines, where they added $81 million to 26 EW and SIGINT programs, while cutting only $24 million from five programs. The following are some of the highlights:

Navy Procurement:

- Cut $3.5 million from ALE-47 retrofit kits.
- Add $5 million for AAR-47D(V)X missile warning system.
- Add $2 million for Crane Integrated Defensive ECM Depot Capability.
- Cut $3 million from AGM-88 HARM.
- Cut 9.8 million from Air Expendable Countermeasures due to MJU-55 contract delay.
- Cut $5 million from Air Expendable Countermeasures due to "support funding carryover."
- Cut $3 million from SLQ-32 procurement due to "support funding growth" and buying Block 1B2 specific emitter identification systems ahead of need.
- Cut $7.1 million from Nulka Decoy procurement due to cost growth.

Air Force Procurement:

- Cut $9.1 million from LAIRCM procurement for C-17 and C-130 aircraft.
- Add $1.5 million for "podded" LAIRCM systems for Air Force Reserve KC-135 aircraft.

Defense-Wide Procurement:

- Cut $11 million from Special Operations Command funding for ALQ-211 SIRFC procurement.

Army RDT&E:

- Add $2.5 million for Advanced Ground EW and SIGINT System.
- Add $1 million for ALQ-211 Networked EW Controller initiative.
- Add $3 million for "electronic combat and counter terrorism threat developments to support Joint Forces."
- Add $5 million for Joint Threat Emitters.

US Navy RDT&E:

- Add $2 million to the RF Systems Applied Research Line for GaN power technology.
- Add $4.4 million to the Power Projection Advanced Technology Line for AARGM Counter Air Defense Future Capability ($2.5 million) and Tactical High Speed Anti-Radiation Missile Propulsion Demonstration ($1.9 million).
- Add $17 million to the Directed Energy and Electric Weapon Systems Line.
- Add $2 million for the EA-18G Next Generation EW Simulator.
- Add $4 million for the NAWC-WD Point Mugu EW Lab upgrade.
- Cut $10 million from the Next Generation Jammer program due to "program growth."
- Add $1.5 million to the Ship Self-Defense Line for the Laser Phalanx program.
- Add $2 million for the Navy Advanced Threat Simulator.

US Air Force RDT&E:

- Add $2.5 million to the Materials Line for GaN Microelectronics.
- Add $1.5 million for Advanced Electromagnetic Location of IEDs Defeat System.
- Add $3 million for Senior Scout COMINT Capability Upgrade.
- Add $2 million for Electromagnetic Battlespace Management
- Add $2.5 million for Rivet Joint Services Oriented Architecture.

Defense-Wide RDT&E:

- Add $6 million for Unattended SIGINT Node.

The Senate is expected to finish its version of the defense appropriations bill when it returns from recess early this month. The two bills will be resolved in conference. The President has threatened to veto the defense appropriations bill if a number of controversial Congressional adds, such as the alternate engine for the F-35 and new presidential helicopters, remain in the bill when it is sent to the White House. – *JED Staff.*

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world report

EWMS SELECTED FOR CANADIAN CHINOOKS

The Boeing Company, having won a $1.15 billion order for 15 CH-47F Chinooks from Canada last month, has tapped Danish EW house Terma A/S to supply its ALQ-213 EW Management System (EWMS) on the helicopters.

The systems will manage the Chinook's radar warning receiver, missile warning system, laser warning receiver and flare dispensers. The aircraft may also be outfitted with directed IR countermeasures systems. EWMS development and subsystem integration work will be carried out by Terma's North American business unit in Warner Robins, GA. The Chinooks are designated CH-147s in Canadian service. Boeing will deliver the Chinooks in 2013 and 2014.

The selection follows an agreement in March between the two companies to explore collaborative opportunities. Terma is conducting a trade study to evaluate the feasibility of integrating Terma's 3-Dimensional Audio and Active Noise Reduction technology on Boeing's F/A-18E/F Super Hornet. – *JED* Staff

BRAZILIAN FIGHTER COMPETITION DECISION NEARS

The Brazilian Air Force (Força Aérea Brasileira or FAB) FX-2 fighter competition is gathering speed. Last month, to expedite the administrative process, the Brazilian Government made a preliminary request to the US for the F/A-18E/F Super Hornet. Although Brazil has not yet selected an aircraft, the request enables Boeing to move as quickly as possible with deliveries if the Super Hornet is selected.

The request detailed the Super Hornet package on offer. The EW suite includes 36 ALR-67(V)3 radar warning receivers from Raytheon, 36 ALQ-214 RF Countermeasures subsystems from ITT Electronic Systems, 112 ALE-50 Towed Decoys from Raytheon and 40 ALE-47 chaff/flare dispensers from Symetrics. It is not clear if Brazil will be cleared to receive the ALE-55 Fiber-Optic Towed Decoy when it becomes available.

The Super Hornet is competing against the Rafale from France and the JAS-39 Gripen NG from Sweden. The Rafale is equipped with the Spectra EW suite from Thales and MBDA. While the Gripen offer includes the EWS39 along with some recently developed upgrades. The Rafale and the Gripen bids reportedly include substantial cooperative technology development, including EW and radar work, with Brazil. The technology transfer offer with Super Hornet is restricted primarily to component technology.

As early as next month, the FAB could select a winner for the initial order of 36 aircraft. Eventual follow-on orders could boost the total to 120 aircraft. – *J. Knowles*

EW COMPANIES VIE FOR AUSSIE NAVAL EW CONTRACT

Later this year, Australia's Defence Materiel Organisation (DMO) is expected to select an EW system for the Royal Australian Navy's three new Hobart-Class Air Warfare Destroyers (AWDs). Four companies were invited to submit bids earlier this year.

The AWD is based on the F100 frigate design and two of the selected bidders have already integrated systems onto that class. Indra of Spain is offering its SLQ-380, a variant of which is installed on F100s in service with the Spanish Navy. US EW manufacturer ITT Electronic Systems is bidding its CS-3701 ESM system which has been integrated onto the Norwegian Navy's Nansen-Class F100 ships. ITT recently announced that it is teaming with two local companies, Jenkins Engineering and Avalon Systems.

Thales of France is bidding a solution from its Vigile family. Elisra of Israel is offering its NS9003A, which is in service with the Israeli Navy and the Singaporean Navy.

The Royal Australian Navy is buying three AWDs with deliveries beginning in 2014 and running through 2017. The EW suite selected for the AWDs could be selected for other Royal Australian Navy ships, such as the Landing Helicopter Dock (LHD) at a future date. – *JED Staff*

IN BRIEF

- **TCI International, Inc.** (Fremont, CA) completed Factory Acceptance Testing Aug. 5 of three 802C Radio Intercept and Direction Finding (DF) systems to protect the Amazon Basin region in Brazil. The systems, which include the capability for remote receiver control, audio monitoring, digital signal decoding and audio recording, will allow the Brazilian government to identify and locate radio communications throughout the Amazon Jungle to help control illegal activities such as border crossing, tree cutting and poaching.

- **India** last month began conducting flight trials of its five candidate aircraft for the Indian Air Force's Multirole Combat Aircraft (MRCA) program. The IAF is being offered the MiG-35, Rafale, Eurofighter, JAS-39 Gripen, F-16IN and F/A-18E/F. The trials will include assessments of each aircraft's EW suite.

- **Egypt** has requested the Foreign Military Sale of six CH-47 Chinook helicopters at an estimated cost of $308 million. The potential deal includes six APR-39A(V)1 radar warning receivers with mission data sets.

- **The United Arab Emirates** has requested the sale of various defense items for its AH-64 Apaches helicopters. The package includes 21 APR-39A(V)4 radar warning receivers and 15 AAR-57 missile warning systems, as well as Hellfire missiles and radars.

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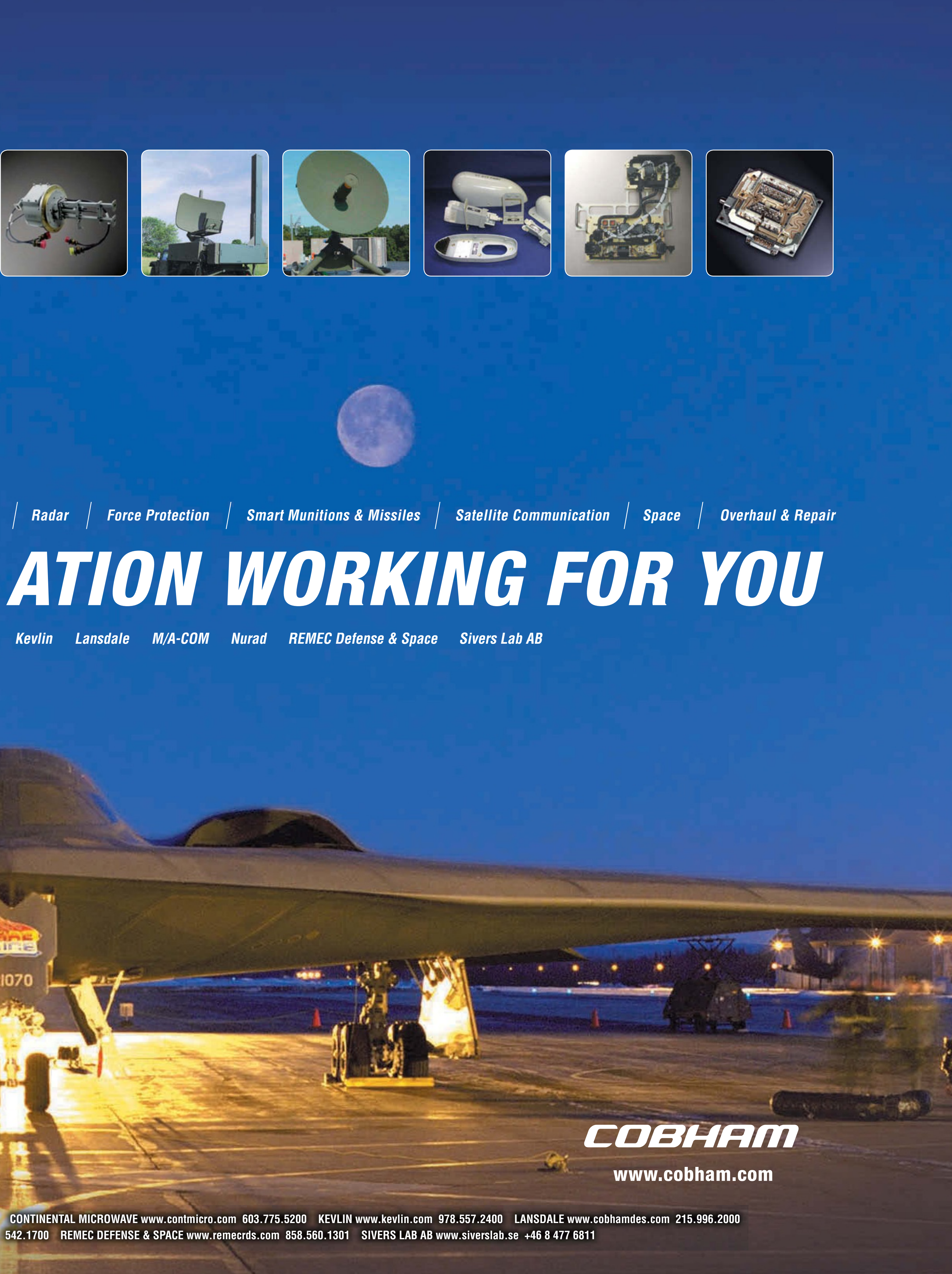

Defeating Threats to Large

By Glenn Goodman

When it comes to combat survivability, transport aircraft pose many unique challenges. Hampered by slow speeds, poor maneuverability, large radar cross-sections and substantial infrared signatures, these aircraft have traditionally achieved survivability by flying far outside high- and medium threat areas.

However, with the increased pace of peacekeeping operations during the 1990s and the even less structured battlespace of today's Global War on Terror, transport aircraft often must fly near (and sometimes directly over) hostile areas, where they are vulnerable to IR threats during take-offs, landings and air-drops. In addition, the proliferation of advanced, long-range radar-guided surface-to-air missiles is also becoming a problem for transport aircraft because they increase the threat zones and limit the ability for transport aircraft to fly avoidance routes. With a very limited menu of combat survivability solutions, transport aircraft rely heavily on EW self-protection systems to ensure they can complete their missions.

TAILORED PROTECTION FOR TRANSPORTS

Up through the 1990s, most transport aircraft around the world either carried no self-protection equipment or were outfitted with relatively standard radar warning receivers, missile warning systems and chaff/flare dispensers. Flares (and unique flare pat-

Aircraft

terns) designed specifically for large aircraft were used to defeat IR-guided threats. RF and IR jammers had been fitted to some transport aircraft in a very limited basis, but the cost of developing affordable jammers that could generate the required jamming-to-signal ratios to protect such large aircraft was considered cost prohibitive for large-scale installations.

During the 1990s, the US Air Force became increasingly aware of the threats its transport aircraft faced and of the availability of new EW systems that could protect these aircraft. Finally, in 2001, the Air Force started the Large Aircraft IR Countermeasures (LAIRCM) program, which leveraged the AAQ-24 Nemesis system that had been jointly developed by the US and UK during the 1990s. After the September 11 attacks that year, the LAIRCM program became a major Air Force priority.

Large transport helicopters, such as the CH-46, CH-47, and CH-53, also pose unique self-protection challenges, especially against MANPADS. The US Marine Corps and the US Army have begun fielding laser-based directed infrared countermeasures (DIRCM) systems for the first time this year on their large helicopters flying in Iraq and Afghanistan. (Existing US laser DIRCM systems are too heavy to put on smaller helicopters, but the Army, Marine Corps and Navy are now jointly pursuing lighter-weight systems.)

The Marine Corps early this year began fielding an Air Force-developed DIRCM system from Northrop Grumman on its CH-53E heavy-lift helicopters in Iraq; CH-46E and CH-53D installations are slated to follow. The Army is installing a laser-based DIRCM built by BAE Systems on its CH-47 Chinook heavy-lift helicopters under a Quick-Reaction Capability (QRC) program.

Another significant trend in the market is the increasing number of DIRCM manufacturers. Several EW companies from the US, Europe and Israel are offering laser-based DIRCM solutions for fixed- and rotary-wing aircraft. The pending sale to the Italian Air Force of an Israeli-designed system, which also will be installed on Israeli commercial airliners, is a recent example.

BEATING THE HEAT-SEEKER

The predominant means used globally to protect low-flying military aircraft from shoulder-launched IR SAMs, such as SA-7s, is to dispense expendable flare decoys, which draw the enemy missile away from the targeted aircraft by presenting a greater heat signature than the aircraft's engines and exhaust.

Aircrews sometimes dispense flares preemptively to prevent the missile from gaining a targeting solution and this preventing its launch. However, most aircraft typically carry limited numbers of flares. Large aircraft, such as multi-engine transports, can't maneuver away from incoming missiles in time and have to dispense numerous flares to present a more attractive IR target to divert the missile.

Passive missile warning systems (MWS) have become prevalent on military aircraft. They automatically detect IR missile launches or approaching IR missiles and cue the flare dispensers and/or DIRCM systems. Multiple (4-6) electro-optical warning sensors are typically installed externally around the fuselage of an aircraft to provide full spatial coverage. They detect the ultraviolet (UV) or IR radiation emitted by the IR SAM's exhaust plume. Northrop Grumman's AAR-54 MWS has been in use with Air Force LAIRCM Phase I systems, and ATK's AAR-47 is widely installed on Navy/Marine Corps rotary-wing aircraft. BAE System's AAR-57 Common Missile Warning System (CMWS or 'see-maws') is fielded on all deployed Army combat helicopters. The AAR-47, -54 and -57 use UV sensors. The latest version of the AAR-47, the AAR-47B(V)2, features a laser warning receiver integrated into each sensor head.

Under the Phase II LAIRCM program, the Air Force funded, and in late 2008, selected a new two-color IR missile warning sensor developed by Northrop Grumman that it calls the Next-Generation (NexGen) MWS. It provides faster and longer-range detection than a UV sensor and much lower false alarm rates even against a cluttered IR background because it compares the IR energy levels of a potential threat in two separate frequency bands. The NexGen MWS is being fielded as part of the Phase II LAIRCM installations on Air Force C-17s and C-130s and DoN LAIRCM installations on the Marine Corps' CH-53E, CH-46E and CH-53D helicopters.

Naval Air Systems Command (NAVAIR) is developing a next-generation MWS for itself, the Marine Corps and the Army under its Joint and Allied Threat Awareness System (JATAS) program. NAVAIR was set to award technology development contracts to two companies as this issue went to press. JATAS, which will be more advanced than NexGen, is expected to use either one- or two-color IR sensors.

The primary flare/chaff dispenser used on US and allied military aircraft is the ALE-47, currently produced by Symetrics (Melbourne, FL) and BAE Systems (Austin, TX). BAE Systems also produces the Improved Countermeasure Dispenser (ICMD), which is integrated with the company's AAR-57 CMWS on Army helicopters.

Outside the US, the MWS predominantly used on Israeli helicopters and transports is the Passive Missile Approach Warning System (PAWS), produced by Elisra Electronic Systems. It features staring IR focal-plane-array missile warning sensors. PAWS 2 is a two-color IR warning system with similar applications.

EADS of Germany builds the UV sensor-based AAR-60 MWS, which is installed on many transport aircraft. It is integrated with a variety of dispensers and DIRCM systems.

EADS and Thales of France are slated to provide the new Multi-Color IR Alerting Sensor (MIRAS) MWS for some customers of the troubled European A400M transport program. At least 85 of the 180 aircraft currently on order are slated to receive an EW suite comprising the MIRAS, the ALR-400 RWR from Indra of Spain and a chaff/flare dispenser. A later phase of the program will address DIRCM solutions for these 85 aircraft. Germany, France, the UK and Spain, as well as five other nations, are negotiating with EADS to restart the A400M program.

Denmark's Terma has supplied the Modular Countermeasures Pod, which includes up to 10 flare dispensers, for Germany's C-160 Transall aircraft. . The Transalls carry a pair of MCPs, plus eight "top of fuselage" dispensers.

LASER DIRCM SYSTEMS

The advent of new imaging IR missile seekers that are more resistant to flares is hastening the move to laser-based DIRCM systems, which can counter all known and projected IR-guided missile threats. While capability is not a problem for DIRCM systems cost, maintenance and reliability concerns have limited their application to a relatively small number of transport aircraft. However, the prospects appear promising, as the advent of lasers improve these factors.

A DIRCM system consists of three components: a gimbaled pointer-tracker turret or jam head, which protrudes from the fuselage, with typically one on each side of an aircraft; a laser transmitter, which is mounted in the turret or close behind it; and a jam head control unit. The aircraft's MWS sensors cue the jam head to the direction of arrival of the IR missile. The DIRCM system determines if the detected missile is threat to the host aircraft. The jam head tracks the missile with an IR sensor, locks on to it and then jams the missile's guidance system with a high-intensity modulated beam of IR laser energy that confuses it and directs the missile away from the aircraft. This all takes place within a few seconds.

The Air Force's AAQ-24 LAIRCM system, built by Northrop Grumman Defensive Systems (Rolling Meadows, IL), was a derivative of the company's earlier-vintage AAQ-24 Nemesis system. In 1999, Nemesis became the first DIRCM system to enter major production in the UK, with full-rate production beginning in the US in 2001. The system was acquired jointly by the UK for its SeaKing, Lynx and EH-101 helicopters and C-130s and US Special Operations Command for Air Force Special Operations Command's MC/AC-130s and MH-53 Pave Low helicopters. The Nemesis originally used a directable xenon arc-lamp jammer, and a laser jammer was planned as a retrofit once it was ready for production.

The laser chosen for Northrop Grumman's Nemesis and LAIRCM systems was the multi-band Viper, developed by Fibertek, which operates in all three segments of the IR waveband used by heat-seeking missiles. The Air Force LAIRCM Phase I system became operational in 2005. Its jam head is called the Small Laser Transmitter Assembly. The LAIRCM Phase II program developed a smaller and lighter jam head, called the Guardian Laser Transmitter Assembly, along with the NexGen MWS. Northrop Grumman began delivering the new Guardian jam head to the Air Force in late 2008.

Selex Galileo, a subsidiary of Italy's Finmeccanica, has built all of the pointer-tracker jam heads for the Nemesis and LAIRCM programs in Edinburgh, Scotland, as a key supplier to Northrop Grumman. LAIRCM has been in service on the UK's C-130s and C-17s and is going on its Future Strategic Tanker Aircraft (an A330-200 Airbus) as well as on Australia's C-130Js. Air Force Special Operations Command's CV-22 tilt-rotor aircraft also are fitted with LAIRCM.

Terma has integrated the AAR-54 MWS and the AAQ-24 into a pod for the Netherlands' new Boeing CH-47F helicopters. Called the Chinook Aircraft Survivability Equipment (CHASE) program, the Chinooks will carry two CHASE pods, one on each side of the helicopter, to provide 360-degree spherical coverage. Each pod contains three missile warning sensors and a laser DIRCM turret. Tracking of a threat missile can be handed over between the two pods.

Development of the ALQ-212 ATIRCM by BAE Systems (Nashua, NH) to replace the ALQ-144 on Army helicopters began in 1991 and was coupled with the AAR-57 CMWS and the ICMD as the Suite of Integrated IRCM (SIIRCM). In the months following 9/11, the Army postponed production of SIIRCM by several years due to budget constraints. (SIIRCM was only fielded on MH-47 Chinook, MH-60 Blackhawk and AH/MH-6 helicopters of the Army's 160th Special Operations Aviation Regiment.) However, once IR-guided missiles and small arms began shooting down its helicopters in Iraq in late 2003, the Army hurried the AAR-57 CMWS and ICMD portions into production to protect its helicopters, including its Chinooks.

The Army subsequently began moving forward with the ATIRCM program. In June 2007, the service's Program Executive Office for Intelligence, Electronic Warfare and Sensors (PEO-IEWS) at Ft. Monmouth, NJ, awarded BAE Systems contracts to integrate a multi-band laser into the ATIRCM system to replace its existing flash lamp and single-band laser combination. Installation of the upgraded ATIRCM system on the Army's CH-47 Chinooks is slated to begin this fall under a QRC program.

Elbit Systems of Israel's Electro-Optics Ltd (El-Op) subsidiary has achieved that goal already. Its DIRCM system, designed for Israeli military helicopters and transports, is called MUSIC (multi-spectral IRCM). It has evolved over the past several years from a lamp-based to a state-of-the-art, "fiber-laser" system. The Italian Air Force plans to acquire it in the form of the ELT/572 system, offered by El-Op and domestic EW supplier Elettronica, for use on its transport, refueling tanker and rotary-wing aircraft in out-of-area operations.

The A400M program is structured to enable customer nations to choose the


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self-protection suite for their aircraft. This has led to at least two new DIRCM programs. The Spanish Air Force has funded domestic EW supplier Indra to develop the MANTA DIRCM system for its A400Ms. MANTA uses a relatively high-power chemical laser, supplied by Russia's Rosoboronexport. Compared with most other DIRCM systems, the MANTA is somewhat large, due to the size of the chemical laser. However, the laser generates the required power to protect large aircraft and it can use closed-loop techniques to identify the incoming threat (SA-7, SA-14, SA-16, etc.) and generate optimal jamming techniques against that threat. With the delay in the A400M program, the Spanish Air Force has altered its plans and is qualifying the MANTA for eventual installation on its CASA-295 aircraft. Flight tests began last year on a CASA-212 aircraft. Production is scheduled to begin later this year.

Another DIRCM program that has been targeting the A400M is the FLASH or Flying Laser Self-Defence System Against Infrared Seeker Head Missiles. For the past 10 years, Diehl BGT Defence, EADS Defense and Security and Thales Land and Joint Systems have been developing FLASH as an eventual upgrade that could be integrated with the MIRAS. According to program officials, FLASH will feature closed-loop techniques and can either jam or damage the seeker of the incoming IR missile via independent lasers. Although FLASH has completed early stages of development, full-scale development is dependent on the successful restart of the A400M program.

RECONSIDERING THE RF THREAT

Over the past decade, air forces have focused a lot of attention on the IR threat to their transport aircraft. While that work will certainly continue, the next decade is likely to see more attention directed on RF threats. Advanced long-range threats from S-300 and S-400 families are just as lethal for transport aircraft as they are for any other large aircraft. With maximum engagement ranges between 75 and 250 nmi, these systems can deny transports from accessing large areas of the battlespace.

The US Air Force and Air National Guard have shown interest in equipping their transports with digital radar warning receivers, such as the ALR-69A, under the Advanced Situational Awareness and Countermeasures (ASACM) program. While digital RWRs will provide these aircraft with better threat avoidance, the Air Force will need to consider how to equip these aircraft with adequate, yet affordable RF countermeasures systems.

ESSENTIAL ASSETS

More than ever, transport aircraft are demonstrating that they are essential for global military operations. The traditional reluctance to spend money on self-protection systems for transport aircraft is fading. The investment over the past decade in new IR countermeasures systems demonstrates that fact. However, the onus is on the EW industry to continue developing IR and RF countermeasures solutions that are effective and affordable.

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The Threat Test Resource Gap

Let's Get on With the Fix

By Tom Brannon

It is hardly news that aircraft (fixed and rotary wing) electronic warfare (EW) systems are emerging much faster today than verified, validated, and accredited threat test resources. The implication is that complex and expensive aircraft threat warning and self-protection systems may arrive at operational squadrons with unresolved key performance parameters (KPPs) and unresolved critical operational issues (COIs). It is not a single service problem. The USAF F-22 and CV/MV-22 are becoming operational in militarily significant numbers and in need of threat test resources. Figure 1 is a notional depiction of the gap between the projected threat test resources (blue bars) and emerging systems (fuchsia bars) to be tested.

The then Director of Operational Test and Evaluation, Thomas P. Christie, in a Dec 13, 2003 memorandum to the SecDef said that to strengthen our joint warfighting capabilities, the Department should not only "train as we fight" but also "test as we fight."(1) That there is a gap is not particularly news worthy; that the gap is likely to widen is significant. *The critical question:* are we putting precious aircrew and air assets in harm's way with aircraft self-protection and warning systems that are not fully tested and evaluated when there may be reasonable alternatives?

What has changed? Today the US Government borrows about 50 percent of Federal Budget placing extraordinary pressure to reduce cost in all Federal budget areas.

John Young, former Pentagon Acquisition Chief, referring to UAVs, encouraged the test community to be more agile and able to deliver systems quickly to the field. (2) This article is not a call to abandon long standing T&E processes or to co-mingle Major Range and Test Facility Base assets with traditional service Title 10 acquisition or service training functions. Rather, it proposes a new look at some old ideas to accomplish robust test and evaluation. To do nothing means we watch the gap between threat test resources and systems under test grow. Unacceptable. Worse, if we cannot test a system until long after it is fielded; do we have a legitimate test requirement?

The problem: technological innovation by threat nations has increased

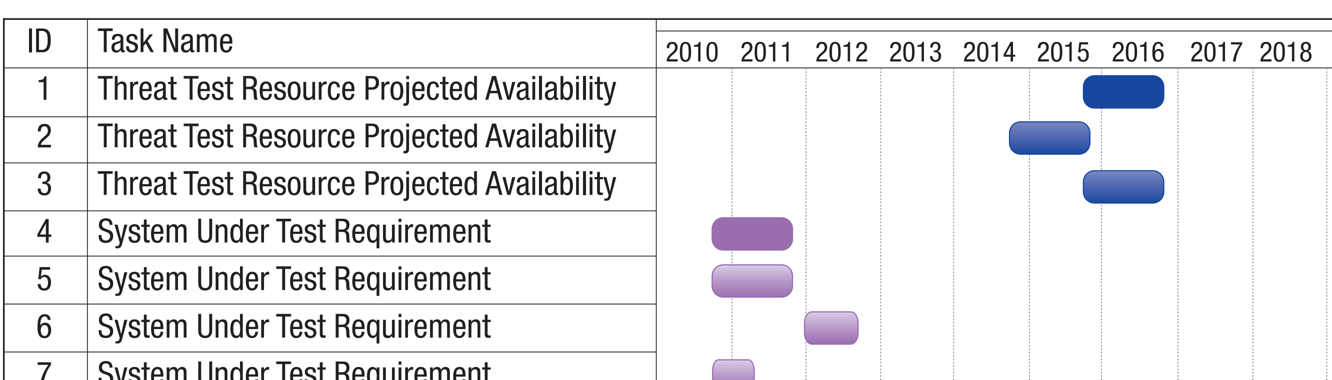

Figure 1: Notional depiction of Threat Test Resource Projected Availability vs. System Under Test (SUT) Requirement. Depicted is a gap between the test requirements and threat system availability.

exponentially faster than our access to threat test resources. The issue is both access and dollars. There are threat systems to be tested against but no access and there is access but no dollars. Complicating the issue, US aircraft warning and protection systems are emerging faster because of technological innovation.

A Douglas SBD-3 "Dauntless" scout bomber, of USS Enterprise's Bombing Squadron Six (VB-6), on the USS Yorktown (CV-5) during the Battle of Midway. The newly installed electrical arming system resulted in the premature release of bombs. (Photo courtesy of US Navy Historical Center)

TEST AND EVALUATION (T&E): A HISTORICAL FOOTNOTE

Just prior to the Battle of Midway (4-7 June 1942) US Navy dive bombers were retrofit with an electric arming device for the single 500 lb bomb and wing mounted machine guns. At the critical moment of the Midway battle, Navy aircrew found the Japanese fleet. As the procedure directed, aircrew armed up their weapons electrically, inadvertently causing the bombs to fall harmlessly away from the aircraft. There was a glitch in the electrical arming system.

The problem was the lack of a full regime of robust T&E. The decision to field an incompletely tested electrical arming system was hardly cavalier. We were losing the War in the Pacific and the Atlantic and it became expedient to set aside long accepted T&E principles.

LETHALITY AND PROLIFERATION OF THREAT AIR DEFENSE SYSTEMS

Pundits often get windy about the future of aviation and the emerging mission capabilities, *but EW systems make the mission possible*. While US aircraft are exponentially more expensive, the capability (and proliferation) of threat air defense assets is exponentially more lethal. Worse, access to threat test resources is becoming problematic.

Arms sales by regimes indifferent to US interests to anyone willing to pay complicates US defense planning and the acquisition process that underpins readiness. UPI Asia reported that "China has put its HQ-9 surface-to-air missile on the export market under the name FD-2000." (3) We are likely to discover what makes the HQ-9 significant is not its range or lethality, but its proliferation by the Peoples Liberation Army (PLA) Navy and global sales.

Further, vintage Soviet systems, mass produced and marketed globally, are now being upgraded to very capable digital systems. Despotic regimes and organizations gain new global military credibility by upgrading. Upgraded systems are significantly cheaper than new systems. Worse, Russia has signaled that a state-of-art double digit SAM systems may be up for sale. Russian and Chinese global interest in arms sales is more than an attempt to tweak the US. It is a cash cow; the source of the cash is secondary.

Just as deadly is the global proliferation of unguided small arms (40 mm and below). The February 2007 shoot down of *Morphine 12,* a USMC CH-46 transporting blood supplies to Balad Airbase in Iraq, underscores the problem. There are approximately 8 million small arms manufactured globally each year, and about 500 million in existence. There are 3,192 different types of small arms. Many more aircraft return with bullet holes than damage from surface to air missiles. In Operation Iraqi Freedom, at one point, US forces were losing helicopters at a rate greater than in the Vietnam War.

To address small arms, the Services are pouring great energy into Hostile Fire Indication (HFI) as a part of the aircraft protective kit. One idea is for HFI operate in conjunction with situational awareness. The question is how to do T&E? Firing live rounds using offset aim point at service aircraft is a non-starter. Laboratory simulation is essential, but it does not provide the open air T&E opportunity for an aircraft installed system. There are some innovative solutions and White Papers, but the problem remains.

A PERFECT STORM FOR THE EW COMMUNITY

A perfect storm is brewing. **First**, technology combined with urgent military need has accelerated the availability of highly capable aircraft warning and self-protection systems. **Second**, the advent of single aperture multi-functional sensors, powerful algorithms, and hyperfast processing is substantially ahead of threat test resource acquisition. **Third**, DOD dollars for foreign military acquisition are tight. **Fourth**, these trends are unlikely to change and may expand the gap between systems-under-test and threat test resources.

There are some tantalizing T&E alternatives, even when long standing and very effective testing regimes may not realistically achievable.

WHAT TO DO?

There are no penalty free options. We can and must get creative.

First, recognize that EW exists in the context of US national strategy. The strategy seeks to defend forward, beyond US coastlines. EW systems properly developed, rigorously tested and evaluated, then employed aboard military aircraft, make defending forward possible. At risk now is the capacity to rigorously test and evaluate when weapons platforms are arriving in inventory faster than threat test resources.

Second, time is not our ally. Even if threat test resources subjected to the economic stimulus plan, the resources required to test new platforms would not be available for a considerable time. The DOD's decision to stop production of the F-22 does not change the T&E gap because legacy aircraft defensive systems are being substantially upgraded. Thus, it is incumbent on the EW community (contractor, government civilian and military) to take a hard look at test resource alternatives. The requirement for T&E has not changed; the availability of credible threat systems has changed. The issue is how to do T&E that delivers the best capability. One alternative is to


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look at US government institutional intelligence analyses of threat surface-to-air and air-to-air systems. If the track record between inferred system data and observed system data is strong, consider investing in US-manufactured systems that accurately replicate the threat. For example, US-manufactured radars, co-opted by a certain nation, may accurately simulate threat radar not readily accessible. Is using the US manufactured system an acceptable alternative? Perhaps.

Third, take a critical look at mission testing and net-centric testing. Is there an intersection between the needs of the tester and the needs of fleet trainer that can be exploited? Perhaps. Two examples come to mind.

Example 1: For many years the US Navy 2nd Fleet showcased emerging technologies during Fleet Exercises for soon-to-be-deployed battle groups. While hardly an optimum solution, it may well be possible to achieve both training and some test objectives at the same moment. Example 2: Probably the most demanding and risky mission for any aircrew is the one that requires mission execution farthest from "home plate": the deep strike. Deep strike is essential and unlikely to go away. Arguably, at the farthest extension of airpower is the greatest need for effective EW systems. This sort of training is being done on instrumented threat ranges, but more can be achieved.

Fourth, look at the manpower structure delivering EW capability. Dr. John B. Foulkes, Director, Test Resource Management Center, stated "Since 1996, there has been a steady (manpower) decline in the size of the Major Range and Test Facility Base (MRTFB)." In all there has been a 19 percent decline . . . Most profound is the attrition of active duty military personnel in comparison with the other two categories (government civilian and contractor). (4)

At a recent AOC Symposium in Point Mugu, it was startling and encouraging to see the significant numbers of fresh college graduates (new joins) in attendance. We Vietnam era types are moving on to Social Security and prune juice. One problem, the "new joins" typically do not bring operational experience but

All of the weapons shown were removed from the Volvo passenger car on the right. These weapons represent a significant threat to low flying helicopters and fixed wing aircraft. (Photo by Spec Joe Barnes US Army, Sept 2003, Balad, Iraq.)

neither do they bring the institutional bias. We need to develop in the "new join" an appreciation of military operations in general and EW specifically. This can be done cheaply by selectively placing them in the US Navy TOPGUN Course or US Marine Corps Weapons and Tactics Instructor Course and Red Flag.

Fifth, form a study group of EW mid-career specialists that includes military personnel, government civilians, contractors and "new joins." Task the group to write a plan, based upon innovation, which addresses the gap between EW systems-under-test and the availability threat test resources. The plan must include a section on "Risk." Publish the unclassified part in *JED* for community input and comment.

GENERAL PATTON GETS IT RIGHT

Most of us have seen the movie *Patton* and view him as a hugely successful combat leader with a huge persona. Few realize General Patton was innovative at a time when the war (Defense) budget was miniscule. General Patton commented about a defensive system in France considered then to be the crowning military technical achievement of the 1930s. It was a system of interconnected forts and artillery emplacements called "The Maginot Line." The intent was to keep the Germans out of France and it failed miserably. Referring to the Maginot, General Patton said, "Anything created by man can be overcome by man." *True in 1930, true today.*

Let's get on with solving the problem by looking at innovative ways to address the gap and to accomplish T&E of emerging aircraft defensive systems…even if they are old ideas. It is a great way to support our troops.

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2. *Aviation Week and Space Technology,* May 4, 2009, p. 26.
3. UPI Asia (Internet), March 6, 2009, Andrei Chang, *Photo from www.ausairpower.net.*
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Tom Brannon, a retired Marine aviator, is a Principal Research Analyst for Electronic Warfare Associates, China Lake, CA, working with the US Navy. He flew the F-4 Phantom as the Radar Intercept Officer serving in six different squadrons and was a squadron commander. During 2008 he taught C2 to US military forces on site in Afghanistan. Recently, he developed a math model optimizing Navy EW threat test resource acquisition.

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Communications EW – Part 28

Jamming Chirp Signals

By Dave Adamy

Although chirp is most often associated with range resolution improvement in radars, it can also be used for anti-jamming protection in communication. Frequency modulation (called "chirp" in this case) creates a processing gain that makes the detection or jamming of signals more difficult.

Implementing Chirped Communication

There are two ways to implement chirp. One is to linearly sweep a digital signal across a frequency range much greater than its information bandwidth. The second way is to apply the chirp to every bit of a digital signal. Both have processing gain based on sweep range versus the information bandwidth of the signal. In general, the processing gain reduces the effective jamming to signal ratio (J/S) by an equivalent ratio. As discussed below, there are ways to increase the effective J/S against chirp signals.

Wide Linear Sweep

Using the approach shown in **Figure 1**, a digitally modulated IF signal is swept across a frequency range much greater than the bandwidth of the information carried by the signal. This produces a transmitted waveform as shown in **Figure 2**. Note that the start times of the sweeps are randomly varied to prevent a hostile receiver from synchronizing with them. The intended receiver has a similar circuit with a sweeping oscillator that is synchronized to the transmitter. As noted in an earlier column, the information must be carried in digital form so that it can be transmitted at a faster bit rate during the linear part of the sweep and returned to the constant bit rate in the receiver. Otherwise, there would be significant signal drop-outs that would interfere with communication.

Because the data is digital, optimum jamming causes about 33 percent bit error rate in the received signal, so partial band jamming will provide the best practical jamming performance in non-sophisticated jammers. (See the July 2009 "EW 101" column.) If the chirped transmitter has a fixed sweep synchronization pattern or if the jamming signal can be delayed (perhaps using a DRFM) it may be practical to analyze the chirp pattern and match it with a follower jammer. This would provide significantly better J/S by overcoming the processing gain advantage of the intended receiver. Note that the chirp may not have a constant sweep rate, but can follow any desired frequency vs. time pattern.

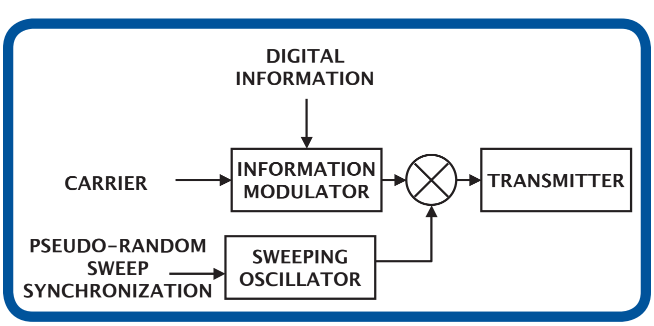

Figure 1: Chirp can be applied to a digital data stream to provide anti-detection and anti-jam protection.

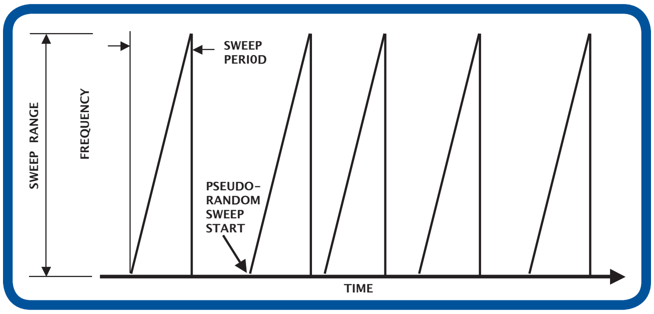

Figure 2: A chirped signal is swept across a large frequency range with pseudo-randomly selected start times for its sweep cycles. This precludes a hostile receiver from synchronizing to the chirp sweep.

Chirp on Each Bit

The chirp communication technique discussed in most literature places a chirp modulation on each data bit transmitted and recovers the digital data in the receiver as shown in **Figure 3**. The chirp can be applied either with a sweeping oscillator or using a surface acoustic wave (SAW) chirp generator. A de-chirping filter in the receiver converts signals with specific chirp characteristics into impulses because it has a linear delay versus frequency characteristic. In effect, the signal is delayed to the end of the chirp period to produce an output impulse. In this figure, an "up-chirp" is applied, so the de-chirp filter must have decreasing delay as the frequency increases. This chirp technique allows the digital data to be carried in two different ways: parallel binary channels or single channel with pulse position diversity.

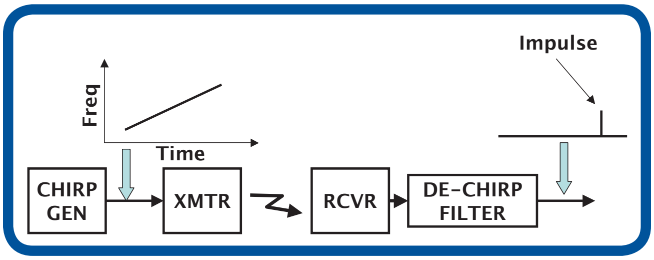

Figure 3: When a swept FM is placed on a bit of a digital signal, it can be processed by a matched de-chirp filter to create an impulse.

Parallel binary channels

In some systems, logical *ones* cause one chirp direction (perhaps increasing frequency) while logical *zeros* cause the opposite chirp direction (in this case decreasing frequency). This type of system is shown in **Figure 4**. The chirp frequency slope is typically linear. In the receiver, each received bit causes an impulse output from the appropriate de-chirping filter. Note that the data stream input in the figure is 1, 0, 1, 1, 0; thus the upchirp filter outputs impulses for the first, third and fourth bits while the downchirp filter outputs impulses for the second and fifth bits. These impulses are converted into logical bits to reproduce the digital input to the transmitter.

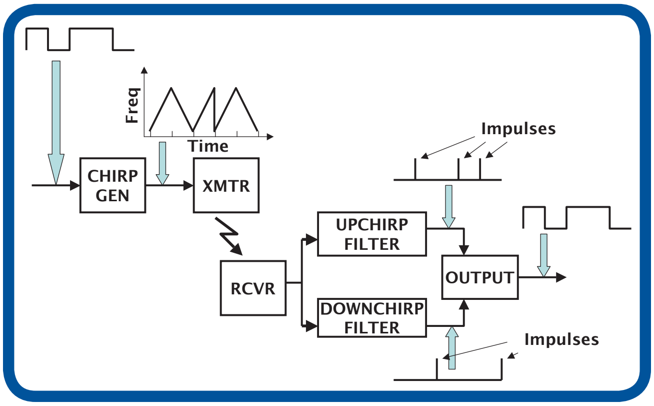

Figure 4: If chirp is placed on each bit of a digital signal with opposite sweep direction for ones and zeros, two de-chirp filters (one matched to the upchirp and one to the downchirp) will produce impulses for each one or zero. These impulses allow reproduction of the transmitted digital data.

The processing gain is the product of the chirp frequency excursion and the bit duration, which is also the ratio of the chirp excursion to the data bit rate. If analyzed in an averaging spectrum analyzer, the transmitted waveform will be as shown in **Figure 5**. This allows the end points of the chirp modulation to be determined. If noise jamming is applied across this frequency range, the J/S will be reduced by the processing gain. However, because the transmitted signal is digital, pulse jamming can be applied (causing bit errors while the jamming pulse is up) to increase the jamming effectiveness.

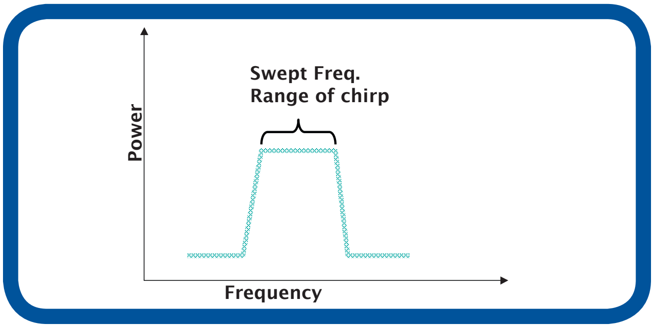

Figure 5: An averaging spectrum analyzer will show the frequency range covered by the chirp on a signal.

If the chirp slope and end points are determined with a spectrum analyzer, a linearly chirped signal can be used as a jamming waveform. The jamming chirp can be randomly positive or negative. Because a data signal can be expected to have roughly equal numbers of ones and zeros, half of the bits will be jammed at full J/S. Fifty percent bit error rate is more than enough to stop the transfer of information over the jammed channel.

Single channel with pulse position diversity

As shown in **Figure 6**, the timing of the impulse from the de-chirping filter in the receiver is a function of the start frequency of the chirp generator in the transmitter. Thus, if logical ones start at one frequency and logical zeros start at another frequency, the timing of impulses from the de-chirping filters allows the separation of ones and zeros by time. In this example, an up-chirp is used and the chirps on zeros begin and end at higher frequencies than for ones. This will cause the impulses from zeros to be output with less delay than the impulses for ones.

Note that the output of the de-chirping filter has an impulse in the left part of the time slot when the input data is a logical zero and in the right part of the time slot when the input data is a logical one. Because the figure shows an input data stream, 1, 0, 1, 1, 0; the impulses for the first, third and fourth bits are late and those for the second and fifth bits are early.

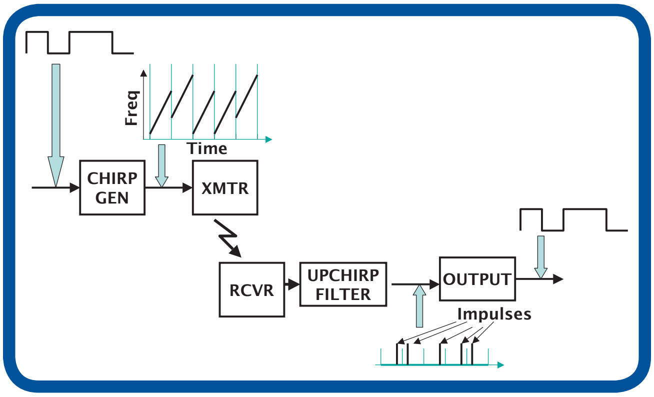

Figure 6: If the chirp start-frequency is different for logical ones and zeros, the impulse output of a matched de-chirp filter will have different delays allowing the reproduction of the original data stream.

There is a patent for a chirp communication system that uses the time separation of ones and zeros as above, but has a pseudo-random start-frequency selection feature for security. This causes the output impulse from the de-chirping filter to have a pseudo-random time pattern. The intended receiver is synchronized with the transmitter so that this time randomness can be resolved.

Noise jamming across the chirp range will have its J/S reduced by the processing gain. Again, pulse jamming will increase jammer effectiveness and use of a chirped waveform matched to the transmitted signal (with random ones and zeros) will significantly improve the J/S.

About Barrage Jamming

In the July "EW 101" column, there was a mistake (it was the author's inadvertent error not the magazine's). The column says that a barrage jammer should be placed close to the enemy *transmitter* if practical. This should, of course, have advocated placing the jammer near the enemy *receiver*. If you know where the receiver is located, this is clear. In normal tactical circumstances, an emitter location system will not tell you where the receiver is located. However, you may be able to locate the receiver from other considerations: for example, if an enemy net uses transceivers, a receiver will be located with a transmitter.

A second, very important example is an RCIED in which the receiver is located at the weapon, which is presumably near its intended target. A third example is jamming the uplink to a cell phone tower; the receiver is, of course, in the tower. In practical terms, it is much better to have a barrage jammer near the enemy, where it will cause maximum J/S and minimum fratricide to friendly communication. Of course, this consideration also applies to partial band jamming.

What's Next

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

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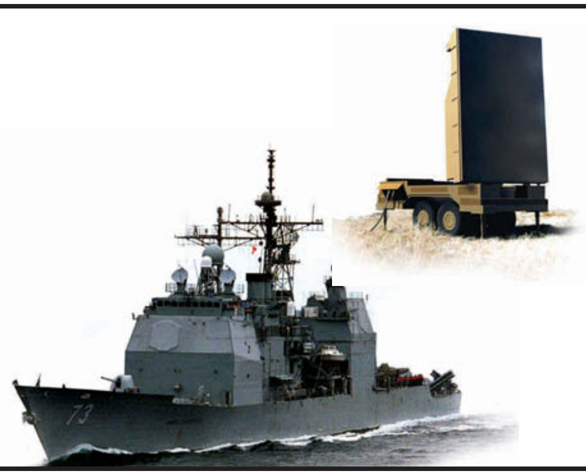

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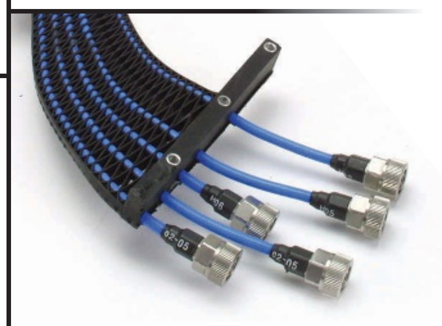

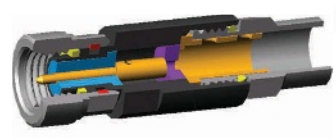

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association news

AOC ELECTION RESULTS

PRESIDENT-ELECT
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The July AOC Election elected new officers for AOC President and the AOC Board of Directors. Of the 12,033 eligible voters, 1,263 voted for a turnout of 10.5 percent. Most positions will begin in October 2009. The new AOC President begins his term in October 2010.

CENTRAL REGION
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AOC Clarifies AF Times Article Quote

In a recent Air Force Times article (August 16) entitled "Electronic Warfare in Transition," the Association of Old Crows (AOC) was quoted as saying, "The Air Force's Compass Calls are not combat aircraft, so they do not carry High-Speed Anti-Radiation Missiles and cannot fly as low as Prowlers and Growlers for aggressive electronic attack."

The AOC recognizes that this is an inaccurate statement that was the result of a miscommunication with the reporter. The quote was taken from a discussion about the capabilities, roles, and missions, of EW assets in each military service, and does not reflect AOC's understanding of, or support for, electronic warfare, and the EC-130 Compass Call and its warfighter community.

The AOC wants to clarify that the Compass Call is a very capable combat weapon system, and it is one of the most highly tasked aircraft in the US Air Force inventory. Compass Call squadrons have been deployed almost continuously in Afghanistan and Iraq since the beginning of Operation Enduring Freedom and Operation Iraqi Freedom. Their mission is to help control the electromagnetic spectrum in combat to ensure mission success of our joint forces. While the EC-130H platforms are aging, the weapons system is constantly being modernized. The AOC strongly supports the Compass Call community, and we are active in educating academia and government leaders on the important role of such key weapon platforms in current and future operations.

AOC: ABOUT INFORMATION OPERATIONS

Information Operations (IO) are activities conducted in or via the information environment with the intent to affect and protect cognition, cognitive processes, information, and the connectivity and processing systems necessary to create and exchange information. IO uses any or all means, in integrated and coordinated means, to create cognitive effects. IO spans the full range of activities in human interaction from person to person through complex, multistate, intercultural, and international communications.

The focus of IO is to affect human beliefs, expectations, decision making and behavior; whether individuals or groups. As a US DoD-originated term, the general intent of conducting IO has been to affect the outcome of military operations; whether to head off combat altogether, undermine the ability of potential opponents to muster effective combat forces, enable the defeat of an opponent, or to ease the stand down from combat operations and transition to peace. The field is not limited to military applications however and the increasing focus of interagency efforts has been on inform, persuade, and influence (IPI) activities supporting nation building and strategic communication beyond the edges of typical military operations. Perhaps the greatest difficulty in IO is identifying the measures of effectiveness for desired outcomes because the means used to achieve them can vary considerably depending on whether the application occurs during peacetime, crisis, pre-hostilities, battle, or transition to peace. An additional significant problem is developing measures of effectiveness that enable evaluation of the efficacy of IO on the perceptions of foreign leaders or groups in crisis.

Whatever the situation, IO is critically dependent on and a voracious consumer of intelligence and technical information. The ability to affect decision makers appropriately, precisely, and legally may require, depending upon the specific effect desired, considerable background information about topics as diverse as the cultural mores of a leader, the internal processing algorithms of radar receivers, telecommunications system protocols, images trusted by various cultures, the extent of foreign intelligence penetration of friendly diplomatic communications, or nearly any other topic describing what someone knows, how they found it out, how reliable they think the information is, and how information is processed.

The tradecraft and expertise of IO continues to evolve through a number of doctrinal and intellectual approaches. Modern IO began with the command and control warfare (C2W) concepts employed during Desert Shield/Storm integrating operations security, electronic warfare, military deception, psychological operations, and kinetic operations. The original C2W term was eventually replaced by information warfare and now IO. The list of disciplines and missions has swelled and contracted over time; sometimes including concepts as diverse as counterintelligence, strategic communication, perception management, and information assurance. The more recent additions to the panoply of IO-associated disciplines are anything using the term "cyber" and the various disciplines involved in interagency IPI.

The debate about the scope of IO and what is 'in' or 'out' has sometimes been referred to by participants as the Definition War. The existence of such vigorous debate is indicative of the importance that modern military and political theorists place on the evolving ability of governments, NGOs, and individuals to effect decision makers at all levels of competition. DoD is once again internally debating a change in the definition intended to reflect the evolving maturity of real world IO and the increasing importance of the integrated application of multiple capabilities to achieve desired soft power outcomes.

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