November 2009
Vol. 32, No. 11

# The JED
## The Journal of Electronic Defense

The AOC Electronic Warfare Publication
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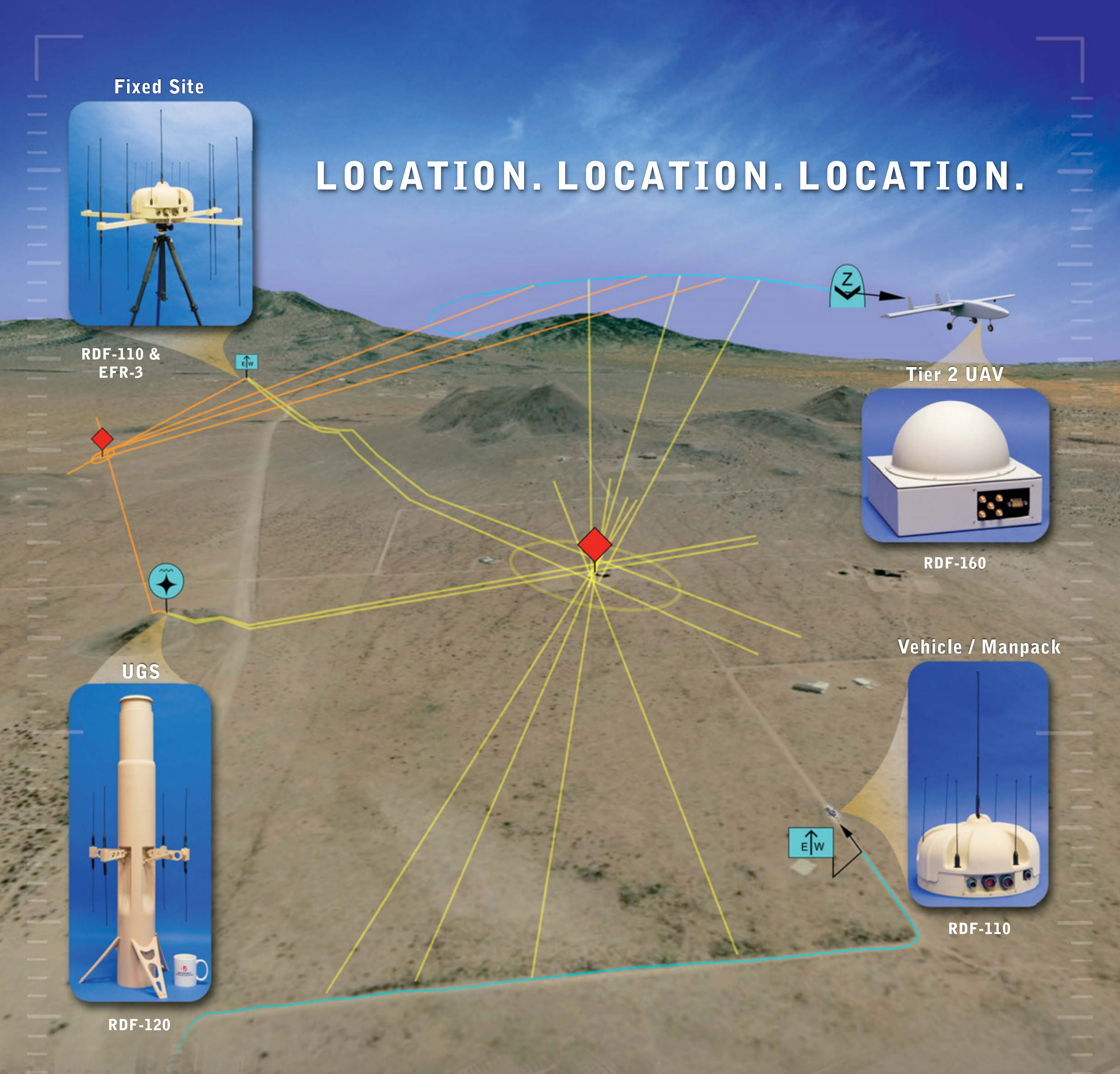
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# FILLING THE VACUUM IN US EW POLICY

EW export policy hasn't been much of a front-burner topic for the US EW industry since the Global War on Terror (GWOT) began. This is not because EW export policy has been working well. Rather, the strong domestic market for EW systems has meant that most US EW companies have not been very dependent on export sales. That dynamic will probably change over the next five years, as the domestic market cools off and companies once again look to the larger global market for important business opportunities. As this trend emerges, US EW companies will become more aware of the problems they face when they compete amidst the better organized and less restrictive policies of governments on the international market, such as France, Israel, Sweden, Italy and South Africa, to name a few.

The last time the DOD took a hard look at EW export policy was in the 1990s. Since that time, EW technologies and systems designs have evolved significantly. Yet the export bureaucracy often seems unaware of how modern EW systems work or, at the very least, export officials seem unable to assess the technology and security mechanisms used to protect the data in today's EW systems. When Pakistan wanted to buy US jammers for its F-16s a couple of years ago, it was denied access to US digital RF memory (DRFM) technology, despite the fact that more than a dozen countries now make DRFMs and Pakistan can easily turn to one of them for this critical capability. Today, very few countries are allowed to buy US-made directed IR countermeasures (DIRCM) systems for their military aircraft, despite the urgent IRCM needs of many NATO allies in Afghanistan. Yes, these are the allies that have fought alongside the US since the earliest days of the GWOT. By themselves, these examples may not seem important. However, the US has allowed these types of failures to pile up over time (as they have over the past several years), and the result is a less effective set of foreign policy tools and a weaker industrial base.

It is not surprising that the US government has little insight into the shortfalls of EW export policy or the technology in modern EW systems. After all, there is no one in the Office of the Secretary of Defense who is working EW policy issues on a daily basis. There is no one in OSD looking at EW industrial policy, joint service EW policy, acquisition policy or export policy, to name just a few of the most significant EW policy shortfalls of today. The one OSD office that did handle those types of issues was disbanded back in 2002 during an OSD reorganization. Isn't it amazing how many people in the US EW community today miss that OSD EW office – even if they don't know it?

*– John Knowles*



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www.asiandefense.com

**AAAA ASE Symposium**
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www.quad-a.org

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Dubai, UAE
http://dubaiairshow.aero/

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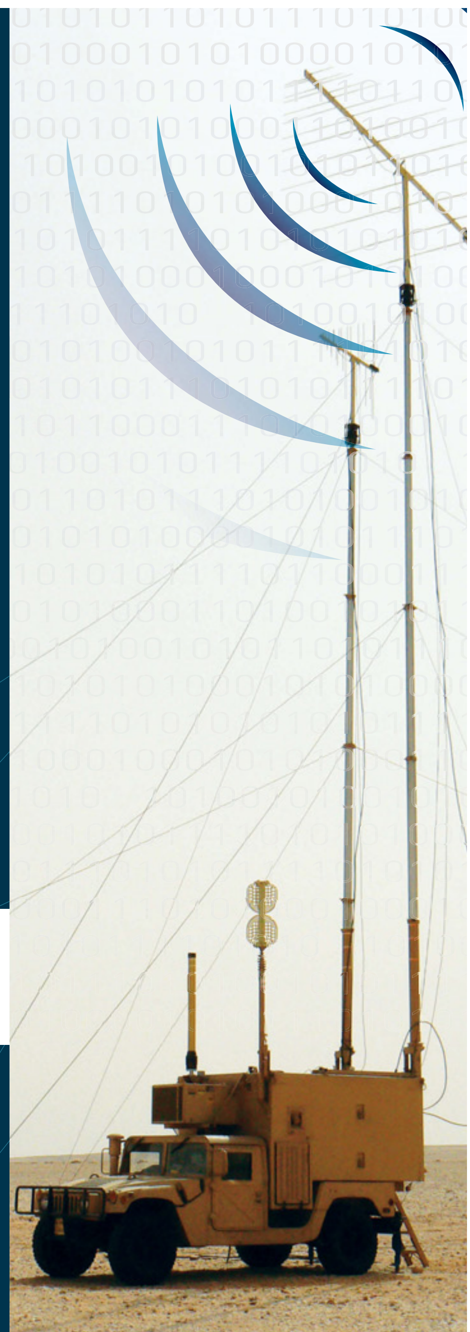

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**Operationalizing Intelligence in EW for the 21st Century Conference**
December 1-2
NASIC, Wright Patterson AFB, Dayton, OH
www.crows.org

**Worldwide EW Infrastructure Conference**
December 1-3
Atlanta, GA
www.crows.org

**EW Symposium**
December 2-3
Shrivenham, UK
www.cranfield.ac.uk

## JANUARY

**AUSA Army Aviation Symposium**
January 5-7
Arlington, VA
www.ausa.org

**Surface Navy National Symposium**
January 12-14
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www.navysna.org

**Mugu Crows Annual Symposium**
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## FEBRUARY

**EW India 2010**
February 9-11
Bangalore, India
www.shephard.co.uk

**Air Warfare Symposium**
February 18-19
Orlando, FL:
www.afa.org

**Cyber and Spectrum Integration**
February 23-25
Chantilly, VA
www.crows.org

## MARCH

**Joint SEAD**
March 17-18
Nellis AFB, NV
www.crows.org

**Dixie Crow Symposium**
March 21-25
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## APRIL

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**Survivability**
November 23-December 4
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www.cranfield.ac.uk

**Cyber Warfare Tutorial**
November 30
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www.crows.org

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www.afcea.org

**IR Countermeasures**
December 8-11
Atlanta, GA
www.pe.gatech.edu

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www.aticourses.com

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**Pyrotechnics Course**
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# EW LEADERSHIP – TO THE EDGE

As I step into my role as AOC President, leadership stands at the forefront of my thoughts. Over the past few years, the EW community has been informed by a number of studies and recommendations calling for a single "EW Czar" to provide advocacy, vision and oversight to DOD Electronic Warfare. And while the AOC could devote an entire magazine to that particular topic, this is not the type of EW leadership I want to address in my first column.

In my 30 years within the EW community, I have observed many leaders. As a detachment commander in combat operations, I saw EW leadership every day. It was apparent in the daily execution of the mission by junior and senior officers alike. With a determined professional demeanor, these leaders launched out of bases far from home and were willing to lead squadron mates into combat in order to ensure the survivability of others.

It is easy to think of this form of leadership alone; but it is also important to remember that the EW mission area requires leadership to the edge. This is the form of leadership that takes responsibility for delivering capability when and where it is needed. I saw this form of leadership in the non-commissioned officers and enlisted personnel that maintained and prepared my weapon system for employment.

My memories of combat operations will forever be inscribed with the leadership I saw from these individuals. I will always have the picture of looking down at the end of the runway after my EF-111 was "gear up" out of Incirlik AB, Turkey. There, just on the runway infield, Raven maintainers gathered to wave Old Glory as their aircraft headed out to support air strikes in Croatia. The leadership and expertise exhibited by Raven maintainers to get these aircraft in the air was remarkable and story in itself. Suffice it to say that this was leadership to the edge; it is not always recognized the way it should be, but it is at the core of our delivery of combat capability around the globe.

So, wherever you are in the EW community, remember to thank those who are delivering our capability to the edge.

Non Videbunt

*– Chris "Bulldog" Glaze*



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## US NAVY KICKS OFF NEW MISSILE WARNER PROGRAM

Naval Air Systems Command (NAVAIR) has selected teams led by ATK and Lockheed Martin to develop competing versions of the Joint and Allied Threat Awareness System (JATAS), a new missile warning system for Marine Corps, Navy (and likely Army) rotary-wing aircraft. NAVAIR awarded each company a 16-month contract for the JATAS technology demonstration phase, which involves building and testing prototypes. ATK Integrated Systems (Clearwater, FL), which is teamed with BAE Systems (Nashua, NH), received a $32.2 million contract; Lockheed Martin Missiles and Fire Control (Orlando, FL) was also awarded a $32.2 million contract.

JATAS would detect incoming infrared-guided missiles, particularly those launched by shoulder-fired, man-portable air defense systems, and would cue the aircraft's flare decoy dispenser or directed IR countermeasures (DIRCM) system to defeat the attacking missiles. JATAS also would provide warning of enemy laser range finders, illuminators and beam riders.

An additional capability desired for JATAS is hostile-fire indication (HFI) of small arms, rocket-propelled grenades and other ground-fire threats. The contracts include tasking to try to mature the HFI capability to Technology Readiness Level 6 for subsequent insertion into the JATAS baseline.

JATAS will feature imaging IR sensors, which offer faster and longer-range missile detection compared with the ultraviolet sensors used on the existing ATK AAR-47, Northrop Grumman AAR-54 and BAE Systems AAR-57 missile warning systems. The latest US system, in production for Air Force transports as well as the Marine Corps' large CH-53E, CH-46E and CH-53D helicopters, is Northrop Grumman's Next-Generation (NexGen) MWS. It uses two-color imaging IR sensors, which evaluate threat missiles in two separate frequency bands.

ATK (along with teammate BAE Systems) and Lockheed Martin will perform a JATAS requirements analysis and preliminary design and must deliver three prototypes for testing by August 2010. NAVAIR plans to select a single company for a follow-on engineering and manufacturing development and low-rate initial production phase to begin in FY2011. The lead platform for JATAS will be the Marine Corps' MV-22 Osprey tilt-rotor aircraft.

## JCREW 3.3 CONTRACTS AWARDED

US Naval Sea Systems Command (NAVSEA) selected ITT and Northrop Grumman last month to competitively develop a next-generation Joint Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (JCREW) 3.3 family of mounted, dismounted and fixed-site jammers with common components. The two companies will conduct a six-month system development and demonstration phase for the JCREW 3.3 "System of Systems."

The CREW Program Office (PMS 408) at NAVSEA is the DOD's executive agent for developing and procuring common ground-based CREW systems for the joint military services. It awarded ITT Force Protection Systems (Thousand Oaks, CA) a $16 million contract; Northrop Grumman Space and Mission Systems (San Diego, CA) received a $24.3 million contract. The contracts run through March 2010, culminating in a preliminary design review. The contracts include a series of options that would complete the system design and support testing of engineering prototypes.

Key features of the advanced JCREW 3.3 family of IED jammers will be the use of open-architecture standards and an emphasis on incremental software rather than hardware upgrades to keep pace with changes in the threat. The system also offers the potential to be part of the battle network, feeding situational awareness to other vehicles in addition to self-protection capabilities.

The latest JCREW systems being procured by PMS 408 are based on existing technology from the JCREW 3.1 (dismounted) and JCREW 3.2 (vehicle-mounted) systems. Sierra Nevada Corp. (Sparks, NV) won the 3.1 development competition last June and was awarded a contract with a potential value of $248.3 million to supply up to 2,500 of the dismounted backpack systems. Competing for the JCREW 3.2 production contract are Sierra Nevada, Northrop Grumman Space and Mission Systems, ITT Advanced Engineering and Sciences (Annapolis Junction, MD) and Syracuse Research Corp. (Syracuse, NY). The companies delivered prototypes that the Navy has tested, and NAVSEA issued a request for proposals for JCREW 3.2 low-rate initial production in late September with the bidders given 30 days to respond. – *G. Goodman*

Under an agreement with the Navy forged by senior Pentagon officials, the Army has taken responsibility for developing a new laser-based DIRCM system, called Common IRCM (CIRCM or "kerkum"), for the two services' rotary-wing aircraft, while the Navy focuses on developing the JATAS MWS. While the Army will likely remain committed to its significant investment in the AAR-57, it may leverage some future upgrades from the JATAS program.

The JATAS program is managed by the Advanced Tactical Aircraft Protection Systems Program Office (PMA-272) within the Program Executive Office for Tactical Aircraft Programs at NAVAIR (NAS Patuxent River, MD). – *G. Goodman*

## USAF PONDERING NEW COMMS EA PROGRAM

The US Air Force is seeking information from industry for a potential new program to acquire a communications electronic attack system for its tactical aircraft. Last month, the Air Force issued an Airborne Electronic Attack Communications Network Attack: Expeditionary (ACNAE) Technology capabilities request for information (CRFI) in order to assess available systems and technologies that would support acquisition of low-cost ACNAE system that could be operational by 2012. The Air Force's Air Combat Command is seeking the ACNAE capability in order to ease the pressure on its EC-130E Compass Call squadrons, which have been continuously supporting operations in Iraq and Afghanistan for several years.

The Air Force is concerned about the flight hours being racked up by its Compass Call aircraft, even though the counter-IED missions they are supporting use only a small portion of the Compass Call aircraft's EA capabilities. It would like a communications EA capability that is better matched to the needs of the counter-IED mission, such as a low-cost communications EA pod flown on a more widely available fighter or transport aircraft.

The Aeronautical System Center's Capabilities Development Division (ASC/XRS) issued the CRFI, which said companies could respond with information about complete communications EA systems or unique EA technologies that could be integrated into a system. Details of the requirement are available from a classified (Secret) supplement, *AEA Communications Network Attack: Expeditionary Technical Baseline*. The main goal of the CRFI is to assess the maturity of systems and technologies in advance of a potential request for proposals for an ACNAE program.

The CRFI said three classes of aircraft are being considered to host the ACNAE system. These are small platforms, such as UAVs; medium platforms, such as F-16s and A-10s; and large aircraft, such as transports, bombers and special operations aircraft. Depending on the host platform, the ACNAE system could be configured in a pod or carried internally.

Responses to the RFI are due by November 6. However, the CRFI also stated that since the RFI is only being used to assess the maturity of communications EA systems and technologies, failure to respond to the RFI would not preclude companies from participating in a future ACNAE request for proposals. The program point of contact is Bob Matthews at (973) 904-4427, e-mail robert.matthews@wpafb.af.mil. – *J. Knowles*

## MAJOR SLQ-32 UPGRADE UNDERWAY

Lockheed Martin-Syracuse edged out BAE Systems and Northrop Grumman to win a highly coveted NAVSEA contract awarded on September 30 for preliminary design of the Surface EW Improvement Program (SEWIP) Block 2 system. SEWIP Block 2 is the largest Navy surface ship EW acquisition program in many years. It entails the first major hardware upgrade to key portions of the SLQ-32(V) EW system on Navy surface combatant ships, effectively creating a new-generation shipboard EW system with much greater capability.

The SLQ-32, introduced into the fleet in the early 1980s, is the Navy's primary shipboard EW system. Featuring an electronic support measures (ESM) system, it provides early warning and 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 a "soft-kill" active radar jamming capability.

Lockheed Martin's initial $9.9 million contract runs through June 2010. It includes options for a follow-on engineering and manufacturing development phase and subsequent low-rate initial production that give it a potential value of $167 million. The company's principal teammates are ITT Reconnaissance & Surveillance Systems (Morgan Hill, CA) and DRS Signal Solutions (Gaithersburg, MD).

Previous low-risk SEWIP Block 1 upgrades to the SLQ-32 have included the addition of a modern signal-processing computer and some adjunct stand-alone sensor systems. SEWIP Block 2's 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 must feature 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 lead ship for the SEWIP Block 2 forward-fit configuration is the DDG 1000 Zumwalt-class destroyer. The Navy once planned to buy 32 of the ships but has reduced that number to three. SEWIP Block 2 also is being designed for installation on the Navy's planned CVN-78 next-generation aircraft carrier. The SEWIP Block 2 back-fit configuration will be installed on existing *Arleigh Burke*-Class DDG-51 destroyers.

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*

## NEW ARMY PM-EW OFFICE STOOD UP

The US Army's Program Executive Office for Intelligence, Electronic Warfare and Sensors at Ft. Monmouth, NJ, changed the name of its Project Manager (PM) Signals Warfare to PM EW on September 1 to reflect the service's growing EW acquisition and integration needs. Over the next three years, the Army is adding nearly 1,600 EW personnel to its ranks who will serve at every level of command. The Product Managers for CREW, the Prophet vehicle-mounted signals-intelligence system, and Information Warfare will remain under the PM EW, COL Rod Mentzer, as the organization takes the prominent position in the Army in fielding and sustaining EW systems. "We're changing the name to highlight the core competencies of this Project Management Office as the Army transitions into an era of increased emphasis on capabilities associated with EW," said BG Thomas Cole, the PEO IEW&S, in a statement.

PM EW fielded more than 36,000 CREW jammers and more than 30 Prophet systems in FY09. COL Mentzer told reporters, "As we have evolved in the EW world with CREW systems, it's becoming

a much broader mission. There are many emerging requirements to sense and gather intelligence on what the enemy is doing in the electromagnetic spectrum, to eliminate the enemy's ability to communicate or remotely detonate IEDs, and to protect our own systems so we can maintain our communications links.

"Those requirements for electronic warfare support, electronic attack and electronic protection are being solved piecemeal in our Army today by strapping more and more [single-mission systems] on different types of platforms. We finally reached a point where we said as a community, 'There has to be a better, more efficient way of doing this,' and that's through some type of integrated EW system that encompasses all three of those pillars."

He noted that an Initial Capabilities Document that spells out the requirement for an integrated solution was recently approved at the joint level. "We are still refining that requirement, which we hope will be funded in the Army's FY12-FY17 [budget requests] and allow us to begin work on some type of integrated system. By consolidating and integrating EW functions into a single package, we can reduce size, weight and power requirements compared with our current individual EW systems." An integrated EW system would share equipment, such as power amplifiers, antennas, power supplies and receivers, he added.

As an example of what such a system could do, Mentzer noted that there are more than 40,000 CREW devices in Iraq, Afghanistan and Kuwait. "In addition to being jammers," he said, "all of those also are sensors that could help us detect and locate enemy activity. Why not collect some of that sensor information, which we do nothing with today, and disseminate it for intelligence, targeting and situational awareness purposes?" – *G. Goodman*

## ONR BAA TARGETS DIRECTED ENERGY WEAPONS

The Office of Naval Research (ONR) has issued a broad agency announcement (BAA) soliciting proposals for counter directed energy weapons research. Directed energy weapons can be used in naval warfare to undermine or disrupt operational capabilities.

The BAA is looking for white papers that describe and examine the best technologies for future Navy defense needs, with particular interest in addressing directed energy weapons threats against existing or planned naval ship platforms, underwater systems, aviation systems and weapons systems. Research proposals from academia and industry, including innovative methods of countering the effects of directed energy weapons against platforms, personnel and assets are sought.

The BAA defines directed energy weapons as high energy lasers (HEL), radio-frequency weapons, such as high power microwaves, dazzlers or non-lethal lower energy lasers (typically milli-watt power) and "weapons that combine the effects of the above, or are otherwise part of the electromagnetic spectrum, as characterized by the transmission of energy by a means other than kinetic energy to defeat a military target of interest."

The BAA's primary focus is to develop research and educational opportunities

based on "broad scientific principles" evolving from lab testing or applications where there is either low technical readiness or no capability.

Multiple awards are planned; however, most awards will range from one to three years at totals of $250,000-$900,000 each year. Proposals are due by April 10, 2010, with initial evaluations from the Navy a month later. Final proposals are due by June 30 with awards expected by Aug. 30. The technical point of contact is Peter A. Morrison, peter.a.morrison@navy.mil; the business point of contact is Jeff Wellen, jeff.wellen@navy.mil. – *E. Richardson*

## IN BRIEF

**Alliant Techsystems (ATK)** (Clearwater FL) has received a $49.3 million firm-fixed price, sole source contract from Naval Air Systems Command for production of components of the AAR-47 missile warning system, as well as up to 100 Countermeasures Signal Simulator (CSS) Test Guns.

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**SRCTec** (Syracuse, NY) has been awarded at $53.2 million firm-fixed price, sole source contract for procurement of 1,851 "urgently needed" CREW Duke V2 systems for the US Army. This contract follows an initial $188 million, five-year IDIQ contract, awarded in August 2009 for Duke V2 system upgrades.

✪ ✪ ✪

**Kilgore Flares** (Toone, TN) and **ARMTEC Defense Products** (Coachella, CA) have received contracts for $42.2 million and $45.6 million, respectively, for provision of M206, MJU-7A/B and MJU-10/B flares to protect fixed and rotary wing aircraft. Estimated completion date is November 2011.

✪ ✪ ✪

**DRS Codem** (Merrimack, NH) was awarded at $10 million firm-fixed-price contract for a ground intelligence and surveillance system. The work will be performed in Morgan Hill, CA, with a completion date of September 2011. The contracting agency is the US Army Corps of Engineers, CECOM Acquisition Center at Fort Monmouth, NJ.

✪ ✪ ✪

**BAE Systems** (Nashua, NH) was awarded an $11.2 million contract to provide performance based logistics services to support the company's sole-source countermeasures test set, though at this time no money has been obligated. The 762nd Combat Sustainment Group at Robins Air Force Base, GA, is the contracting agency.



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**Sierra Nevada Corp.** (Sparks, NV) received a $14.1 million firm-fixed-price cost-plus fixed-fee, indefinite delivery/indefinite quantity contract from the Naval Surface Warfare Center (Indian Head, MD) for provision of the Transmitting Set, Countermeasures (TSC) AN/PLT-5 to support joint services explosive ordinance personnel (JSEOD) requirement for man-portable equipment and support for the JSEOD CREW program. The contract combines purchases for the Navy (72 percent), Air Force (24 percent) and Army (4 percent). Work is expected to be completed by September 2010.

✪ ✪ ✪

**CPI, Inc.** (Palo Alto, CA) was awarded a $5.2 million contract from the Naval Surface Warfare Center (Crane, IN) for provision of Low Band Traveling Wave Tubes for use in the ALQ-126B airborne defense countermeasures system.

✪ ✪ ✪

**Cobham Sensor and Antenna Systems** (Lansdale, PA) has received an $11 million contract from the Naval Surface Warfare Center (Crane, IN) for Band 5/6 replacement amplifiers for the ALQ-99 tactical jamming system. The Band 5/6 transmitters currently use traveling wave tubes (TWTs), which will be replaced by a solid-state amplifier.

✪ ✪ ✪

**Northrop Grumman** (Rolling Meadows, IL) has received a $19.3 million contract to provide engineering services for the ALQ-135. The company also received a $9.4 million contract to provide engineering services. 55 CONS/LGCD, Offutt Air Force Base, NE, is the contracting entity.

✪ ✪ ✪

**Terma North America** (Warner Robins, GA) has been awarded a $29.5 million contract to provide engineering services in support of ALQ-213 countermeasures sets. The 542nd Combat Sustainment Group, Robins Air Base, GA, is the contracting entity.

*Monitor photos courtesy of the US Navy and US Department of Defense.*

# washington report

## CONGRESS PASSES FY2010 DEFENSE POLICY BILL

The House and Senate have agreed to a single version of the FY2010 Defense Authorization Bill after completing a conference session early last month. The conference session reconciled differences between the House and Senate on the defense policy bill. At press time, the bill was expected to be sent to the White House for President Obama's signature.

In the defense authorization bill, Congress approved most of the EW and SIGINT funding requested by the DOD in the FY2010 budget. This included provisions in the "baseline" DOD budget, as well as funds for overseas contingency operations (OCO) in Iraq and Afghanistan, which in previous years had been provided in supplemental funding bills. The bill authorized:

- $25.9 million for RF aircraft survivability equipment (ASE) production (Army);
- $50 million for Guardrail SIGINT modifications in support of OCO (Army);
- $298 million for IR ASE production (Army), which includes $11.6 million for OCO;
- $164.4 million for production of Warlock counter IED capabilities in support of OCO (US Army);
- $1.8 billion for EA-18G procurement, plus $20.6 million for EA-18G advance procurement and $25 million for research and development (Navy);
- $84.9 million for procurement of EA-6B upgrades, including $45 million for OCO (Navy/Marines);
- $9.5 million for the Fleet EW Support Group (Navy);
- $49.4 million for the common ECM equipment procurement, which included a $2 million plus-up for the CRANE IDECM Depot (Navy);
- $47 million for US Navy High Speed Anti-Radiation Missile (HARM) modifications;
- $30.3 million for procurement of US Air Force HARM upgrades
- $74.8 million for US Navy expendable countermeasures procurement, including a $9.8 million cut due to the termination of MJU-55 production and $5.5 million for OCO;
- $34.3 million for production of SLQ-32 upgrades (Navy);
- $89 million for development of shipboard EW capabilities, including SEWIP Block 2 (US Navy)
- $105.9 million for production of shipboard IW exploit systems, such as the Ships Signal Exploitation Equipment (Navy);
- $22.7 million for Army EW technology development, including a $1 million plus-up for light helicopter DIRCM technology and a $2.5 million plus up to develop an advanced ground EW and SIGINT system;
- $134.2 million for procurement of C-130 upgrades, which $3.8 million for a Senior Scout COMINT upgrade (Air Force);
- $29.2 million for procurement of Compass Call upgrades;
- $44.6 million for Air Force Combat Training Ranges, including a $3 million plus-up for Unmanned Threat Emitter (UMTE) production and a $1 million plus-up for Joint Threat Emitter production above the DOD's request;
- $7 million for directed energy weapons research and development, including a $2 million add for Joint Technology Insertion & Accelerated System Integration Capability for EW (Navy);
- $67 million for JCREW counter-IED development (Navy)
- $128 million for development of the Next Generation Jammer (Navy);
- $11 million for EP-X (EP-3E replacement) research and development (Navy)
- $31 million for Air Force EW technology development;
- $97.3 million for Air Force EW systems development;
- $64.2 million for counter-space systems development (Air Force);
- $11.1 million for Air Force airborne electronic attack research and development;
- $31.8 million for LAIRCM upgrades (Air Force);
- $177 million for the Air Force's Airborne SIGINT Enterprise; and
- $19 million for the Joint Spectrum Center.

While the above provisions were outlined in the authorization bill, the true fate of these programs will depend on funds provided in the FY2010 Defense Appropriations Bill, which was still being worked out in a House-Senate conference session at press time. At press time, conferees were debating if and how to include funding for some programs that Defense Secretary Robert Gates has said the DOD does not want to pursue, such as a second engine for the Joint Strike Fighter, further production of C-17 aircraft and the continued development of a new Presidential Helicopter. If the bill includes funding for those programs, the President Obama has signaled that he may veto it. No EW or SIGINT programs are proving to be a major source of controversy, but the appropriations bill may be stalled as the White House and Congress work to resolve their differences.

One possibility could see Congress attach the defense appropriations bill to a larger omnibus spending bill, which would make a Presidential veto less politically palatable for the White House. The 2010 fiscal year began on October 1 and current funds were being provided on a stopgap basis through October 31.
*– J. Knowles*

# world report

## EGYPT REQUESTS MORE F-16s

Egypt has made a formal request to the US to buy Block 52 F-16s via Foreign Military Sales channels in a program that could be worth up to $3.2 billion, if all options for associated parts, weapons and equipment are exercised.

The Egyptian Air Force, which is already the fourth largest operator of F-16s in the world with a fleet of nearly 200, is seeking up to 24 Block 50/52 F-16 C/D aircraft. The purchase would, presumably, replace either some of the country's older aircraft fleet, including aging MiG-21s and Mirage 5s, or F-16 A/B variants.

Egypt has not decided on the EW suite for the new aircraft. It uses ALQ-131 pods on its older model F-16s. Egypt is seeking 28 systems, which include spares. The primary competitors for the EW portion of the program are ITT Electronic Systems, which is offering its ALQ-211 Advanced Integrated Defensive Electronic Warfare System (AIDEWS) and Raytheon, which is offering its Advanced Countermeasures Electronic System, comprising the ALR-93 radar warning receiver and the ALQ-187 jammer. Both suites would interface with ALE-47 countermeasures dispensers manufactured by Symetrics Industries.

The Egyptian Air Force, which flies the F-16 in multiple roles, is also seeking EO/IR reconnaissance systems, as well as a ground targeting systems for the aircraft. Egypt is being offered four F-9120 Advanced Airborne Reconnaissance Systems or DB-110 Reconnaissance Pods and 12 AAQ-33 SNIPER Advanced Targeting Pods from Lockheed Martin or AAQ-28 LITENING Targeting Pods from Northrop Grumman. The sale also covers spares, personnel training and other logistics support.

While in the past Lockheed Martin has produced Egyptian F-16s in Turkey through an agreement with Turkish Aerospace Industries (TAI), the current deal is reportedly free of offset requirements. – *E. Richardson*

## FIRST LOOK AT THE EUROHAWK

Northrop Grumman and EADS unveiled the EuroHawk, the first international configuration of the RQ-4 Global Hawk unmanned aerial system.

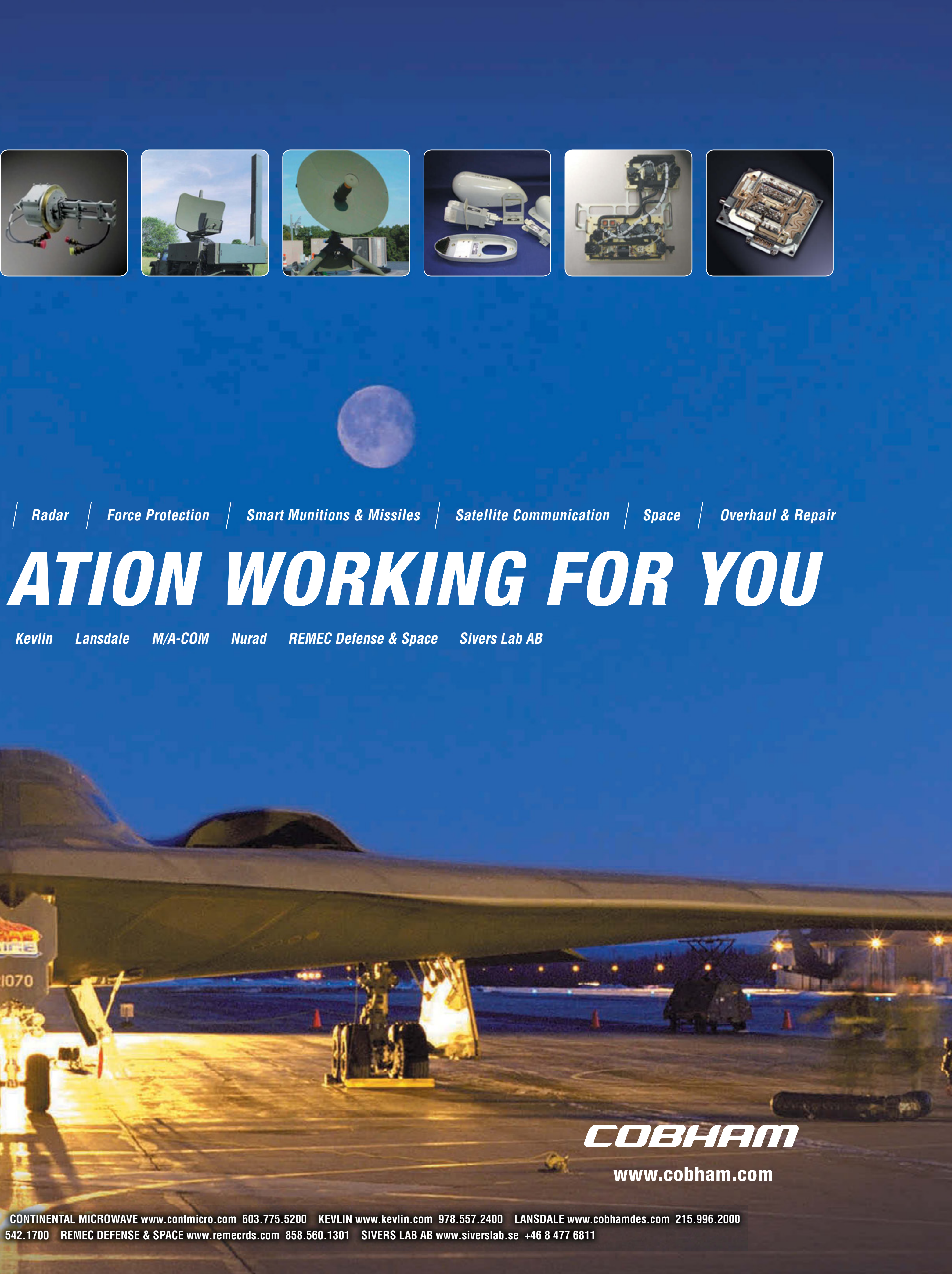
The EuroHawk, planned for initial service in 2011, will replace Germany's aging fleet of manned Breguet Atlantic aircraft, which are scheduled for retirement in 2010. In 2007, the German MoD awarded EuroHawk GmbH, a 50-50 joint venture between Northrop an EADS Defence & Security, a $559 million contract for development, test and support of a new EADS' developed signals intelligence (SIGINT) system for the unmanned platform.

EADS is also developing a SIGINT ground station to analyze data from the high altitude, long endurance (HALE) UAS as part of an "integrated system solution."

"The SIGINT system provides standoff capability to detect electronic and communications emitters," Nicolas Chamussy, senior vice president of Mission Air Systems for EADS Defence & Security, said in a press release. "The German Armed Forces will be able to independently cover their needs for SIGINT data collection and analysis, thus contributing to NATO, EU and UN peacekeeping operations." – *E. Richardson*

## In Brief

- Taiwan will add the AAR-47 Missile Warning Approach System (MAWS) for the 12 P-3C maritime reconnaissance aircraft ordered from Lockheed Martin. **Alliant Techsystems** (Clearwater, FL) has received a $1.7 million contract to supply 60 AAR-47 systems, including optical converters, indicators and computer processors.
- According to press reports, South Korea has eliminated indigenous fighter and attack helicopter development plans scheduled for next year as part of defense spending cuts. Working with foreign partners, the country had embarked on development of the KF-X, a new fighter to replace old F-4 and F-5 aircraft after 2010, as well as the Korean Attack Helicopter (KAH) plan to replace 270 aging Bell AH-1Ss and Hughes 500s after 2018. Though defense spending may be further adjusted during Korean National Assembly discussions in coming months it's uncertain if or when the development programs may be re-started.
- Germany's Federal Office of Defense Technology and Procurement (BWB) has selected four preferred bidders for a contract to supply an RF threat simulators in support of the German Navy's P-3C program. The four companies are **Elisra** of Israel, **EWST** of the UK, **Indra** of Spain and **Northrop Grumman (Amherst Systems)** of the US. The simulator will be used to test the ALR-95(V)2 ESM systems on the aircraft.
- **e2v** (Chelmsford, Essex, UK) has received an additional order from BAE Systems (Nashua, NH) worth $3.9 million to supply electroni devices in support of the US Navy's ALE-55(V) fiber optic towed decoy low-rate production phase. The order follows an initial contract awarded to e2v in 2008.
- **Saab** has updated its proposal for the sale of 36 next generation Gripen fighters to the Brazilian Air Force. The updated proposal offers an increased role for Brazilian companies in development, production and maintenance, as well as full technology transfer, up to 80 percent in-country airframe production – including creation of a full Gripen NG assembly line – commitment from Saab to deliver more than 175 percent of the total value in industrial cooperation to Brazilian industry and plans for Saab to replace the Swedish Air Force fleet of SK 60/Saab 105 trainers with Brazil's Super Tucano.



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# Airborne RWR/ESM Forecast: Strong Past, Gr

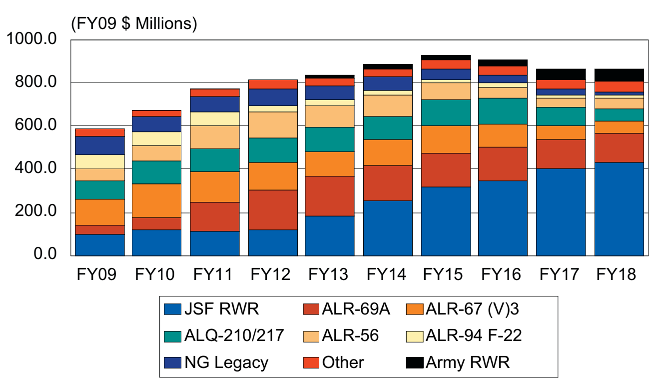
By Dr. David L. Rockwell

Radar warning receivers (RWRs) have been a vital component of the combat aircraft electronic warfare suite since World War II, especially for fighters and fighter-bombers that must detect and counter multiple ground-based and airborne radars, as well as radar-guided missiles. RWRs have been mounted on nearly every modern fighter in recent decades. Because of this long legacy, today's fighters often still serve with systems procured during the Cold War. These older systems are in many cases approaching the end of their useful service life, and the RWR market over the next decade will see replacement of many of these systems with new or upgraded RWRs and electronic support measures (ESM) systems. Combined with the beginnings of production for the F-35 Joint Strike Fighter (JSF), the airborne RWR/ESM market will grow steadily, dampened only by an equally long legacy of delays and limited funding for EW systems and upgrades – many aging RWRs will soldier on beyond the next decade despite their inadequacy.

The overall RWR market will grow strongly throughout our forecast period, with compound annual growth rates (CAGRs) of 8.6 percent (FY09-FY14) and 4.4 percent (FY09-FY18). Beyond the next few years, however, the market will depend primarily on the Joint Strike Fighter. Forecast to be worth $2.4 billion from FY09-FY18, the JSF RWR will be worth almost twice as much as the next most valuable program, Raytheon's AN/ALR-69A(V) and related Precision Location and Identification (PLAID) technology. Even more important, JSF production will still be ramping up in FY18, while the combined funding forecast for all other RWRs will likely peak in FY12 and drop from then on. This article will look only at US RWRs and ESM systems for the fixed- and rotary-wing market, but forecasts include all US and international sales and funding for these systems.

RWR Funding Forecast

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




## JOINT STRIKE FIGHTER: QUESTIONS

The JSF's EW suite is being designed by BAE Systems and Northrop Grumman, with the current EW contract including options worth as much as $7 billion. BAE's RWR is a major component – about 40 percent of total funding in Teal Group Corp.'s estimation – of the aircraft's overall EW suite. In December 2007, BAE Systems opened a new 30,000 sq. ft. facility in South Nashua, NH, for production of F-22 and JSF EW systems. The site will employ more than 1,400 personnel. In January 2009,

| | JSF RWR | ALR-69A | ALR-67(V)3 | ALQ-210/217 | ALR-56 | ALR-94 F-22 | NG Legacy | Other | Army RWR |
|---|---|---|---|---|---|---|---|---|---|
| FY09 | 98 | 46 | 116 | 87 | 52 | 66.4 | 86 | 32 | 2 |
| FY10 | 118 | 57 | 160 | 103 | 69 | 64 | 70 | 30 | 0 |
| FY11 | 114.4 | 131 | 142 | 111 | 102 | 68 | 68 | 35 | 4 |
| FY12 | 120.4 | 184 | 130 | 114 | 116 | 31.4 | 74 | 37 | 5 |
| FY13 | 181.2 | 188 | 110 | 119 | 99 | 23.2 | 66 | 36 | 12 |
| FY14 | 257.2 | 158 | 126 | 105 | 95 | 25.6 | 59 | 39 | 21 |
| FY15 | 316.8 | 158 | 124 | 123 | 76 | 20 | 47 | 40 | 20 |
| FY16 | 345.6 | 159 | 104 | 119 | 49 | 20.8 | 35 | 46 | 26 |
| FY17 | 400.4 | 140 | 64 | 80 | 46 | 14.4 | 24 | 47 | 46 |
| FY18 | 431.2 | 138 | 51 | 60 | 48 | 13 | 20 | 49 | 54 |

# owing Future



the first JSF with a complete mission system was completed by Lockheed Martin, including Block 0.5 mission systems software, which incorporates more than half of planned combat-ready Block 3 software (the final Block under the program's system development and demonstration phase).

While the EW suite testing has reportedly been going well, there have been many questions regarding JSF performance (low power-to-weight ratios, high wing loading, a small ordnance payload and limitations for close air support), cost, and producibility, which leave the growing blue bars in our forecast graph somewhat speculative, if JSF sales prove less robust than most have been predicting. Our forecast (which still sees JSF account for 50 percent of the RWR market in FY18) is somewhat lower than the current plan.

Regarding cost and production readiness, crucial for a solid ramp-up of RWR numbers, the US budget for the first LRIP batch of F-35s provides more than $200 million per fighter. Early full-rate production lots will cost well over $100 million per aircraft. Lockheed Martin and the US hope unit costs in later production will eventually drop to $60 million, but this looks increasingly unlikely, even if production numbers stay extremely high. Other issues, even if US funding and international interest remain high, include a remarkable produce-before-testing procurement plan. DOD plans show 100 percent of JSF flight testing will not be complete until 2014, when several hundred JSFs will have already been procured. Also, the DOD's revised test plan relies on "state-of-the-art simulation labs," a flying test bed, and "desk studies" to verify nearly 83 percent of JSF capabilities. Only 17 percent is to be verified through flight testing. In March 2009, the Government Accountability Office published a report, *Joint Strike Fighter; Accelerating Procurement before Completing Development Increases the Government's Financial Risk,* in which it expressed grave doubts that JSF plans will meet schedule. By March 2009, fewer than 100 sorties of a 5,000-mission flight test program had been flown, even though Lockheed's production line had already begun churning out fighters.

What this means for the RWR market is, though JSF funding will likely remain high, the number of JSF RWRs flying may remain low through our forecast period. This analyst fears a vast parking lot of already-produced JSFs waiting for major changes and upgrades once testing – not complete before 2014 – finally reveals the changes necessary to make them ready for service. This possibility means that the legacy and upgrade RWR markets discussed below may remain stronger than we forecast after 2012.

**FY09-FY18 Value (FY09 $ Millions)**

| | |
|---|---|
| 1. AN/ALR-X (F-35 JSF RWR): | $2.4 Billion (BAE Systems) |
| 2. AN/ALR-69A(V) PLAID: | $1.4 Billion (Raytheon) |
| 3. AN/ALR-67(V)3: | $1.1 Billion (Raytheon) |
| 4. AN/ALQ-210(V): | $770 Million (Lockheed Martin) |
| 5. AN/ALR-56(V): | $750 Million (BAE Systems) |
| 6. AN/ALR-94 (F-22 RWR): | $350 Million (BAE Systems) |
| 7. AN/ALQ-217(V): | $260 Million (Lockheed Martin/ Northrop Grumman) |
| 8. AN/APR-39A/B(V): | $220 Million (Northrop Grumman) |
| 9. Army Digital RWR: | $190+ Million (Available) |
| 10. AN/ALR-93(V) IRWR: | $90 Million (Northrop Grumman) |
| 11. AN/ALR-69(V): | $90 Million (Northrop Grumman) |
| 12. AN/ALR-67(V)1/2: | $80 Million (Northrop Grumman) |
| 13. AN/ALR-95(V)X: | $65 Million (ITT) |
| 14. LR-100: | $40 Million (Northrop Grumman) |
| 15. AN/ALR-66(V): | $30 Million (Northrop Grumman) |

## A VAST FIGHTER LEGACY: UPGRADE OR REPLACEMENT?

Regardless of JSF production rates, thousands of legacy radar warning receivers will remain in service for the next one or two decades, at least. Northrop Grumman's AN/ALR-69(V) (originally developed and produced by Litton) is a standard analog USAF RWR that first entered production in 1978. Almost 2,000 ALR-69s were procured by the Air Force for F-16s alone. The system has now been superseded by BAE Systems' AN/ALR-56M on newer aircraft such as the F-16 Block 50, but substantial upgrade & support funding will continue for in-service ALR-69(V)s, worth $90 million through FY18.

In August 2001, Raytheon won a USAF contract to develop a new RWR, the ALR-69A. Touted by Raytheon as the only all-digital RWR available today, the ALR-69A program will likely be the most valuable non-JSF RWR program of the next decade.

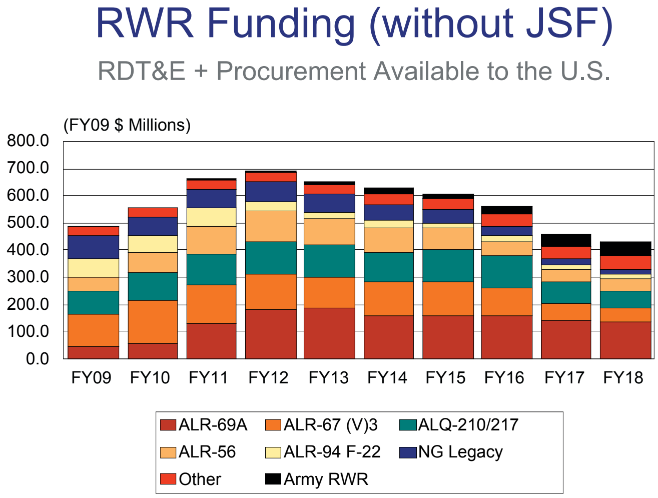
The program's first low-rate initial production contract was awarded in October 2007. The first installations will be performed on US Air Force Special Operations aircraft. The Air Force has pushed back its plans to buy the ALR-69A for its C-130 transport aircraft. (The DOD's FY10 budget proposal only funded 26 LRIP systems.) However, this is not unusual, as many RWR/ESM (electronic support measures) programs are "on hold" until the Obama administration performs a QDR prior to the FY11 budget request. We forecast funding will be restored for most or all US Air Force C-130 upgrades that were previously planned.

A bigger question is, how many ALR-69As will the Air Force buy to replace the older ALR-69s on its F-16s? There are tentative plans to ramp up ALR-69A production in FY12, but this may change due to other budget priorities. Our forecast assumes legacy US Air Force F-16s *do* begin receiving a new RWR in a few years. Regarding the ALR-69A's strengths in the market, the Air Force has spent considerable time developing the extra ESM capabilities of PLAID over other RWRs, and they seem satisfied. The biggest problem we see is the ALR-69A is still relatively expensive as an "upgrade" option for legacy aircraft, and it may drive additional costs in Group A aircraft modifications on the host aircraft. These are very significant factors in the upgrade market, and it may leave the door open for less expensive ALR-69 and ALR-56M upgrades, especially among international customers

But for now, we forecast substantial ALR-69A production for USAF F-16s in a few years, and we forecast the Air Force will stick with the ALR-69A. We believe unit costs will drop after full-rate production begins. Our forecast numbers may ultimately prove conservative, but we include only a partial F-16 ALR-69(V) replacement program. In total, we speculatively forecast the ALR-69A will be worth $1.4 billion through FY18.

The US Air Force's other standard RWR, BAE System's ALR-56(V), is an analog system originally produced for F-15s, with the miniaturized ALR-56M version serving aboard newer F-16C/Ds and some C-130s. Production has ended for US F-15s and F-16s, but international sales continue. The USAF and USMC have placed continuing orders for ALR-56Ms for C-130Js since July 2005, and small international sales have also been made for C-130Js. We forecast moderate continuing production, and upgrades will continue for a decade or more for newer systems.

In 2006, the USAF was considering replacing its F-15 ALR-56Cs with a new digital RWR, but an undefined contract to BAE Systems in 2008 seemed to be funding an upgrade program for ALR-56Cs instead. Congress added funding in FY09, but no further upgrade money was planned in the FY10 budget. It seems only a question of time, however, before a substantial upgrade or replacement is funded for the F-15s that will remain in service for another couple of decades. Now that F-22 seems definitely dead and JSF numbers are more definite, a major ALR-56C upgrade program may be near, probably based on BAE's JSF RWR technology. Our forecast is speculative, but we assume the past few years' RDT&E funding will increase soon, to be followed by a major surge in upgrade and support funding. The next year or two will be crucial for the future of the ALR-56, potentially worth $750 million through FY18.




The US Navy also operates thousands of radar warning receivers aboard F/A-18C/D Hornets and F/A-18E/F Super Hornets, and it shares the Air Force's dilemma of upgrading or replacing these systems. Northrop Grumman's (formerly Litton's) AN/ALR-67(V)1/2 has been the Navy's standard RWR for fighter and strike aircraft since the 1980s, with more than 2,000 sets procured. Production has been complete for several years now, but upgrades and support will continue, and Northrop's legacy system may still equip half of all USN Hornets in 10 years, earning $80 million from FY09-FY18.

But as early as Operation Desert Storm, the performance of the ALR-67(V)2 (before the ECP-510 upgrade) convinced the Navy it needed a new RWR. Raytheon's AN/ALR-67(V)3 has been in production for the Navy's F/A-18E/F Super Hornet for a decade, with the first full production option awarded in August 1999. The Navy plans to use the (V)3 both with and without IDECM (Integrated Defensive Electronic Countermeasures), and expects the (V)3 to remain in front line service for at least twenty years.

For years the (V)3 looked likely to be produced only for US Navy Super Hornets. But in 2007, several other Hornet users became buyers: first Australia (in 2006), for new F/A-18E/Fs and legacy F-18As, and then Canada for CF-18s and Switzerland for F/A-18C/Ds. Finland also contracted for four systems in 2007, though follow-on buys have stalled. Boeing is also pushing the Super Hornet for several major international

procurements, most importantly Brazil's FX-2 competition (as many as 120 fighters) and India's Medium Multi-Role Combat Aircraft (MMRCA) program, worth $10 billion for 126 aircraft. In mid-2009, Brazil made a preliminary request to the US for the Super Hornet, including 36 ALR-67(V)3 RWRs, but there had still not been a final decision at press time and Dassault's Rafale seemed the favorite over the F/A-18E/F and Saab's JAS-39 Gripen.

Beginning in FY10, the US Navy also appears likely to buy ALR-67(V)3s to replace ALR-67(V)2s on at least some (as many as 100) legacy F/A-18C/D Hornets. Our forecast includes moderate production for Hornets. But ALR-67(V)3 funding will still depend most heavily on US Navy Super Hornet production, which will almost certainly end for good before the end of our forecast period. Thus, Teal Group sees ALR-67(V)3 funding peaking in FY10 and declining gradually from there. The ALR-67(V)3 will be the third most valuable RWR program of the next decade after JSF and the ALR-69A, worth $1.1 billion.

Although funding for new aircraft is ending, production of the EW Suite for the F-22 Raptor, including the BAE Systems AN/ALR-94 ESM/RWR system, will continue for a couple more years. The first production F-22 EW suite was delivered in the summer of 2001, with testing continuing through the end of 2003, and the 100th suite was only delivered in December 2007, making the ALR-94 still quite a contemporary program. Upgrades based on JSF technology are likely, and with nearly 200 systems in service, the F-22 RWR should be worth $350 million, or more.

## BEYOND FIGHTERS

Beyond the programs above, which involve thousands of systems, only a few RWRs will see substantial funding. Lockheed Martin's AN/ALQ-210(V) ESM/RWR system is in production for the Navy's new-build MH-60R Seahawk helicopter, which saw many delays before finally entering full-rate production in May 2006. The US Navy plans to buy nearly 300 ALQ-210 systems. In April 2007, Canada became the first international customer to buy a derivative of the ALQ-210, contracting for 28 ESM systems for its CH-148 Cyclone helicopters. In total, we see $770 million for the ALQ-210 from FY09-FY18.

Lockheed Martin's similar AN/ALQ-217(V), derived from the ALQ-210, recently completed production for the US Navy's E-2C Hawkeye and for new-build Hawkeye 2000s. ALQ-217 production continues for the Canadian CP-140 (P-3) AIM (Aurora Incremental Modernization) program and for international E-2s, and it is now entering production for the US Navy's E-2D Advanced Hawkeye. We see a value of $260 million.

The final RWR programs to be worth more than $100 million over our forecast period are in fact vital programs that have simply received very little funding for years. Northrop Grumman's AN/APR-39(V) is the US Army's standard RWR for helicopters and light aircraft, with almost 10,000 systems already manufactured for US and international use (originally by Litton). Production of the APR-39 began in 1968 and the system has been continually modified and upgraded since. Production has slowed, but new contracts were still being awarded in 2009 (APR-39(V)4s for Egyptian and United Arab

Emirates Apache attack helicopters), and about 3,000 systems were still in Army service in early 2009.

As an interim measure, the Army awarded Phase I APR-39 upgrade development funding to Northrop Grumman in FY05. Phase I upgrades the processor Line Replaceable Unit (LRU) of the APR-39A(V)1, for improved maintainability and reliability, increased processing speed, and expanded memory, resulting in faster response time, better performance in dense signal environments, and improved parameter measurement. Phase I development was completed in FY08, with the Milestone C production decision in 3QFY08. Despite being a fairly minor upgrade, the sheer number of APR-39s in service mean total APR-39 funding should reach $220 million over the next decade.

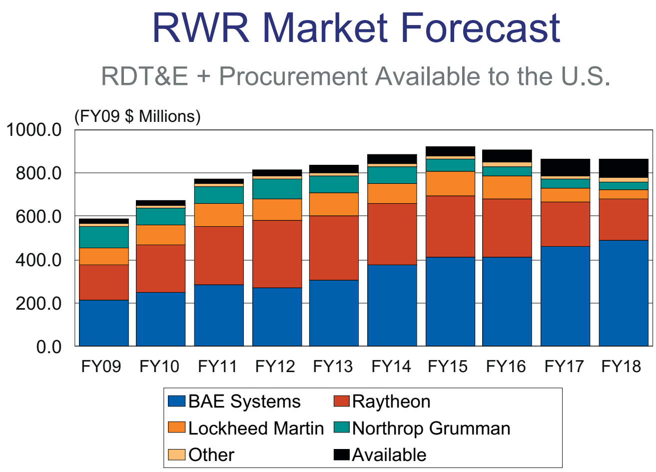
In May 2009, the FY10 budget laid out a proposed schedule for a follow-on Phase II Digital RWR development. However, even the Army admits this is not in any way definite. The schedule calls for "Prototyping" in FY09, FY11, and FY12, with Milestone B for SDD in FY13. Developmental Test (DT) is listed in FY14, and LRIP in FY15. Phase II would develop an improved Digital RWR for modernized platforms by capitalizing on emerging technologies to provide enhanced aircrew situational awareness. Teal Group speculatively forecasts about $200 million to be spent by FY18, with funding growing after that.

Several smaller programs round out our Top 15 RWRs, including Northrop Grumman's AN/ALR-93(V) Improved Radar Warning Receiver (IRWR), developed for international sales. Production has ended for Argentinian A-4AR upgrades and Taiwanese Ching-Kuo fighters, but a new contract was signed in April 2003 for 60 systems for Greek Block 52+ F-16C/Ds (as part of the Greek Air Force's Airborne Self-Protection Suite – ASPIS). A follow-on order for 33 more systems for Greece was awarded in July 2006, but development problems delayed delivery of these new systems. Value: $90 million.

ITT's AN/ALR-95(V)X electronic support measures system is an upgrade to the ALR-95 ESM system flown on US Navy P-3C Orion aircraft. Development contracts were awarded in 2007 and 2008, but Navy FY10 budget documents in May 2009 listed no ALR-95 funding. Our forecast is highly speculative, but this may be a fairly significant program, given the importance of the Orion. Value: $65 million or more.

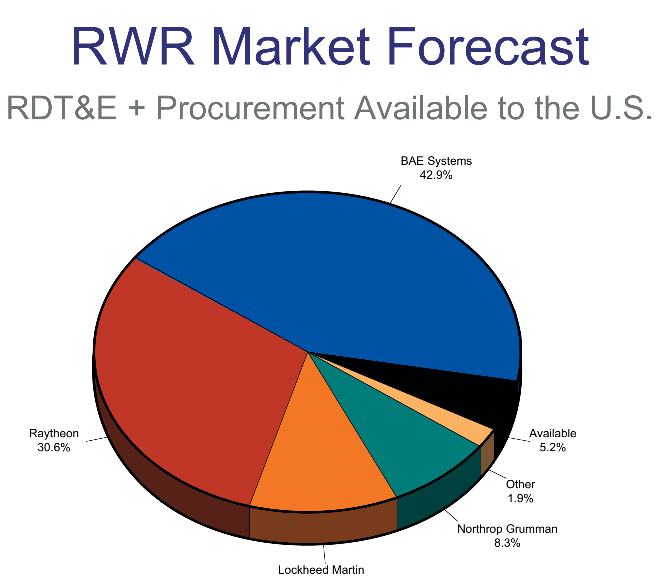
The LR-100 is a lightweight radar signal receiver designed in-house by Litton (now Northrop Grumman) using COTS components. It can serve as an RWR, but also provides precision emitter location and identification (ESM/ELINT [Electronic Intelligence]). There have been a number of small contracts reported, but few have been confirmed. It seems that early block models of the Global Hawks feature the LR-100 as standard equipment, and this may continue until it is replaced by the new Airborne Signals Intelligence Payload (ASIP) SIGINT (Signals Intelligence) system. Value: $40 million.

Northrop Grumman's AN/ALR-66(V) is an airborne electronic warfare receiver developed by the US Navy for a variety of aircraft. In its simplest




| | BAE Systems | Raytheon | Lockheed Martin | Northrop Grumman | Other | Available |
|---|---|---|---|---|---|---|
| **FY09** | 216 | 162 | 76 | 98 | 13 | 21 |
| **FY10** | 251 | 217 | 90 | 83 | 12 | 18 |
| **FY11** | 284 | 273 | 101 | 79 | 14 | 25 |
| **FY12** | 268 | 314 | 101 | 87 | 15 | 27 |
| **FY13** | 303 | 298 | 106 | 80 | 14 | 34 |
| **FY14** | 378 | 284 | 93 | 71 | 16 | 44 |
| **FY15** | 413 | 282 | 112 | 58 | 16 | 44 |
| **FY16** | 415 | 263 | 106 | 49 | 18 | 54 |
| **FY17** | 461 | 204 | 66 | 39 | 19 | 74 |
| **FY18** | 492 | 188 | 45 | 35 | 20 | 83 |

configuration, it is used as an RWR on naval helicopters. In its more elaborate forms, it also serves for over-the-horizon targeting for Harpoon anti-ship missiles, and can function as an ESM system. It has secondary applications on naval small combatant craft. ALR-66C(V)3 upgrades are being produced for the final USN AIP (Aircraft Improvement Program) P-3Cs. Value: $30 million.




## BAE TO LEAD RWR MARKET

With the JSF and F-22 RWRs, as well as the ALR-56C for F-15s and ALR-56M for F-16s, BAE Systems will continue to lead the radar warning receiver market for the next decade, earning nearly $3.5 billion in funding and capturing 42.9 percent of the market. BAE was even more dominant in the recent past, but Raytheon's share has increased based on its ALR-67(V)3 production contracts and the prospects for the ALR-69A(V). In fact, we forecast Raytheon to briefly surpass BAE Systems to lead the RWR market in FY12. But as soon as JSF RWR production ramps up, BAE will once again begin to dominate, to hold a still-growing 57 percent share of the market in FY18. Raytheon should earn $2.5 billion from FY09-FY18, but will be in decline after the middle of the next decade, unless major new upgrade programs are contracted.

Lockheed Martin will earn a fairly stable $900 million over our forecast period, but will also be in decline by FY18. Northrop Grumman, once a very strong player with thousands of ALR-66s, ALR-67s and ALR-69s, will have a much smaller stake in the market over the next decade. It will pursue opportunities such as B-2 EW upgrades and any competitive ALR-56 upgrade/replacement programs, as well as potential upgrades to thousands of older ALR-69(V)s and ALR-67(V)2s. But even with substantial upgrade work, and even if it wins a US Army Digital RWR follow-on to the APR-39, Northrop will be challenged to remain a leader in the future RWR market, with less than $700 million forecast (8.3 percent of the market).

Finally, ITT is developing the ALR-95(V)X and also produces RWR components for AN/ALQ-211(V) AIDEWS (Advanced Integrated Defensive Electronic Warfare System) suites for international F-16s. Their share is hard to predict, as these programs do not provide funding breakouts, but they should earn a substantial share of the "Other" and "Available" wedges.

| [Numbers are $Millions, but graph as %s] | |
|---|---|
| BAE Systems | 3482 |
| Raytheon | 2486 |
| Lockheed Martin | 894 |
| Northrop Grumman | 677 |
| Other | 156 |
| Available | 425 |

Beyond the prime contracts (the basis for all Teal Group's forecasts), future RWR/ESM upgrades and replacements will offer excellent subcontracting opportunities for other EW firms.

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# TECHNOLOGY SURVEY

## ELINT RECEIVER TECHNOLOGY

**By Ollie Holt**



This month's technology survey takes a look at ELINT receivers. ELINT receivers are a special class of EW receivers specifically designed to detect and collect radar emissions for data analysis either in real time by an operator, by post-flight analysis on the ground or both.

In terms of receiver technology, there is really not much difference between the receivers found in an ESM system and those found in an ELINT system. They both have high-sensitivity, variable bandwidths and the ability to support at least one of the many types of direction finding. The major difference is that the ESM system continually searches the environment and provides the user with a real-time view of the RF environment while the ELINT receiver has the ability to stop the search to allow the operator to review the detected signal and/or save the collected data for additional analysis post flight. An ELINT receiver typically does not have a response time requirement like an RWR or ESM system, so it can spend more time collecting information on interesting signals.

This survey addresses some of the basic performance parameters of receivers. The first is the frequency coverage. This simply describes the total operating range of the receiver. An ELINT receiver usually just covers the typical operating frequency range of radar systems or a subset of that frequency range.

The survey next addresses the available bandwidths. Most receivers can't receive the total frequency range simultaneously, and the wider the simultaneous-viewed frequency range, the lower your ability to detect weak signals. So the available bandwidths describe the range of different amounts of frequency coverage that can be observed in a single look.

For an ELINT receiver, the wide bandwidths are used for searching for signals while the narrower bandwidths are used to collect signal data for real-time or post-flight analysis. The narrower bandwidths also provide increased sensitivity, allowing a better view of the signal and an increased detection range for lower-power signals. The survey shows that some receiver systems have capabilities for wide bandwidths of up to 500 MHz and narrow bandwidths of down to 80 MHz. All have the ability to adjust the bandwidth to match the action being performed.

Another important parameter is the system sensitivity, although the sensitivity issue is only partially addressed by the number shown in the survey. The sensitivity number may be related to total system sensitivity or just the receiver sensitivity. System sensitivity addresses not just the receiver, but antenna sensitivity (gain or loss), and the cabling loss from the antenna to the receiver. Receiver sensitivity typically only addresses the sensitivity at the input to the receiver terminals and not total system sensitivity. Not all sensitivities in the survey are defined equally.

The final important parameter is the dynamic range. Dynamic range is important because it defines the ability of the receiver to process high- and low-level signals simultaneously within the same bandwidth. The survey looks at both instantaneous dynamic range and total dynamic range. Instantaneous dynamic range is range of sensitivity values from the lowest power signal that can be detected to the point at which a 1-dB input results in less than 1 dB output (the 1-dB compression point) without additional attenuation. The total dynamic range is the dynamic range that can be achieved by adding attenuation to the signal.

This survey was performed similar to the previous surveys with a set of questions sent to known ELINT receiver suppliers. The companies were asked to provide information for up to five of their ELINT products for inclusion in this survey. Only information supplied by the survey respondents was used in this compilation.

*Our next survey, covering naval chaff/flare rounds and launchers, will appear in the January 2010 issue. E-mail editor@crows.org to request a survey questionnaire, or visit www.jedonline.com for a list of 2010 surveys and to fill out requests for the entire year's surveys.*

# TECHNOLOGY SURVEY: ELINT RECEIVER TECHNOLOGY

| MODEL | REC TYPE | OP FREQ | INST BW | TYP INST SENS | DYN RANGE | INST DYN RANGE |
|---|---|---|---|---|---|---|
| **AMESYS; AIX EN PROVENCE, France; +33-442-607000; www.amesys.fr** | | | | | | |
| ELIT-500-RF | superhet intrapulse | 0.5 to 18 GHz | 500 MHz | -82 dBm for PW > 1µs<br>-70 dBm for PW > 50ns | > 65dB | > 40dB |
| **Applied Signal Technology, Inc; Allen, TX;+ 214-547-4700; www.appsig.com** | | | | | | |
| Pegasus Family of Systems | superhet/digital channelized | * | 1GHz IF - 500 MHz IBW | > 80 dBm | > 70dB | > 60dB |
| **Argon ST, Inc.; Fairfax, VA; +703-682-9570; www.argonst.com** | | | | | | |
| NBS-2500 | superhet | 0.5-40 GHz | 80 and 500 MHz | -80 dBm Typ. (0 dB gain) | > 110 dB | 70 dB (80 MHz BW)<br>60 dB (500 MHz BW) |
| NBS-2501 | superhet and block RF converters | 0.5-40 GHz | 80, 500, 4,000 MHz | -80 dBm Typ. (0 dB gain) | > 110 dB | 60 dB SFDR (80 MHz BW)<br>53 dB SFDR (500 MHz BW)<br>60 dB SFDR (4000 MHz BW) |
| **Cobham Sensor Systems, CDES - M/A-COM SIGINT Products; Hunt Valley, MD; +410-329-7900www.macom-sigint.com** | | | | | | |
| SMR-5550I | superhet, set-on | 0.5-20 GHz | 100 MHz @ 1 GHz IF | -101 dBm | 65 dB, 1 MHz BW | * |
| SMR-3822 | superhet, sweeper | 0.5-20 GHz | 500 MHz @ 1 GHz IF | -104 dBm | >90 dB 1 MHz BW | * |
| SMR-3822A | superhet, sweeper | 0.5-20 GHz | 500 MHz @ 1 GHz IF | -104 dBm | >90 dB 1 MHz BW | * |
| TU-6401/02 | superhet tuner, stepped sweeper | 0.5-18 GHz | 500 MHz @ 1 GHz IF | -99 dBm | >90 dB 1 MHz BW | * |
| DRX-5571 | superhet, set-on | 0.5-20 GHz | 100 MHz @ 1 GHz IF | -101 dBm | 65 dB, 1 MHz BW | * |
| **DRS Signal Solutions, Inc.; Gaithersburg, MD; +301-948-7550; www.drs-ss.com** | | | | | | |
| SI-9250 | superhet | 0.5-18 GHz | 880 MHZ | -89 dBm at 1 MHz BW | 64 dB at 1 MHz BW | 64 dB at 1 MHz BW |
| SI-9155 | superhet | .350-24.5 GHz | 1,000 MHz, 500 MHz, 100 MHz | -96 dBm at 1 MHz BW | 110 dB at 1 MHz BW | 65 dB at 1 MHz BW |
| SI-9253 | homodyne | 0.02-6 GHz | 1,000 MHz | -114 dBm at 1 MHz BW | 68 dB at 1 MHz BW | 68 dB @ 1 MHz BW |
| **Elbit Systems; Haifa, Israel; +972-4-831-5234; elbitsystems.com** | | | | | | |
| TIMNEX II | channelizer | 2-18 GHz or 0.5 -18 GHz | 2-18 GHz or 0.5-18 GHz | -65 dB | 85 dB | 60 dB |
| **ELETTRONICA S.p.A.; Rome, Italy; +39 06 4154; www.elt-roma.com** | | | | | | |
| ELT 888 family | wband superhet | * | many selectable superhet bandwidths | very high | double | * |
| SEAL family | superhet, digital, IFM | * | wide open and many selectable superhet bandwidths | high to very high | double | * |
| ELT/800 family | superhet, digital, IFM | * | wide open and many selectable superhet banddwidths | high to very high | double | * |
| ELT/243 family | superhet, digital, IFM | * | wide open and many selectable superhet bandwidths | high to very high | double | * |
| **Elisra Electronic Systems Ltd.; Bene Beraq, Israel; + 972-3-6175 111; www.elisra.com** | | | | | | |
| AES210 Family | digital, IFM | 0.1 - 40 GHz | 4 MHz -3 GHz | * | >90 dB | 60 dB |

| MOD TYPES | SUPPORT DF | SIZE (in in./cm) | WEIGHT (in lb./kg) | FEATURES |
|---|---|---|---|---|
| | | | | |
| PRI, FN, PW,AMOP, FMOP, PMOP | amplitude, phase, time | form factor - 3U: 19 in. rack, 450mm depth | 15kg | In interception mode, detected and identified radar tracks are displayed to the operator. Extendable to 40 GHz. |
| | | | | |
| * | monopulse phase interferometer, TDOA capable | config dependent | 70 -200 lbs. | High accuracy DF. wband digital channelized RxR. |
| | | | | |
| IMOP, FMOP, UMOP, AMOP | spinner, interferometer | 19 in. rack, 8U total 47 in. spinning antenna | < 250 lbs. | Signal processor samples demodulated IF. Real Time Raster and PDW X-Y plots form the basis of analysis functions. |
| IMOP, FMOP, UMOP, PMOP, AMOP | spinner, interferometer | 19 in. rack, 8U total 47 in. spinning antenna | < 250 lbs. | Signal processor directly samples IF with high speed A/Ds. Signal Audio, PDW and Intra-pulse data recording provided. Automatic modes support ESM functions. |
| | | | | |
| AM, FM | yes | 1.75 x 20.16 x 17 in. | 20 lbs. | Very low integrated phase noise. 40-GHz extension. |
| AM, FM, LOG | * | 3.5 x 8.5 x 22.5 in. | 27 lbs. | Full band sweep (0.5-20 GHz) <80 msec, 10 MHz RBW. 40-GHz extension |
| AM, FM, LOG | * | 3.5 x 8.5 x 22.5 in. | 26 lbs. | Full band sweep (0.1-20 GHz) <85 msec, 10 MHz RBW. 40-GHz extension |
| N/A | yes | VME, 1 or 2 slots 6U high | 5.5 lbs. | ≤2 usec any frequency step |
| FPGA based demod | * | 1.75" H x 20.16" D x 17" W | 22 lbs. | 1000BaseT, optical and electrical STM-1 outputs. 40-GHz extension. FPGA based demod for decoding and demultiplexing complex digital signals. |
| | | | | |
| analog IF output | yes | 6U VME; 9.2 in. x 6.3 in. x 1 in. | 4.5 lbs. | * |
| STD: analog IF output; Option: digital IF | yes | 6U VXS; 9.2 in. x6.3 in. x 1 in. | 4 lbs. | Tuning speed < 35 μsec. Tuning steps of 1 MHz. Integrated digitizer designed to provide digital IF or modulation on pulse or custom demodulation. |
| Analog IF Output | yes | 3U VPX; 3.5 in. x 6.3 in. x 1 in. | 1 lb. | Tuning speed < 90 μsec. Tuning steps of 1 MHz. |
| | | | | |
| * | amplitude or phase | * | * | Recording and replay |
| | | | | |
| * | spinning parabolic dish/monopulse | * | shelterized | Localization through triangulation. |
| * | amplitude monopulse (4 to 8 antennas) and TDOA | * | configuration dependent | Fast localization through triangulation. |
| * | amplitude monopulse (4 to 8 antennas) and TDOA | * | configuration dependent | Fast localization. |
| * | amplitude monopulse (4 to 8 antennas) and TDOA | * | shelterized | Fast localization through triangulation. |
| | | | | |
| FMOD, PMOD | phase, amplitude, DTOA | * | 25 kg | ELINT/ESM ,remote operation. |

## TECHNOLOGY SURVEY: ELINT RECEIVER TECHNOLOGY

| MODEL | REC TYPE | OP FREQ | INST BW | TYP INST SENS | DYN RANGE | INST DYN RANGE |
|---|---|---|---|---|---|---|
| **IAI ELTA Systems Ltd.; Ashdod, Israel; +972-8-857-2312; www.elta-iai.com** | | | | | | |
| Digital Receiver | superhet | 0.5-18 GHz | 20/500/4,000 MHz | high at 500 to 4000 MHz very high at 20 MHz | 80 dB | 60 dB |
| **ITT Electronic Systems - Reconnaissance and Surveillance Systems; Morgan Hill CA; +408-201-8000; www.rss.es.itt.com** | | | | | | |
| ES-3701 | IFM plus superhet channels | 2-18 GHz | 16 GHz plus nband options | < -70 dBm | 60 dB | 60 dB |
| ES-5054 | multiple superhet channels | 0.5-18 GHz | to 500 MHz | < -72 dBm on omni | >80 dB | > 60 dB |
| ES-5080 | superhet with digital receiver | 0.5-18 GHz | 500 MHz each channel, combinable | < -72 dBm on omni | >80 dB | > 60 dB |
| **Lockheed Martin Systems Integration; Owego, NY; +607-751-2000; www.lockheedmartin.com/si** | | | | | | |
| Advanced Digital Receiver Processor | superhet | * | * | * | * | * |
| AN/ALQ-217 | superhet | * | * | * | * | * |
| AN/ALQ-507 | superhet | * | * | * | * | * |
| AN/ALQ-210 | superhet | * | * | * | * | * |
| **Mercury Computer Systems, Inc.; Chelmsford, MA; +978-967-1401** | | | | | | |
| RF 1800GT | superhet | 0.5-18 GHz | 500 MHz on 1GHz IF; 80 MHz on 160 MHz IF | -85 dBm | 90 dB at 1MHz BW | For 500 MHz BW: 51 dB; For 80 MHz BW: 57 dB; For 1 MHz BW: 69 dB |
| **Microvave Technologies, Inc.; Burke, VA; +703-250-6485; www.microwavetech.com** | | | | | | |
| PUMA, Condor and Vigilant systems | superhet, IFM | 0.1-18 GHz | * | -75 dBm | 70 dBm | * |
| **Patria Aviation Oy Systems; Tampere, Finland; +358-20-4691; www.patria.fi** | | | | | | |
| ARIS (Advanced Real-time Intelligence System) | wband digital receiver | 0.5-18 GHz | 500 MHz | * | * | SNR up to 86 dB |
| **Rafael Advanced Defense Systems Ltd; Haifa, Israel; +972-4-879-4372; www.rafael.co.il** | | | | | | |
| Top Scan & C-PEARL-DV | * | 0.5-40 GHz | * | -65 to -85 dBm w/o antenna | 90 dB | 60 dB |
| **Rockwell Collins EW&IS; Richardson, TX; +972-705-3920; www.rockwellcollins.com/ewsigin** | | | | | | |
| CS-5020C Tuner | superhet | 0.1-18 GHz | 500 MHz at 1 GHz IF 100 MHz at 160 MHz IF | NF= 13 dB typ, Gain = 15 dB typ | >100 dB | 90 dB typ (1 MHz ref BW) |
| RC-5800 Tuner | superhet | 0.5 -18 GHz | 500 MHz at 1 GHz IF 85 MHz at 160 MHz IF | NF = 13 dB typ, Gain = 8.5 dB typ | * | 95 dB typ (1 MHz ref BW) |
| PRISM-6090 RF Search System | superhet sweeping | 0.5-18 GHz | 500 MHz | -75 dBm | >100 dB | 60 dB |
| CS-5998 Tuner | superhet | 0.5-18 GHz | 2000 MHz at 3 GHz IF 500 MHz at 1 GHz IF 100 MHz at 160 MHz IF | NF = 13 dB typ, Gain = 15 dB typ | >100 dB | 90 dB typ (1 MHz ref BW) |
| IFMR-6070 IFM Receiver | IFM | 0.5-18 GHz | 0.5-18 GHz | -65 dBm | 60 dB | 60 dB |

| MOD TYPES | SUPPORT DF | SIZE (in in./cm) | WEIGHT (in lb./kg) | FEATURES |
|---|---|---|---|---|
| | | | | |
| all MOP types | amplitude, phase, time | 9.1 x 10.6 x, 16.5 in. | 23 kg | Digital recording – pulses, samples and signals. Processing – Signal and ELINT/ESM/RWR. Self-test and Calibration. Can be extended to 0.03-40 GHz. |
| | | | | |
| radar pulse, CW , FMCW | circular array phase interferometer | interferometer ant. plus one rack equipment | config.dep. | Selectable bandwidths. Very good interference rejection. Built-in PDW recording. Nband receiver. FMCW receiver with DF. Frequency extension. Extendable to 0.5 GHz. |
| radar pulse, CW | spinning DF | omni and spinning DF ant. with 2 1/2 racks of equipment | config.dep. | Selectable bandwidths, 500, 50, 25, 10, 5, 2.5, 1, 0.5, 0.1 MHz. Multiple channels, multiple operators. Intrapulse recording and analysis. |
| radar pulse, CW, FMCW | spinning DF | spinning DF antenna with 1 rack mount chassis | config.dep. | Selectable bandwidths: 500,250,100,50,20,10,5,2.5 MHz. Digital receiver with very high fidelity. Extensive networking capabilities for remote operations. Extendable up to 40 GHz. |
| | | | | |
| * | * | 7.75 x 12.7 x 12.6 in. | 73 lbs. | Enhanced modular architecture and digital signal processing capability. |
| * | * | 28 x 8.8 x 14.2 in. | 85.6 lbs. | Record capability. SEI. |
| * | * | 28 x 8.8 x 14.2 in. | 87.5 lbs. | Open systems architecture, record capability, and SEI. |
| * | * | 7.7 x 10.1 x 15.3 in. | 56.6 lbs. | SEI and digital capabililty. |
| | | | | |
| * | * | 5 x 9 x 1.6 in. (2-Card 6U VME Format) | < 3.2kg | Tuning Speed (ITAR Controlled). Tuning resolution of 3 Hz. Two IF frequency outputs. Low Phase Noise: -100dBc/Hz @ 1kHz offset; -120dBc/Hz at 100kHz offset. |
| | | | | |
| IMOP, FMOP, UMOP, PMOP, AMOP | amplitude, phase | * | * | Extenbable up to 40 GHz. |
| | | | | |
| measurement tools for FMOP, PMOP and AMOP | * | 9U 19-in. rack mount chassis | 27 kg | Continuous real-time ELINT analysis capability. Recording capability of IF up to 500 MHz BW. Remotely operable. |
| | | | | |
| IMOP, FMOP, UMOP, PMOP, AMOP | phase | * | * | * |
| | | | | |
| * | amplitude, time | 2U, 1/2 rack width, 3.5 x 8.5 x 21 in. | 18 lbs. | ELINT or COMINT versions with optional IF output frequencies, BW, demodulation, LAN controlled or stand alone use. Extendable to 40 GHz. |
| * | amplitude, time | 6U VME, 2 VME slices | 6.7 lbs. | High speed, low phase noise VME-based tuner supports N-Channel configurations. |
| * | * | 4U rack mount, 7 x 17 x 21 in. | 32 lbs. | Continuously sweeps from 0.5 to 18 GHz at 25 sweep/sec rate. FFT-based panoramic displays via Gigabit Ethernet with flexible GUI. |
| * | amplitude, time | 2U, 1/2 rack width, 3.5 x 8.5 x 21 in. | 18 lbs. | Ultra-wide 2-GHz bandwidth centered at 3 GHz IF. Also - GHz and 160-MHz IF outputs. Optional integrated demodulator for video outputs. Extendable to 40 GHz. |
| * | amplitude, time | 2U rack mount, 3.5 x 17 x 26 in. | 35 lbs. | Continuously staring from 0.5 to 18 GHz. Generates PDW data including Freq, PW, PRI, Amp with modulation flags. Extendable to 40 GHz. |

# TECHNOLOGY SURVEY: ELINT RECEIVER TECHNOLOGY

| MODEL | REC TYPE | OP FREQ | INST BW | TYP INST SENS | DYN RANGE | INST DYN RANGE |
|---|---|---|---|---|---|---|
| **RUBISOFT; Paris, France; +33-1-53-94-79-95; www.rubisoft.fr** | | | | | | |
| RUBILINT V4 | superhet | 0.5-18 GHz | 500 MHz | -75 dBm | 80 dB | 60 dB |
| **Saab Avitronics; Jarfalla, Sweden; :+46-8-580-840-00; www.saabgroup.com** | | | | | | |
| U/SME-200 | hybrid comprising DIFM, CVR + mult-channel superhet | 2-18 GHz | 100 MHz/16 GHz | -75dBm | 80 dB | 60 dB |
| ESP-3 | digital FFT channelizer | 0.5-18 GHz | 500 MHz | -70dBm | 60 dB | 50 dB |
| EPS-200 | digital FFT channelizer | 0.5-18 GHz | 500 MHz | -90 dBmi | >85 dB | 55 dB |
| **Sierra Nevada Corporation - Sensors Systems Technology; Los Gatos, CA; +408-395-2004; www.sncorp.com** | | | | | | |
| SS-505 | digital channelizer | 0.5-18 GHz | 500 MHz WB, 80 MHz nband | -81 dBm | > 55 dB | >55 dB |
| SS-2005 | digital channelizer | 0.5-18.0 GHz | 0.5 GHz | -81dBm | >55 dB | >55dB |
| **Thales Aerospace Division; Elancourt, France; +33 1 34 81 75 38; www.thalesgroup.com** | | | | | | |
| ELINT Polyphase Digital Receiver | superhet with bank of cascadable self-adaptive digital filters | 0.1-40 GHz | Up to 4 GHz | Up to -86 dBm | 90 dB | 50 dB |
| **Ultra Electronics Telemus; Ottawa, ONT, Canada; +613-592-2288; www.ultra-telemus.com** | | | | | | |
| Eagle 1 P/N SLR-505 | superhet | 0.375 to 18.25 GHz | 500 MHz (1 GHz IF) >75 MHz (160 MHz IF) | <-80 dBm w/o Antenna (500 MHz IF BW, 3 MHz Demod BW) <-95 dBm w/ Antenna (500 MHz IF BW, 3 MHz Demod BW) | >90 dB | >60 dB |
| Eagle 2 P/N TER-803 | superhet | 0.375 to 18.25 GHz | 500 MHz (1 GHz IF) >75 MHz (160 MHz IF) | <-80 dBm w/o Antenna (500 MHz IF BW, 3 MHz Demod BW) <-95 dBm w/ Antenna (500 MHz IF BW, 3 MHz Demod BW) | >90 dB | >60 dB |


| MOD TYPES | SUPPORT DF | SIZE (in in./cm) | WEIGHT (in lb./kg) | FEATURES |
|---|---|---|---|---|
| | | | | |
| IMOP, FMOP, UMOP, PMOP, AMOP | amplitude | 20 in. x 20 in. x 25 in. | 50 kg | Delivered with ANALINT™, a complete intrapulse analysis software, Matlab compatible. |
| | | | | |
| detection and analysis of PMOP, FMOP and AMOP | phase and amplitude, 2 deg. | ant.: 460 x 230 mm; receiverpProcessor: 400 x 425 x 267 mm | ant. 38kg, proc. 45kg | Parallel ELINT and ESM, intra- and inter- pulse analysis, scan pattern analysis, open architecture, MFC multiconsole operation, advanced interoperability. Extendable to 40 GHz. |
| IMOP, FMOP, PMOP, AMOP | phase, amplitude 1 deg. RMS (2-18 GHz) 3 deg. RMS (0.5-2 GHz) | controller: 36 x 10 x 19 cm; antenna: 17x 11 cm; DFaArray: 25 x 32 cm x 32 cm | controller 15kg; ant. 9.5kg; omni ant. 1.1kg. | Intra-pulse analysis. Inter-pulse analysis. Scan-rate analysis. Beam shape analysis. High accuracy DF. Emitter location. Pulses can be recorded for UMOP non-real time analysis. |
| IMOP, FMOP, PMOP, AMOP | spin DF (phase/ amplitude) | configurable | 75 kg | Raw intra-pulse data recording and analysis. Adaptive frequency search programs. User programmable library. Extendable to 40 GHz. Pulses can be recorded for UMOP non-real time analysis. |
| | | | | |
| IMOP, FMOP, UMOP, PMOP, AMOP | phase, amplitude, time | ATR | 70 lbs. | Comprehensive real-time GUI. Record of I/Q PDW, EDW. |
| IMOP, FMOP, UMOP, PMOP, AMOP | phase, amplitude, TOA | 14 x 14 x 18 in. | 125 lbs. | Fully automatic ops, autonomous collection, man-in-loop analysis, comprehensive GUI, all-environment. |
| | | | | |
| CW, pulse, IMOP, UMOP (FMOP, PMOP, AMOP) | amplitude, phase, time | Variable | 30 kg | This receiver is the core equipment of a family of ELINT systems: ASTAC, ARTICA, and PETREL. Data link option; ground based operator station; data recorder. |
| | | | | |
| FMOP, PMOP, AMOP per PDW IMOP, UMOP in software post analysis | Spinning DF antenna (<2 deg rms accuracy typ.) Linear baseline phase interferometer (<1 deg rms accuracy typ., <2 deg rms max.) | 21 x 19 x 26 in. | <70 lbs. | Talon Analysis Software Suite – Automatic PDW de-interleaving, emitter parameter estimation, automatic raw IF pulse detection, measurement, and analysis, graphical and interactive measurement and analysis tools. |
| FMOP, PMOP, AMOP per PDW IMOP, UMOP in software post analysis | Spinning DF antenna (<2 deg rms accuracy typ.) Linear baseline phase interferometer (<1 deg rms accuracy typ., <2 deg rms max.) | 5.25 x 19 x 26 in. | <50 lbs. | Windows OS base; socketed-IP remote connection with ICD; software defined radio (SDR) processing techniques. |


# Survey Key – ELINT Receivers

**MODEL**

*Product name or model number*

**TYPE**

*Receiver type*

- CVR = crystal video receiver
- DIFM = digital instantaneous frequency measurement
- FFT = fast fourier transform
- IFM = instantaneous frequency measurement
- superhet = superheterodyne

**OP FREQ**

*Operating frequency in gigahertz*

**INST BW**

*Instantaneous bandwidth in megahertz or gigahertz (if different from operating frequency)*

- IF = intermediate frequency

**TYP INST SENS**

*Typical Installed sensitivity*

**DYN RANGE**

*Total dynamic range*

**MOD TYPES**

*Modulation types*

- AMOP = amplitude modulation on pulse
- CW = continuous wave
- FMCW = frequency modulated continuous wave
- FMOP = frequency modulation on pulse
- IMOP = intentional modulation-on-pulse
- MOP = modulation-on-pulse
- PMOP = phase modulation on pulse
- UMOP = unintentional modulation-on-pulse

**SUPPORT DF**

*Does it support DF and with what technology and accuracy?*

- TDOA = time difference of arrival
- RMS = root mean square

**SIZE (in inches or centimeters)**

*Size by height x weight x length, or diameter*

**WEIGHT**

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

**FEATURES**

*Additional features*

- A/D = analog to digital
- EDW = emitter descriptor word
- ESM = electronic support measures
- GUI = graphical user interface
- I/Q = in-phase-quadrature
- ITAR = International Traffic in Arms
- LAN = local area network
- MFC = multi-frequency code
- PDW = pulse descriptive word
- RWR = radar warning receiver
- SEI= specific emitter identification

**OTHER ABBREVIATIONS USED**

- ant = antenna
- BW = bandwidth
- config = configuration
- deg = degree
- dep = dependent
- freq = frequency
- min = minimum
- max = maximum
- nband = narrowband
- opt = option/optional
- wband = wideband
- < = less than
- > = greater than

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

**OTHER COMPANIES**

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

| Company Name | Website |
|---|---|
| Elcom Technologies | www.elcom-tech.com |

## Communications EW – Part 30

# Fratricide

By Dave Adamy

Any situation in which communication jamming is employed has a potential for "fratricide" – the unintentional jamming of friendly communications. Particularly when broadband (barrage) jamming is used, friendly command and control communication, data links and command links can suffer significant degradation.

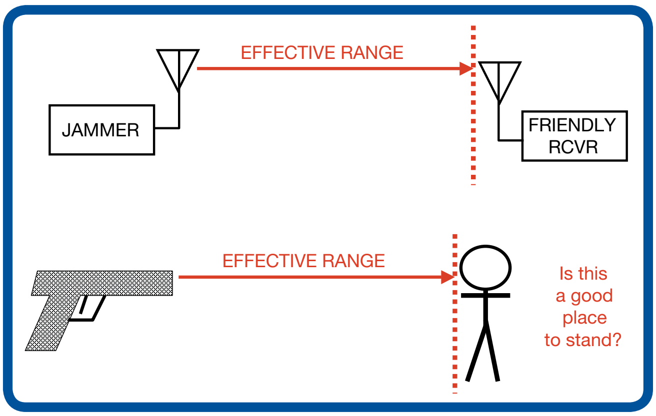


*Figure 1: Electronic fratricide is an important consideration in the employment of any jammer.*

There have been accounts of individuals who believe that because the effective range of a jammer is some specific distance, communication will be unaffected beyond that range. **Figure 1** is intended to dramatically illustrate the danger of this misunderstanding. The analogy between the effective range of the jammer and the firearm is apt. The effective range of a firearm is the range at which it can be expected to hit and cause sufficient damage to a target when employed by an appropriately trained individual; the bullet travels much farther than the effective range. The effective range of a jammer is the distance at which it can cause sufficient jamming-to-signal ratio (J/S) in an enemy receiver to prevent effective communication (with some safety margin); generally, full performance by a friendly link requires that the J/S in the receiver be far lower.

## Fratricide Links

As shown in **Figure 2**, we consider four links in this analysis. The desired jamming operation causes a J/S in the target receiver defined by the following equation:

$$J/S = ERP_J - ERP_{ES} - LOSS_{JE} + LOSS_{ES}$$

Where: $ERP_J$ = The jammer ERP
$ERP_{ES}$ = the hostile transmitter ERP
$LOSS_{JE}$ = the link loss between the jammer and the target receiver
$LOSS_{ES}$ = the link loss between the hostile transmitter and the target receiver

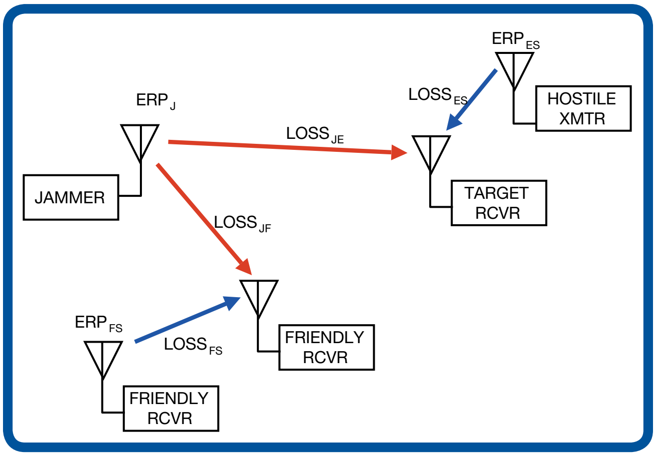


*Figure 2: Fratricide vulnerability analysis requires calculation of J/S for both hostile and friendly communication links.*

Now, consider the "fratricide link." It is convenient to write a parallel equation for the unintended J/S of the friendly receiver.

$$J/S\ (Fratricide) = ERP_J - ERP_{FS} - LOSS_{JF} + LOSS_{FS}$$

Where: $ERP_J$ = The jammer ERP
$ERP_{FS}$ = the friendly transmitter ERP
$LOSS_{JF}$ = the link loss between the jammer and the friendly receiver
$LOSS_{FS}$ = the link loss between the friendly transmitter and the friendly receiver

Unfortunately, there is no magic rule of thumb for evaluating fratricide. If jamming is conducted at a frequency used for friendly communication, it is necessary to work both of these equations with the appropriate link loss models (i.e. line-of-sight, two-ray or knife-edge diffraction), ERPs, link distances and antenna heights or frequency (when appropriate). (See the July, August and September 2007 "EW 101" columns.) The effective J/S (Fratricide) should generally be significantly below 0 dB (-15 dB is a reasonable target).

## MINIMIZING FRATRICIDE

**Figure 3** summarizes the approaches to the minimization of fratricide. Each of them either reduces the jamming power received in the friendly receiver or enhances desired signals to reduce the effective J/S.

**Minimize the jammer to target receiver distance and maximize the jammer to friendly receiver distance.** Stand-in jamming involves the remote operation of a jammer as close to the enemy as is practical. This includes jammers on UAVs,

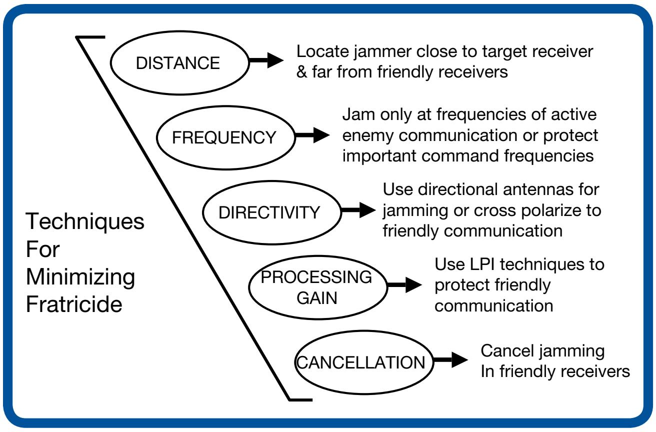


*Figure 3: Several techniques can be used to minimize fratricide.*

artillery placed jammers and hand placed jammers. Remote jammers can be activated by command or timed to turn on in some optimum pattern. In general, they will be either barrage or swept spot jammers so they will be sure to cover the enemy's operating frequencies without direct operator intervention. The anti-fratricide advantage comes from the ratio of the link distances as shown in **Figure 4**. The advantage will be the square of the distance ratio for line-of-sight propagation or the fourth power of the distance ratio for two-ray propagation.

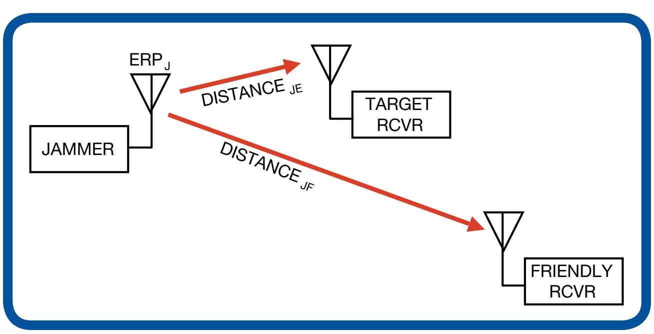


*Figure 4: Relative distance to target and friendly receivers strongly impacts fratricide.*

**Use frequency diversity.** It is best, whenever practical, to jam only on active enemy frequencies. Not only does this maximize the jamming effectiveness, but it reduces the probability of fratricide. This assumes that command and control frequencies are chosen to be those not requiring jamming. It may also be practical to filter broadband jamming to protect friendly frequencies.

Note that where an enemy frequency hopper is jammed with a follower jammer (See the August 2009 "EW 101"), friendly communications will be minimally degraded because the jammer is seldom on a friendly frequency.

**Use directional antennas for jamming** as shown in **Figure 5**, when practical. If the jamming antenna is directed at the enemy's location, friendly receivers will most likely be in the lower gain side lobes of the jamming antenna. This will reduce the effective jammer ERP toward the friendly receiver by the side lobe isolation ratio.

Another antenna consideration is polarization. Where practical, match the polarization of the jamming antenna to that

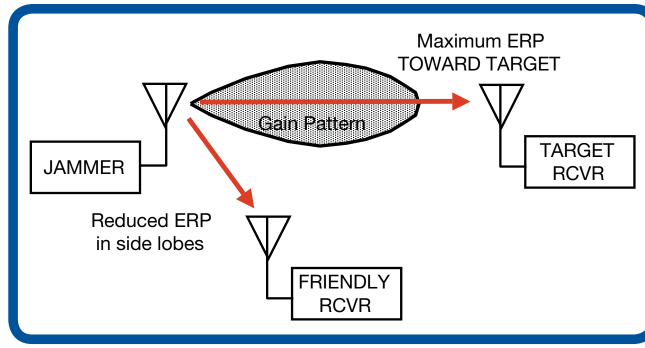


*Figure 5: A directional jamming antenna will reduce the ERP toward friendly receivers.*

of the enemy antennas and use cross polarized antennas for friendly communication. Note that when everyone is communicating with whip antennas, friendly and enemy antennas will all be vertically polarized, so this technique does not apply.

**Use low probability of intercept (LPI) modulations for friendly communication**. This will provide processing gain for desired signals in the friendly receiver, thus reducing the effective J/S from enemy or friendly jammers.

**Signal cancellation techniques** can sometimes be applied to reduce the effectiveness of jamming signals. As shown in **Figure 6**, an auxiliary antenna receives the jamming signal and passes it through a 180-degree phase shifter. When this phase shifted signal is added to the signals from the normal communication antenna, the jamming signal will be cancelled (by some number of dB). Note that the auxiliary antenna must typically have some advantage toward the jammer (10 dB in one case). The cancelling signal could also be hard connected to the jammer output, but this would only cancel the primary signal. In virtually all situations, there will be multipath signals that add to form the signal actually received by the communication antenna. An auxiliary antenna should capture at least some of these multipath signals, improving the quality of the cancelation process.

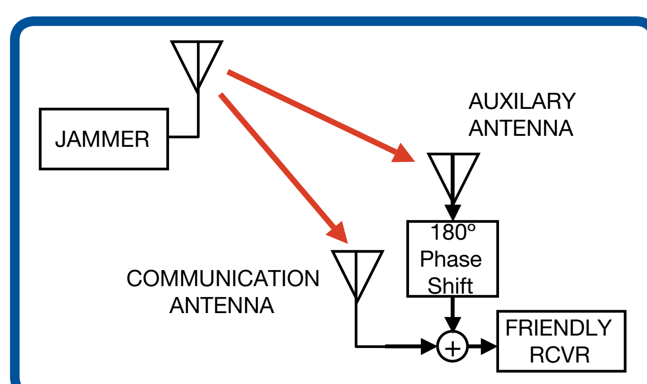


*Figure 6: Injecting a 180-degree phase shifted version of the jamming signal significantly reduces it.*

## What's Next

Next month, we will start a new series of columns on the EW considerations of modern radars. For your comments and suggestions, Dave Adamy can be reached at dave@lynxpub.com.

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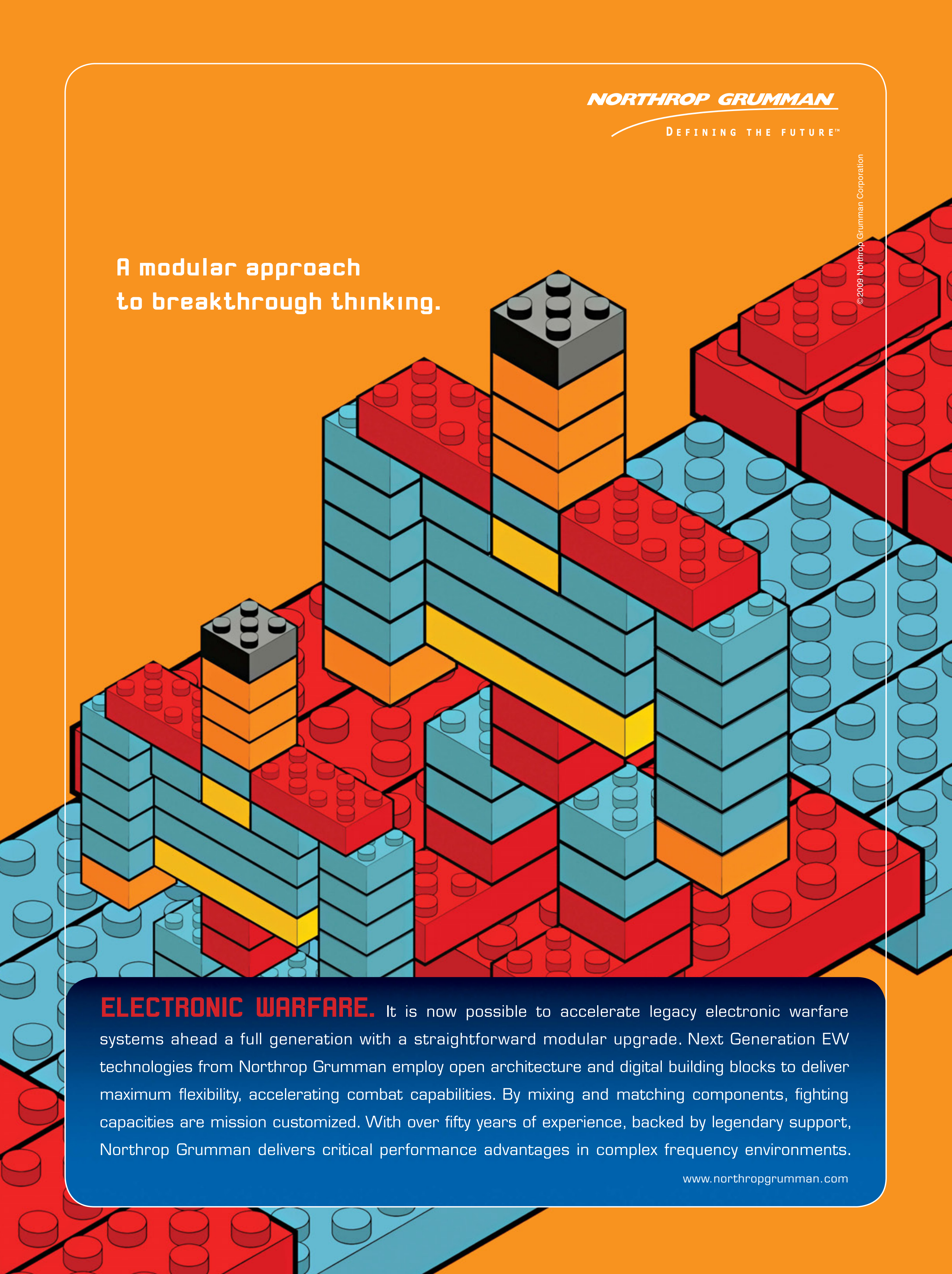
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