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The AOC Electronic Warfare Publication
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JED

The Journal of Electronic Defense


European EW


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EW FOR THE SOLDIER

This month's *JED* features an article about "cheap and dirty EW." This is a topic that has been emerging for some years now, and it's beginning to mature in the minds of military leaders.

Over the past several years, operations in Iraq and Afghanistan have driven the EW needs of ground forces to the front burner, and we are now beginning to understand what that really means. The number of friendly, enemy and civilian "spectrum users" has exploded, and their impact on the battlespace has been significant. Most of the world's military forces have not invested in the EW capabilities needed to keep pace with the rapidly evolving commercial technology or the unprecedented proliferation of electronics devices. A critical gap has quietly but quickly opened, and the warfighter's ability to achieve spectrum control in the battlespace today has become far less certain.

Across the world, military leaders are beginning to understand this problem and the major challenge that it poses to current and future operations. I recently spoke to an EW expert who had an interesting point to make: just as the Vietnam War drove airborne EW requirements beyond the bomber force and into fighters and helicopters, so the current operations in Afghanistan and Iraq have generated unprecedented requirements for what some are calling "ubiquitous ground EW."

What specifically is "ubiquitous ground EW?" It's not the same concept as "traditional EW" (i.e., the airborne EW that most people envision when they think of "EW") It's not "networked ground-based SIGINT" either. It is "cheaper, quicker and dirtier" than these types of solutions. The concept is primarily defined by large numbers of small, inexpensive, communications-band EW systems that are connected via the tactical battle network. Being inexpensive and lightweight, they can be widely deployed on most of the UAVs, ground vehicles and soldier radios in the battlespace. At the soldier or squad level, these systems can rapidly detect and defeat an IED down the street or simply provide a general picture of communications activity the next village or the next city block. For the soldier this means unprecedented RF situational awareness and protection. He doesn't have to be an EW expert. He only has to be able to read emitter information on his digital map display. For the ground commander, the information from these networked "EW nodes" can be fused to provide a valuable real-time RF picture of the battlespace that complements his signals intelligence.

Although "ubiquitous ground EW" may sound like it's a long way off, the DOD is already taking steps toward realizing this concept through efforts, such as the Army's anticipated $850 million Integrated EW System (IEWS) program. Under the CREW 3.3 technology program, the Navy wants to develop similar capabilities for its newest family of IED jammers. For the ground soldier who faces an ever growing list of RF threats, these capabilities cannot arrive soon enough.

– John Knowles

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message
from the president

EW "DOWN UNDER" – A SOVEREIGN AFFAIR

As I write this month's message, the sun is setting on the beautiful city of Adelaide in South Australia. I am enjoying a wonderful glass of 2006 Shiraz Cabernet Sauvignon from the Bremerton winery which is located in the Adelaide Hills to the north of the city. This full-bodied, passionate wine reminds me of the wonderful people I met during my attendance at the Australian EW and IO Convention 2010. Indeed, I was impressed with the passion and commitment the Old Crows "down under" showed in every aspect of their convention. My congratulations to Ian Hoskins (Chapter President), John Teager (Committee Chair) and the rest of the Directors of our Australian chapter – it was a fantastic event!

Our Australian Crows embody the strength, character and criticality of our AOC chapters around the world. As was apparent at this conference, Old Crows worked together to provide an educational and professional development forum, which highlighted the electronic warfare issues and concerns in their part of the world. One such concern grabbed my attention this week.

In 2009, the Australian Defence Force (ADF) released a document entitled the Defence Capability Plan (DCP). The DCP outlined a plan in which the Australian government would leverage commercial-off-the-shelf (COTS) and military-off-the-shelf (MOTS) technologies to maximize rapid technology insertion and reduce non-recurring development costs. The government's approach is certainly understandable and prudent in a fiscally constrained environment. However, the question raised by the Old Crows in Adelaide was related to the efficacy of indigenous EW suppliers under such a strategy.

The reality is that there are a number of current major ADF EW programs coming to a close in the next year; programs such as Echidna and Wedgetail. When you combine an ADF preference for COTS/MOTS procurement, the lack of new EW programs and the closure of existing major EW programs, there appears to be a significant shortfall of future work to sustain the Australian EW industry. The likely outcome is that the indigenous EW industrial capability and technical expertise will decline as resources are lost altogether or sent to other EW suppliers such as those in the US, UK, France and Israel. Either scenario would result in a strategic loss that will take years to recover.

This brings me to the "culminating point" of this message. In the Information Age, the availability of the electromagnetic spectrum (EMS) must be considered a core national security issue and the ability to attack and control the EMS is clearly the mission of electronic warfare professionals and their capabilities. EW operational and technical expertise cannot and should not be delegated to the will of other nations. I posit that EW capabilities must be supported by sovereign means in order to ensure they are responsive and shaped to national security needs. Sovereign EW capability is an operational imperative in the Information Age; without it, you are at the mercy of others.

– Chris Glaze

the monitor
news

ARMY PROPHET NEARLY OPERATIONAL

The US Army's new wheeled vehicle-mounted Prophet Enhanced signals-intelligence (SIGINT) system will achieve its First-Unit-Equipped milestone in "the very near future," said an Army program official. LTC James Ross, Product Manager-Prophet under the Program Executive Office for Intelligence, Electronic Warfare and Sensors (PEO IEWS) at Ft. Monmouth, NJ, told *JED*, "Brigade combat teams that will deploy overseas this year are currently undergoing New Equipment Training with the 10 systems that have been delivered."

The Army awarded General Dynamics C4 Systems (Scottsdale, AZ) a six-year indefinite delivery-indefinite quantity contract for Prophet Enhanced in February 2009. The first vehicle rolled off the production line last December.

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 systems from L-3 Linkabit (San Diego, CA) in 2007. 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. A key design goal for Prophet Enhanced is an open-system architecture that can be readily upgraded by incorporating new software applications – instead of adding new hardware boxes to the vehicle – to keep pace with changing threat signals of interest.

The first Prophet Enhanced vehicles being delivered are housed in the Army's new blast-resistant Panther wheeled 6x6 Medium Mine-Resistant Vehicle (MMPV), a rapidly deployable command-and-control vehicle built by BAE Systems (York, PA). The Army considers the Panther-mounted systems, 18 of which it has ordered, to be a Quick-Reaction Capability, Ross said. "We're having ongoing discussions as to the final vehicle type for Prophet Enhanced," he noted. "The Army desires that all of its Prophet Enhanced

US ARMY ISSUES CIRCM DRAFT RFP

The US Army has released a draft request for proposals (RFP) for the Technology Demonstration (TD) phase of the Common Infrared Countermeasures (CIRCM) program. Under CIRCM, the Army wants to develop an inexpensive, lightweight, laser-based directed IR countermeasures system that can defeat current and future IR-guided missiles. CIRCM could be installed throughout the Army's fleet of rotary- and fixed-wing aircraft, as well as Army special operations helicopters. It may also be installed on several types of Navy, Marine Corps and Air Force aircraft.

The Army plans to award two cost-plus-fixed-fee contracts for the 21-month TD phase of the program. Each contractor will be required to deliver 12 CIRCM B-kits, (line replaceable units and weapons replaceable assemblies) within 10 months of contract award. The contractors will also deliver an A-kit (platform installation kit including wiring and antennas) for a UH-60. Weight is an important factor in the program. The Army wants each CIRCM B kit to weigh no more than 85 lbs and each A kit to weigh no more than 35-70 lbs (depending on the aircraft type).

At least three teams are expected to bid for the CIRCM program. ITT Electronic Systems is teamed with Lockheed Martin Aculight. BAE Systems has reportedly teamed with Raytheon Missile Systems. Northrop Grumman has teamed with longtime DIRCM partner Selex Galileo. Army program officials are encouraging small business participation in the program via subcontracts with prime contractors.

Program officials will host an industry day on or about May 21, and a final RFP is expected shortly afterward. The program point of contact is Ms. Eddie Whitfield, (256) 955-6299, e-mail eddie.whitfield@us.army.mil. The solicitation number is W58RGZ-10-R-0129 and can be accessed at www.fbo.gov. – *J. Knowles* systems be integrated into an MRAP- [Mine-Resistant Ambush-Protected] type vehicle." One likely candidate is the new 4x4 MRAP-All Terrain Vehicle (M-ATV). MRAP vehicles are a family of heavily armored wheeled transports with V-shaped hulls that are designed to survive IED attacks. The Army no longer plans to mount some of the Prophet Enhanced systems on an up-armored Humvee.

Ross said the Army has not decided on the final number of Prophet Enhanced vehicles it will buy. (Previously, the Army anticipated buying up to 50 systems.) In addition, the service has not decided whether to upgrade its 120+ existing Prophet Spiral 1 systems to the Prophet Enhanced configuration or to replace them with new PE variants.

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 forwarded to brigade intelligence elements. A major capability added in the PE configuration is satellite beyond-line-of-sight communications on the move, which will be provided by the Army's new WIN-T (Warfighter Information Network-Tactical) communications system.

General Dynamics' principal subcontractors are L-3 Linkabit and Northrop Grumman Information Technology (Chantilly, VA). – *G. Goodman*

NEW US NAVY COMINT SYSTEM IN PRODUCTION

Following successful development and operational testing and a favorable Milestone C decision by Defense Department officials, the US Navy's latest shipboard tactical communications intelligence (COMINT) system has entered low-rate initial production (LRIP). The service awarded Argon ST (Fairfax, VA) a $36.9 million contract option on April 11 to begin producing the Ship's Signal Exploitation Equipment (SSEE) Increment F system, which is scheduled to achieve an initial operational capability in the fall of 2011.

SSEE Increment F builds on Argon ST's predecessor system, SSEE Increment E, which has been installed on most US Navy surface combatants since 2003 to replace an array of legacy shipboard COMINT systems. SSEE Increment E marked a fundamental shift away from a custom hardware-centric approach with block upgrades to a software-based approach for readily inserting new or improved capabilities into the system. Increment E's open-system hardware architecture, which uses commercial-off-the-shelf digital receivers and signal processors, hosts different software applications to perform COMINT functions against threat signals of interest in particular frequency bands.

SSEE Increment F leverages Increment E by facilitating software upgrades and offers improvements in receiver sensitivity, signal acquisition and direction finding, as well as dynamic range. A key thrust of Increment F's development has been a net-centric capability that allows afloat Increment F sensors on dispersed ships to be linked in a secure network by which they can pass data and coordinate their efforts. Increment F also can be operated remotely by Navy cryptologists at other locations not on the ship. – *G. Goodman*

USAF COMPETES HARM UPGRADE

The US Air Force's Air Armament Center at Eglin AFB, FL, plans to award sole-source contracts to Raytheon Missile Systems (Tucson, AZ) and Alliant Techsystems' (ATK's) Advanced Weapons Division (Woodland Hills, CA) for a limited competition to perform a guidance upgrade for the service's AGM-88 High-Speed Anti-Radiation Missiles (HARMs). The supersonic AGM-88 HARM, built by Raytheon and no longer in production, has been used for the lethal suppression of enemy air defenses (SEAD) mission since 1984. It is used by the US Air Force and US Navy, as well as the air forces of several European, Middle Eastern and Asian countries.

HARM, typically fired by dedicated strike aircraft in advance of attack aircraft, homes in on an air defense radar's emissions, following them back to their source. HARM's major drawback is that it can lose guidance if the target radar stops transmitting. Thus, both the Navy and Air Force have long desired giving HARM a capability to attack non-radiating radar systems.

The Air Force's planned low-cost HARM upgrade, which the service calls the "HARM Control Section Modification," was developed by Raytheon over the past several years under the name "HARM Destruction of Enemy Air Defenses (DEAD) Attack Module," or HDAM. To provide competition for Raytheon, the Air Force is bringing in ATK, which currently is modifying the Navy's HARMs more extensively under the Advanced Anti-Radiation Guided Missile (AARGM) program. The Air Force has allocated $62.9 million for the HARM Control Section Modifi-

cation program over the period FY2010-FY2013, according to FY2011 budget request documents.

The Air Force's HARM Control Section Modification upgrade will retain HARM's existing front-end guidance seeker section with its anti-radiation-homing (ARH) receiver, as well as the missile's warhead, wings, rocket motor and fins. Its key improvement is the addition of a GPS guidance capability to HARM's mid-body control section, along with an upgrade to the control section's Inertial Navigation System (INS), which will increase accuracy. This will allow HARM to strike non-radiating targets with precision via GPS, including radars that shut down as HARM homes in on their emissions, as well as high-value non-air-defense targets whose coordinates are known.

The Air Armament Center solicitation said the Air Force plans to award Raytheon and ATK each a limited production contract. The companies will be required to deliver two engineering evaluation units, one six months after contract award and the other four months later. These will be followed by five modified HARM control sections 12 months after contract award for a six-month performance verification. Subsequently, the Air Force plans to award two full-rate production lots, apparently to the company offering the lowest cost, totaling about 500 modified HARM control sections.

The Navy has pursued the AARGM program, a more substantial modification effort by ATK to give its existing HARMs the ability to destroy non-emitting targets. The Navy is not only upgrading the HARM's control section with new GPS/INS subsystems, (similar to HDAM), but also is replacing the missile's seeker section completely.

JCREW 3.3 MOVES FORWARD

The two companies competing to build the Joint Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (JCREW) 3.3 family of mounted, dismounted and fixed-site jammers with common components both successfully completed a Preliminary Design Review in March. US Naval Sea Systems Command (NAVSEA) subsequently awarded ITT Force Protection Systems (Thousand Oaks, CA) and Northrop Grumman Space and Mission Systems (San Diego, CA) two-month follow-on contracts in early April that will support completion of their Critical Design Reviews. Following that milestone, NAVSEA plans to award each of the companies a contract six months later to build engineering prototypes for testing.

NAVSEA awarded the two contractors initial six-month JCREW 3.3 system development and demonstration contracts last October; ITT received $16 million and Northrop Grumman $24.3 million. The April contracts were for $31.3 million and $28.4 million, respectively. Key features of the 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 CREW Program Office (PMS 408) at NAVSEA is the DOD's executive agent for developing common ground-based CREW systems for the joint military services. The latest JCREW systems being procured by PMS 408 based on existing technology are JCREW 3.1 (dismounted) and JCREW 3.2 (vehicle-mounted). Sierra Nevada Corp. (Sparks, NV) won the 3.1 competition last June. Competing for the JCREW 3.2 contract are Sierra Nevada, Northrop Grumman Space and Mission Systems, ITT Advanced Engineering and Sciences (Annapolis Junction, MD) and SRCTec (Syracuse, NY). – *G. Goodman*

The new multi-mode guidance section features a more sensitive ARH seeker with a digital receiver and an active millimeter-wave radar seeker. The latter, coupled with the GPS, is used for terminal guidance when a radar target shuts down after missile launch or to destroy other non-emitting high-value targets.

AARGM entered low-rate initial production in January 2009 and is slated to become operational on F/A-18C/D Hornet fighters this fall. The Navy, which originally developed HARM, has planned to convert 1,750 of its more than 5,000 missiles to AARGMs. – *G. Goodman*

USAF AIR-LAUNCHED DECOY OPERATIONAL

Raytheon Missile Systems (Tucson, AZ) reported March 31 that it had delivered enough new Miniature Air-Launched Decoys (MALDs) to the US Air Force to allow Air Combat Command to achieve a planned "required assets available" operational milestone. MALD entered low-rate initial production in June 2008.

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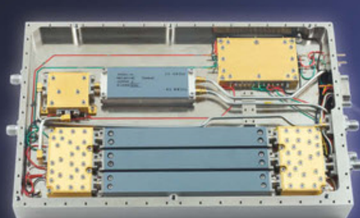

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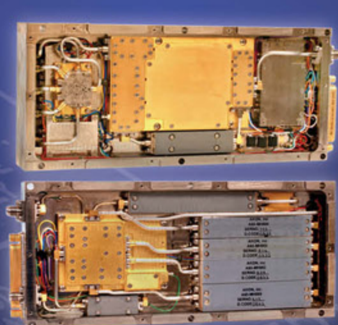

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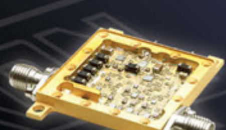

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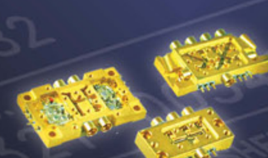

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MALD, a cruise missile-like, expendable maneuvering decoy, is 9.5 feet long, 9 inches in diameter and weighs less than 300 pounds. Powered by a turbojet engine, it flies a preprogrammed flight path into hostile air space and mimics the combat flight profiles and radar signatures of US strike aircraft to distract and confuse enemy air defenses. MALD has a range of 500 nautical miles. The decoy successfully completed 33 of 35 flight tests on F-16 fighters and B-52 bombers.

The Air Force is developing a follow-on version of MALD called MALD-J that adds a small radar jamming payload to the decoy. MALD-J will have the same attributes as the basic MALD but, more important, will also provide key close-range "stand-in" jamming of enemy air defense radars. – *G. Goodman*

P-3C REPLACEMENT ON TRACK

The first US Navy P-8A Poseidon test aircraft touched down at the Naval Air Station Patuxent River, MD on April 10 following six months of flight testing at Boeing's Seattle, WA, facilities. It will be used to evaluate the P-8A's airworthiness and expand its flight envelope. Two more test aircraft will arrive at Pax River later this year and will focus on missions systems and weapons system testing. The P-8A is slated to replace the Navy's aging P-3C Orion maritime patrol and reconnaissance aircraft, with an initial operational capability scheduled for 2013. The Poseidon is a derivative of Boeing's Next-Generation 737-800 commercial airliner.

The company won the aircraft's system development and demonstration contract in 2004. The Navy plans to buy 117 P-8As to replace its fleet of P-3Cs. The Poseidon will be a long-range anti-submarine warfare, anti-surface warfare and intelligence, surveillance and reconnaissance aircraft capable of broad-area maritime and littoral operations. It will be complemented by the Navy's planned Broad Area Maritime Surveillance (BAMS) unmanned aerial vehicle, a derivative of Northrop Grumman's large high-altitude Global Hawk. – *G. Goodman*

IN BRIEF

Andy Humen has been promoted to the position of Vice President of Cobham Sensor Systems. He is responsible for Cobham's sensor and microwave electronics and microwave components business units in San Diego, CA; Richardson, TX; San Jose, CA; Lowell, MA; Roanoke, VA; Milton Keynes, UK; and Lansdale, PA. Humen previously served as Cobham's Vice President for the Sensor Electronics operations in Lansdale, Baltimore, MD, Bolton, MA, and Largo, FL, and prior to that was the Director of Advanced Technology for Cobham Sensor Systems.

SRCTec, Inc. (Syracuse, NY) received a $94.4 million contract on April 1 from the US Army for the procurement of 3,239 urgently required Duke V2 IED jammers. Estimated completion date is December 31, 2010. This is the third Duke V2 contract SRCTec has received since August 2009.

Lockheed Martin (Syracuse, NY) received a sole-source indefinite delivery-indefinite quantity contract from the US Navy on March 16 to supply vehicle-mounted Symphony IED jammers. With an initial task order valued at $40.8 million, the contract runs through September 2014 and has a ceiling value of $940 million. The Symphony systems are US Government-approved for purchases through the Foreign Military Sales program to allied, coalition and partner nations for operations in Iraq, Afghanistan and other countries. Lockheed Martin has delivered more than 1,000 systems since 2006.

Defense Support Services (DS2) (Greenville, SC), a joint venture between Lockheed Martin and Day & Zimmermann, received a $96 million contract from the Air Force Aeronautical Systems Center at Wright-Patterson AFB, OH, to provide support for the service's Large Aircraft Infrared Countermeasure (LAIRCM) system produced by Northrop Grumman and mounted on C-17 and C-130 transports.

Kilgore Flares Co. (Toone, TN), a subsidiary of the UK's Chemring Group PLC, received a $30.9 million order from the US Air Force for the supply of MJU-39 and MJU-40 expendable flare decoys, which are used on the F-22. The company also received a $27 million Air Force order for ALA-17/C expendable flares for the B-52 bomber. The two-year contract has a ceiling value of $49 million. In addition, Kilgore was awarded a $20.4 million contract option from the US Army for M206 and MJU-7A/B flares to be delivered by November 30, 2011.

ARMTEC Countermeasures Co. (Coachella, CA) also received a similar $23.4 million contract option from the Army for M206 and MJU-7A/B flares.

US Special Operations Command (MacDill AFB, FL) has released a request for information for mature SIGINT systems capabilities that are ready for fielding within 180 days from the date of order. Specifically, USSOCOM is interested in industry capabilities in tactical SIGINT receivers, tactical SIGINT antennas, SIGINT payloads for unmanned aircraft systems, signals processing, precision direction finding and geo-locating, net-centric SIGINT systems (to include mobile ad-hoc networking technology, secure mesh technology, secure high-speed wireless networking and data links), and all packaging and power management capabilities. Responses to the RFI are due by May 4. The point of contact is Gerald McGhee at 813-281-0560, ext. 304, or e-mail jerry.mcghee@socom.mil. The solicitation number is H92222-10-R-0024.

ITT (Amityville, NY) has received a $19.6 million contract option from the US Air Force to repair ALQ-161A radio-frequency surveillance/electronic countermeasures system components for B-1B bombers. The Warner Robins Air Logistics Center (Robins AFB, GA) is the contracting activity.

BAE Systems Integration (Austin, TX) received a $6.7 million contract from Naval Air Systems Command for non-recurring engineering associated with the production and integration of 600 new CPU/circuit card assemblies (CCA) to replace the current ALE-47 expendable countermeasures dispenser's programmer CPU/CCA for various aircraft. The estimated completion date is December 2012.

ManTech International Corp. (Fairfax, VA) has received a $40 million ID/IQ contract from the Naval Surface Warfare Center Indian Head (MD) Division to provide engineering and program management support, including studies and analyses on electronic warfare and related systems. The contract covers one base year and four option years.


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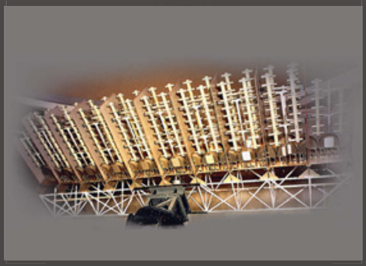

washington report

EW TASK FORCE REPORT DUE SOON

In prepared testimony before the House Armed Services Committee's Subcommittee on Terrorism, Unconventional Threats and Capabilities on March 23, Zachary Lemnios, the DOD's Director of Defense Research and Engineering, noted that he had established an Electronic Warfare (EW) Technology Task Force last year. It was one of a number of short-deadline, fast-ramp studies he launched after initial meetings with the combatant commanders and the Joint Staff. He charged each study with developing a thorough understanding of emerging threats and technical challenges and recommending capability concepts to mitigate the challenges.

"I chartered the EW Technology Task Force in response to concerns that a common denominator among current and potential adversaries is a determined strategy to expand capabilities in the electromagnetic spectrum domain for offensive and defensive purposes. The mission of the EW Technology Task Force is to assess the military implications of the ubiquitous availability of high-performance analog, digital, electro-optical, radio-frequency and signal components, high-performance signal and data processors, and an increased ability to create sophisticated algorithms that will enable these systems.

"The trend is clear," he noted. "The globalization of advanced electronic technology has made it easier for adversaries to develop effective EW capabilities, especially in a domain that is becoming increasingly congested by commercial competition for use. Additionally, we are seeing the convergence of underpinning technologies in areas such as space, cyber, electronic warfare and communications – areas traditionally considered to be independent."

Lemnios told the House members, "We must not only develop new concepts and capabilities to control and dominate the electromagnetic spectrum domain, but we must also be equally agile in fielding those capabilities. Success is crucial to the effectiveness of our forces. The EW Task Force findings are a first step in helping us identify potential solution paths."

Lemnios told an industry symposium last month that the EW Technology Task Force's report "is due shortly, and I intend to recommend funding increases in new concepts and capabilities to control and dominate the electromagnetic spectrum." – *G. Goodman*

NEW EXPORT CONTROL REGIME PLANNED

In a major speech on April 20, Defense Secretary Robert Gates told members of Business Executives for National Security that the US export control system is severely flawed and the Administration is poised to implement needed reforms. The Cold War-era regime no longer adequately protects crucial US technologies, he said, and makes it extremely difficult to quickly share needed equipment, including even parts, with allies and partners. "The current arrangement," Gates said, "fails at the critical task of preventing harmful exports while facilitating useful ones."

Providing an example, he noted, "Today, the US government reviews tens of thousands of license applications for export to EU and NATO countries. In well over 95 percent of these cases, we say 'yes' to the export. Additionally, many parts and components of a major piece of defense equipment require their own export licenses. It makes little sense to use the same lengthy process to control the export of every latch, wire and lug nut for a piece of equipment like the F-16, when we have already approved the export of the whole aircraft. We need a system that dispenses with the 95 percent of 'easy' cases and lets us concentrate our resources on the remaining 5 percent."

Gates proposed a new tiered approach to export control that he said would allow the US to build higher security walls around truly critical technologies while lowering the walls around others. A major shortcoming of the current system, Gates said, is that it does not differentiate among crucial and non-crucial technologies.

The secretary outlined a number of recommendations that grew from a study President Barack Obama directed last summer. "Our plan relies on four key reforms: a single export-control list [one is currently maintained at the State Department and one at the Commerce Department], a single licensing agency, a single enforcement/coordination agency and a single information technology system," he said. "The single list, combined with a single licensing agency, would allow us to concentrate on controlling those critical technologies and items – the 'crown jewels' – that are the basis for maintaining our military technology advantage, especially technologies and items that no foreign government or company can duplicate," Gates said. The single licensing agency would have jurisdiction over both munitions and dual-use technologies, streamlining the licensing process.

It is not clear how the reforms introduced by Secretary Gates will affect the process and policy regarding EW exports. Some US EW manufacturers have criticized the military equipment export apparatus as slow, bureaucratic and overly restrictive, which sometimes prevents their ability to pursue opportunities. These companies have expressed hope that the reforms will eventually lead to better guidelines for EW exports.
– *G. Goodman and J. Knowles*

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world report

AUSTRALIA SELECTS EW FOR DESTROYERS

Australia's Defense Minister, Greg Combet, has announced that the Royal Australian Navy has selected ITT Electronic Systems to supply the EW systems on its Hobart-Class Air Warfare Destroyers.

ITT's Reconnaissance and Surveillance Systems business in Morgan Hill, CA, will supply its ES-3701-02S radar ESM system. ITT's teammate, Southwest Research Institute (San Antonio, TX), will supply its MBS-567A communications ESM system. ITT is also working with two local firms, Jenkins Engineering Defence Systems (Matraville, New South Wales) and Ultra Electronics Avalon Systems (Mawson Lakes, South Australia). According to Combet, Avalon will upgrade its digital receiver and integrate it with the CS-3701 system. Jenkins will provide its low-band receiver as part of the communications ESM portion of the system. It will also provide land-based testing of the complete EW system and manage system installation and testing on the ships.

The contract, valued at AUS$30 million (US$27.7 million), calls for EW systems for the three Hobart-Class destroyers (a variant of the Spanish F105 frigate) that the Royal Australian Navy is building at BAE Systems Australia. The first ship is scheduled to enter service in 2014. In late 2008, the destroyer project awarded an AUS$5 million contract to Terma A/S to provide its Mk 137 Soft Kill Weapon System (SKWS) trainable decoy launcher, which will be integrated with the EW system.

ITT's bid was selected in competition against Thales, Elisra and Indra. The contract could lead to additional business. The Royal Australian Navy may designate the Hobart-Class EW suite for its two *Canberra*-Class landing helicopter dock (LHD) amphibious assault ships in the near future, and it may build a fourth Hobart-Class destroyer. – *J. Knowles*

UAE SELECTS EW FOR FALAJ 2 CORVETTES

The United Arab Emirates' new stealth corvettes, being built by Fincantieri shipbuilding company under the "Falaj 2" program, will be equipped with a similar EW suite to those being installed or procured for the *Abu Dhabi* ASW corvette class and the retrofit of *Mubarraz* and *Murajib* fast patrol boats in service with the United Arab Emirates Navy.

Characterized by a new design, featuring advanced low-observable characteristics, including shaped superstructures, an enclosed mast system incorporating the main multifunctional radar, conformal antennas and retractable weapon systems launchers, the 500-ton, 55-meter vessels will feature an armament encompassing a 76/62 mm Super Rapid gun, four anti-ship MBDA Exocet missiles and six vertically-launched MBDA MICA-VL surface-to-air missiles.

The vessels will feature the IPN-S combat system from Selex Sistemi Integrati and an EW suite comprising an Elettronica Seal-L ESM system and two Rheinmetall Multi-Ammunition Softkill System (MASS) chaff and flare decoy systems. The UAE Navy has ordered two stealth corvettes to be built in Italy with deliveries scheduled for the second half of 2012. The contract also includes an option for two additional vessels and a technology transfer agreement to construct and support these vessels at a local shipyard. – *L. Peruzzi*

MULTIFUNCTION AESA DEMONSTRATOR PROGRAM CONTINUES

Italian and Swedish defense officials have agreed to jointly fund the third phase of a three-phase Multi-role Active Electronically Scanned Antenna (M-AESA) program that will demonstrate a multifunction phased array system for airborne, naval and ground applications. During the third phase, an industrial team, led by Selex Sistemi Integrati and including Saab and Elettronica, is scheduled to begin development of a demonstrator unit in the last quarter of 2010.

The M-AESA program objective is to develop and demonstrate an ultra-wideband system that can perform radar and EW functions as well as communications. From this research, engineers at the companies will gain a better understanding of the technologies and the scalable system architecture required for an operational M-AESA. Phase 2 work has focused on development of a new system architecture for multifunction systems and a generic and multi-application building blocks for future M-AESA products, in addition to defining the Phase 3 system demonstrator.

Compared to existing federated systems, the M-AESA concept could offer better coordination between radar and EW functions on an aircraft or a ship and provide significantly improved overall situational awareness at lower operation and maintenance costs. The use of a scalable and open architecture should make upgrades quicker and less expensive.

The consortium, together with the Swedish and Italian MODs, has established a preliminary program plan to design, manufacture and evaluate a Phase 3 demonstrator, with development to start in the last quarter of 2010 and continue through 2014. – *L. Peruzzi and J. Knowles*


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European EW

Governments continue their investment in EW, while balancing the need for quick upgrades to support the war in Afghanistan

By Luca Peruzzi

Operations in Afghanistan are driving new EW and SIGINT spending among NATO forces. This is leading many European nations to equip their deploying aircraft and ground vehicles with EW equipment tailored for irregular warfare, such as missile warning systems, directed IR countermeasures systems, new flares and RCIED jammers. These urgent EW programs represent a small part of the total defense spending Europe is allocating for Afghanistan operations. So far, this priority spending has not seriously impacted EW acquisitions for more conventional platforms, such as fighter aircraft and ships. With Afghanistan operations showing few signs of slowing, however, it remains to be seen how long European governments can sustain this balancing act in their EW and SIGINT modernization plans.

ROTARY WING

In Afghanistan, helicopters and low-flying fixed-wing aircraft are operating in a threat environment that includes shoulder-launched IR-guided missiles, as well as small-caliber weapons and RPGs. While none of these threats are new to aircraft, the EW industry is coming up with new solutions for them.

In February, the UK Ministry of Defence (MOD) awarded Selex Galileo a four-year contract to pursue its Common Defensive Aids System Technology Demonstration Program (CDAS TDP). The goal of this program is to provide a coherent, cross-platform approach to the acquisition and support of survivability equipment for legacy and new-build helicopters across UK forces. The CDAS TDP will develop an open-architecture approach with standardized interfacing for a range of EW subsystems, encompassing missile warners, DIRCM (Directional Infrared Countermeasures) and Hostile Fire Indicators (HFI).

The DAS controller and architecture will be developed from the Aircraft Gateway Processor (AGP) manufactured by Selex Galileo. The company is supplying the AGP to Boeing (Mesa, AZ) for installation on Block II and Block III AH-64D Apache attack helicopters operated by the US Army, as well as international customers. A UK MOD variant of the AGP is also being installed on RAF Chinook and Puma helicopters, as part of a wider DAS upgrade program.

The AGP is derived from the company's Helicopter Integrated Defensive Aids Suite (HIDAS), which is in service with British Army's Apache WAH-64 Mk1, as well as Greek and Kuwaiti AH-64Ds. The HIDAS is scheduled to enter service (without laser warning) on AgustaWestland AW-159 Lynx Wildcat helicopters operated by the British Army and Royal Navy.

In the UK, Boeing Chinook HC Mk.2/3/3A, Puma, AgustaWestland Merlin HC Mk.3 and Commando Sea King helicopters are equipped with a multi-spectral suite of survivability equipment, including the Selex Galileo Sky Guardian 2000 RWR, BAE Systems AAR-57(V) Common Missile Warning System (CMWS), the Northrop Grumman/Selex AAQ-24(V) Nemesis DIRCM and the Thales Vicon 78 series 455 countermeasures dispensing system. A number of Royal Navy Merlin HM.1 helicopters have also been equipped with the AAR-57(V) CMWS, ALQ-157 IR jammer (also from BAE Systems) and ALE-47 dispensers from Symetrics.

Turning back to the CDAS TDP, the program will also incorporate the Selex/Northrop Grumman ECLIPSE Pointer Tracker and Type 160 Infrared Counter Measure (IRCM) laser, which has been designed for weight-sensitive and space-constrained platforms, such as attack helicopters. The ECLIPSE is also being proposed as part of the Northrop Grumman/Selex proposal for the US Army's Common IR Countermeasures (CIRCM) program, which is about to enter the bid phase.

The UK is also conducting trials to evaluate hostile fire indicator (HFI) solutions for helicopters. Leveraging its extensive expertise in acoustics, Roke Manor Research Ltd, together with Selex Galileo, has participated in the program with an HFI system that has successfully demonstrated the ability to provide warning and locate a wide range of gun calibers. BAE Systems and Thales also participated in the trials. Thales demonstrated its Elix-IR, a single-color IR missile warner that utilizes technology and algorithms developed for Typhoon's PIRATE infrared search and track system. The UK MOD is also interested in the Elix-IR's capability to provide a ground situational awareness while landing a helicopter in "brown-out" conditions.

French forces have also bought a variety of Thales equipment. Its EC-725 Caracal Combat Search and Rescue and Special Forces helicopters are equipped with the company's Sherloc-SF RWR and MWS-20 Damien active missile warner. The helicopters also feature the RALM 01/V2 laser warner from Selex Galileo and MBDA's ELIPS-NG countermeasures dispenser.

Over the past several years, Europe's largest multinational helicopter programs have been the NH-90 and the Tiger, which are in full-rate production today. Both aircraft are equipped with an EW suite comprising the Threat Warning Equipment (TWE) RWR from Thales, which incorporates a laser warning function supplied by EADS, the AAR-60 MILDS UV missile warner from EADS and MBDA's ELIPS-HC countermeasures dispenser. The AAR-60 has been very popular among European customers over the past decade, and it has been installed on a variety of other helicopters, including Spanish Super Puma and Cougar helicopters and German Army CH-53Gs.

Like the UK, the Italian MOD has developed a common helicopter DAS, which it is also fitting to selected fixed-wing platforms. Designated as Sistema Integrato di Auto-Protezione (SIAP), the integrated DAS combines Elettronica's ELT-156X RWR, the AAR-60 MILDS II, Selex Communications' RALM 01/V2 laser warner and the ECSD-2 countermeasures dispenser from Italian manufacturer MES. SIAP is installed on Italian Army A129C Mangusta attack helicopters and CH-47C+ transport helicopters, which have used the system in Afghanistan. The DAS is also installed on the Italian Navy's amphibious support AB-212, SH-3D and EH-101 helicopters.

The Italian Air Force is soon expected to award a contract to AgustaWestland to acquire AW-101 CSAR/SAR helicopters. These will receive a DAS featuring Elettronica's ELT-750 ESM system and the company's ELT/572 fiber-laser directed IR countermeasures system, which was jointly developed with Elbit's El-Op subsidiary. The ELT-572 is undergoing flight qualifications in Israel this year, and production should begin soon, with first unit deliveries expected in 2012. The AW-101's EW suite will also include a missile warning system, a new RF jammer and a countermeasures dispenser, which have not been selected. The Italian Air Force is working with Elettronica to define the remainder of the AW-101's DAS by this summer. The Italian MOD is expected to award the production contract for the first batch of AW-101s later this year.

While many helicopter EW programs have focused on internal suites, Terma A/S and RUAG Aerospace have developed podded IR countermeasures solutions for users that want to quickly and easily transfer their EW suites from one helicopter to another. Terma's Apache Modular Aircraft Survivability Equipment (AMASE) features the AAR-60 missile warner, Terma's Advanced Countermeasures Dispensing Systems (ACMDS) and the company's ALQ-213(V) EW Management System. The Chinook Aircraft Survivability Equipment (CHASE) uses the same equipment plus the AAQ-24 DIRCM. Terma integrated both systems for the Dutch Army's AH-64 Apaches and CH-47 Chinooks, respectively. RUAG Aerospace has worked in partnership with Saab to develop the Integrated Self-Protection System (ISSYS) for helicopters. It incorporates Saab's IDAS/CIDAS suite, comprising the RWR-300 radar warner, the MAW-300 missile warner, LWS-310 laser warner and BOP-L countermeasures dispenser. ISSYS was initially sold as an internal suite to Switzerland, Sweden and Spain, where it was installed on AS 332 Super Puma and AS 532 Cougar helicopters together with the Swedish HKP-14 (NH-90). Slovenia has reportedly installed ISSYS on its Cougar helicopters in a podded configuration, which includes GPS navigation in addition to the EW suite.

FIGHTER EW

In July 2009, Eurofighter industrial consortium and NETMA (NATO Eurofighter and Tornado Management Agency) signed the €9.1 billion contract for the Tranche 3A lot production of 112 Typhoon aircraft, with deliveries planned between 2013 and 2017. Today, Germany, Spain, Italy, the UK (the four original Eurofighter nations) and Austria, are employing the Typhoon in air-defense, superiority and escort missions. The Royal Air Force also operates its Tranche 1 Lot aircraft in an air-to-ground role.

The Eurofighter consortium is currently delivering Tranche 2 aircraft, which also includes 72 Royal Saudi Air Force aircraft. The Eurofighter's Praetorian EW suite comprises an ESM system, an active missile warner, an RF jammer and a fiber-optic towed decoy dispenser. The Praetorian suite is complemented by other Defensive Aids Subsystem elements, such as a laser warner, countermeasures dispensers and a Defensive Aids Computer (DAC). The suite is manufactured by a EuroDASS consortium of four EW companies: Selex Galileo, Elettronica, Indra and EADS. To date, it has delivered about half of the contracted Tranche 2 Lot Praetorian suites.

According to the EuroDASS consortium, Tranche 3 aircraft ESM/ECM suite enhancements are currently focused on obsolescence issues. However, the program is looking to add new capabilities to the Eurofighter fleets, including a new digital receiver, new RF jammer antennas and real-time data networking between platforms.

In France, the Rafale combat aircraft has already conducted operational deployments to the Afghanistan theater of operations. In July 2008, the French MOD certified the latest F3 aircraft version, which includes an enhanced Spectra electronic warfare system, developed by Thales Airborne Systems and MBDA France. The former is responsible for system integration and provision of the RWR, RF jammer and LWS subsystems, while MBDA France supplies the CMDS and the IR MWS. As a "form, fit and function" replacement for current model (DDM), the MWS will be delivered for F3 Lot aircraft in the recently unveiled DDM NG version, incorporating a new infrared array detector that offers improved detection range and false-alarm rejection. It also provides angle-of-arrival information, which helps with flare dispensing and potential DIRCM upgrades in the future.

Since late 2007, Saab has been working on the Gripen NG (Next Generation) program, which aims to develop a series of improvements both as a new production standard and as upgrades for existing operators, which include Sweden, the Czech Republic, Hungary, South Africa and Thailand (from 2011). According to Saab, the highly integrated Gripen NG EWS will encompass a digital RWR to improve system sensitivity and detection of LPI radars, as well as an interferometer capability for better emitter geo-location. Other improvements will include an advanced missile warning capability, as well as a laser warner. The active segment will include an internal DRFM-based AESA jammer (plus an option for a pod-mounted solution), a towed radar decoy and a countermeasures dispenser.

Among Europe's legacy fighters, several countries are upgrading their Tornado aircraft, with a goal of keeping them in service through at least 2025. Last month EADS delivered Tornado cockpit and EW upgrades to the Luftwaffe under the joint German-Italian Avionics Software System Tornado Ada (ASSTA) program. Focused on improving the Tornado's cockpit displays and improving aircraft survivability, the upgrade includes an improved Tornado Defensive Aids Subsystem (TDASS) based on Saab's BOW-21 RWR/ESM, an integrated DAC, the Tornado Self-Protection Jammer from EADS and Elta and Saab's BOZ dispenser pod.

Since 2007, the Italian Air Force has been working on a program to develop and evaluate a new ESM capability for its Tornado IDS/ECR aircraft. Developed by Elettronica in close partnership with Italian Air Force Headquarters and the EW operational support office, it is based on the company's ELT/750 ESM and ELT/553 jamming source unit. In 2009, the new suite successfully underwent in-house testing. The system is awaiting full-scale evaluation and production authorization in 2010, in order to fit within the Air Force's airframe and avionics modernization program.

In partnership with Alenia Aeronautica, Selex Communications and Raytheon-Deutschland, the Italian Air Force is also adding the MSR (Multi-Ship Ranging) capability to Tornado ECRs, allowing the geo-location of emitting threats. This is enabled by the addition of the Link 16 Multifunction Information Distribution System – Low Volume Terminal (MIDS-LVT), which provides data sharing and real-time data fusion between Tornado platforms. In parallel to this, the Italian Air Force is improving its SEAD capabilities through its participation in the AGM-88E Advanced Anti-Radiation Guided Missile (AARGM) program, which has reached the production phase and also includes MBDA in Italy.

Indra Sistemas has been supporting the Spanish Air Force's EF-18 mid-life upgrade by developing an integrated EW suite encompassing its ALR-400 RWR, ASQ-600 ESM system and the ALQ-500 DRFM-based jammer. Indra has also proposed an integrated DAS for the Spanish Air Force's C-295 transport and special mission aircraft, comprising its ALR-400, the AAR-60 and a countermeasures dispenser. The suite may also be used for other Spanish aircraft, such as the Mirage F-1, B-200, F-27 and C-101.

Turkey's Aselsan and MiKES are providing the EW suite for the company-modified RF-4E Phantom under the "Isik" program, which includes BAE Systems' ALQ-178(V)5+ RF EW suite and ALE-47 dispenser.

PLATFORM PROTECTION ENHANCEMENTS

The challenging operational scenarios encountered by European air forces in Iraq and Afghanistan have prompted urgent operational requirements for new protection suites to be installed onboard in service fighter and transport fixed-wing aircraft.

UK, German and Italian Tornado operators have selected Terma and Saab solutions for their requirements. The Luftwaffe deployed six Tornados to Afghanistan in 2008 for reconnaissance missions. These were equipped with Terma's Special Dispenser System (SDS) (MCP-8F) pods, which feature eight dispenser magazines controlled by the ALQ-213 EWMS in the cockpit.

Terma supplied more sophisticated solutions to BAE Systems for the Royal Air Force's Harrier GR.9 and Tornado GR.4 strike aircraft involved in operations in Afghanistan. Deployed in the theater from the second half of 2009, the RAF Tornado detachment was equipped with Terma's AIRCM (Advanced Infra-Red Countermeasures) pod. The pod integrates a six-sensor AAR-57 missile warner, eight countermeasures dispensers and the ALQ-213(V) EWMS. BAE Systems handles pod integration on the Tornados. A similar package, including Terma's MCP-H (MCP-8.2 variant) with five AN/AAR-57 CMWS sensor heads plus 5 CMDS magazines, was previously introduced on board Harrier GR.9 RAF/Royal Navy Joint Harrier Force aircraft, which have been operating in Afghanistan since 2008.

Also in 2008, the Italian Air Force launched a program to acquire an undisclosed number of Saab BOZ102EC pods in order to address an urgent operational requirement (UOR) for protection of its Tornado IDS fleet against IR MANPADS threats. The BOZ-102EC features Saab's CIDAS 100 (Compact Defence Aids Suite) suite, including an EW controller supporting a MAW-300 MWS in a four-sensors configuration and five BOP dispensers. Developed in a strong partnership between the Italian Air Force and Saab, the BOZ-102EC maintains the current aircraft interface and cockpit control panel, although with modified controls and indicators. After first deliveries last summer, followed by more systems contracted in December, the system has successfully completed its tactical evaluation and is ready for deployment in Afghanistan.

European armed forces have also been keen to equip or upgrade their fleet of transport, tanker and special mission aircraft with integrated EW suites that feature DIRCM systems. The Royal Air Force has fitted Northrop Grumman's AAQ-24(V) Large Aircraft Infrared Countermeasures (LAIRCM) system on board its C-130H/J and C-17 transport aircraft. The LAIRCM system is also planned for the RAF's Future Strategic Tanker Aircraft.

Terma has installed its AN/ALQ-213(V) EW management system on various European air force fleets of Hercules C-130s and Transall C-160s to control the DAS suite, based on the EADS AAR-60 MILDS II, ATK AAR-47 and Thales Airborne Systems MWS-20 Damien active MWS.

With the recent announcement that EADS will resume development of the A400M strategic/tactical airlift aircraft the development schedule for its EW suite is expected to be adjusted accordingly. As the A400M program allows the customers to choose the aircraft DAS, at least two new DIRCMs are planned for the aircraft program.

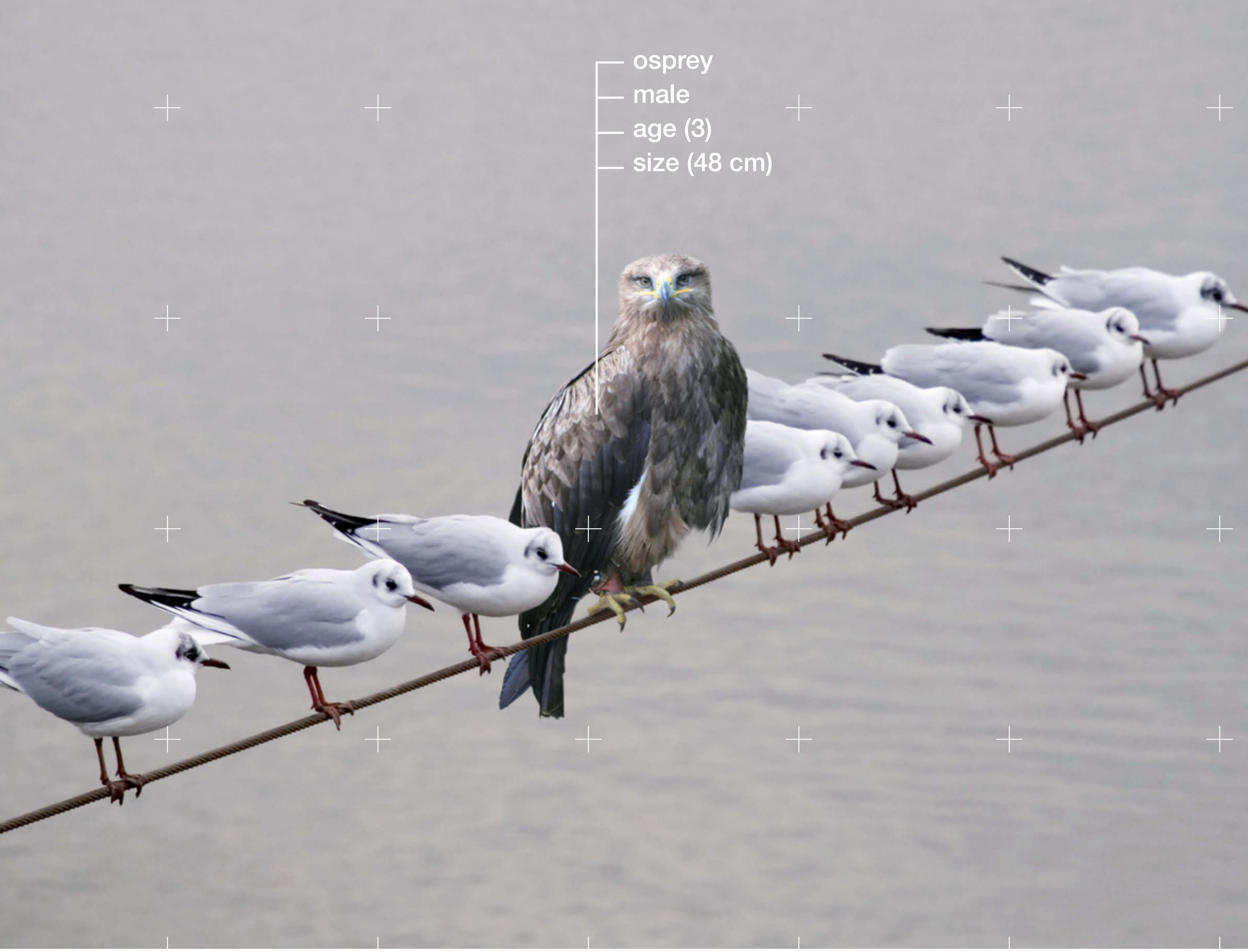
The Spanish Air Force opted for Indra Sistemas' MANTA DIRCM. Equipped with a relatively high-power chemical laser supplied by Russia's Rosoboronexport, the system has undergone flight trials on a CASA C-295 aircraft. It will also be installed on C-130 transports before it is finally installed on the A400M. The other A400M DIRCM solution is based on the FLASH (Flying Laser self-defence System Against IR Seeker Head) DIRCM. Under development by EADS, Thales, Sagem and Diehl, FLASH is based on active closed loop tracking technology that carries out threat confirmation, identification, jamming and defeat assessment. Having completed early development stages, the system requires full-scale activities to reach the evaluation and production phase and be installed beside other original A400M DASS elements, including the Indra and EADS co-developed ALR-400 RWR/ESM, Thales/EADS MIRAS (Multi-colour Infrared Alerting Sensors) bi-spectral MWS and MBDA Saphir-400 ACMDS.

Italian Air Force C-27J Spartan tactical transport aircraft are equipped with a DAS encompassing Elettronica's AR-3C RWR/ESM, the MILDS II (AN/AAR-60) MWS from EADS, the RALM 01/V2 LWS and the MES ECSD-2 dispenser with 14 magazines. The same suite has been selected by Lithuanian, Romanian and Bulgarian air forces for their C-27Js. The Italian Air Force is also working closely with Elettronica to equip its transport (C-130J and C-27J), future tanker (KC-767A) and maritime patrol (ATR-72MP) fleets with an enhanced DAS featuring the ELT/572 DIRCM.

STRATEGIC AND TACTICAL SIGINT PLATFORMS

France has become the first nation in Western Europe to develop a space-based SIGINT program. France's defense procurement agency (DGA), the French space agency (CNES) and aerospace companies have developed and tested electronic intelligence (ELINT) satellite demonstrators, paving the way for a future operational system named CERES, which is scheduled to enter service by 2016. Thales, together with EADS Astrium, supplies the ELISA (ELectronic Intelligence by Satellite), a constellation of four microsatellites (Myriade-series platform) to be launched and operated this year. The ELISA demonstrator employs the ES-SAIM concept of simultaneous acquisition of signals, short revisit times and simultaneous maneuvering capabilities, providing target detection and location of high-frequency emitters.

In Germany, EADS is developing the Euro Hawk with Northrop Grumman to replace the SIGINT-equipped Breguet Atlantic fleet. The two companies will deliver five Block 20-based Euro Hawk platforms to the MOD. The UAVs will be equipped with a new EADS SIGINT suite, including ELINT and COMINT capabilities. Unveiled in October 2009, the first


osprey
male
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Euro Hawk will reach service in 2011, with subsequent systems deliveries anticipated between 2016 and 2017.

After operating its Nimrod R.1 SIGINT aircraft for decades, the Royal Air Force has opted to retire its R.1 fleet and buy three KC-135R aircraft to be converted into RC-135V/W Rivet Joint SIGINT aircraft by L-3 Integrated Systems in the US. The RAF will retire its two remaining Nimrod R.1 aircraft next year and begin training its personnel to operate and maintain the Rivet Joint aircraft, which are scheduled to enter service in 2015.

In France, the Air Force is upgrading its two Transall C-160G Gabriel SIGINT aircraft. The modernization program covers both the aircraft avionics and the mission suite. Thales Airborne Systems was selected in September 2008 to upgrade the ELINT equipment, reportedly together with its sister Land and Joint Systems division, which will supply COMINT equipment. The first fully equipped aircraft are planned for delivery in December 2010.

The Italian MOD is pursuing the Joint Airborne Multi-sensor System (JAMMS) program to replace its single SIGINT G-222VS, which will be retired in 2012. The new platform is to be characterized by flexibility and interoperability within NATO and EU environments, able to conduct a wide range of operational missions, thanks to a sensor suite including ground surveillance synthetic aperture radar and electro-optical sensor payloads in a modular configuration. The Gulfstream G550 is the platform of choice, while industrial sources indicate the SIGINT companies interested in the program include Lockheed Martin MS2 and Elta. Although the estimated €280 million program was approved in 2009, its launch has been postponed for budget reasons.

Except for the Italian Air Force, which has been flying the General Atomics RQ-1 Predator since 2005 (and is soon to receive RQ-9 Reapers), other European air forces have only more recently acquired medium- or long-endurance unmanned platforms. The French Air Force has deployed the Harfang (Eagle) version of IAI's Heron, while the Turkish Air Force and Luftwaffe operate different versions. The British Army opted for the tactical Thales Watchkeeper (Elbit Systems Hermes 450-based), while the Royal Air Force chose the General Atomics MQ-9 Reaper. However, all the in-service platforms are equipped primarily with radar and/or electro-optical sensors for surveillance and/or targeting missions, although different European companies and customers are working on or showing interest in supplying the SIGINT payloads for these UAV programs.

At a tactical or higher level, maritime patrol and antisubmarine warfare aircraft are enlarging their range of activities encompassing over-the-horizon ESM and ELINT. To accomplish these demanding missions, Elettronica developed the ELT-800 ESM/ELINT system modular family. The Italian MOD is integrating the system into the ATR72MP maritime patrol aircraft, with deliveries beginning in 2012. Already selected for the UAE's new maritime patrol and surveillance aircraft, the ELT-800 suite is based on a superhet multi-channel digital receiver architecture, providing full radar warning, automatic electronic support surveillance/situational awareness, elec-

tronic intelligence (ELINT)-type analysis and data collection capabilities.

Thales Airborne Systems Vigile ESM system is, however, being promoted for the upgrading of the French Navy's Breguet Atlantique 2, while Saab is pushing for its HES-21 suite, already in service on the company's ERIEYE AEW&C platform, to form the basis of the dedicated Saab 2000 Airtracer SIGINT platform, which was recently unveiled.

NAVAL EW

The French and Italian navies have recently introduced into service the four Horizon Anti-Air Warfare destroyers and are building the first units of the joint FREMM frigate program. Both programs have installed or will install the advanced integrated EW system comprising Thales Airborne Systems' ESM system and a powerful solid-state DRFM applied ECM supplied by Elettronica. Managed by a dedicated EW controller, the EW system to be installed on board FREMM frigates features a smaller jamming antenna subsystem, based on Elettronica's NETTUNO-4100 jammer family.

The Italian Navy has recently awarded Elettronica a feasibility study to develop the basis of a new family of ESM systems, named ELT/225, to be introduced on board new vessels or to upgrade the ESM capabilities of older ships. Based on the naval SEAL ESM/ELINT family technology developments, which has been procured by the UAE navy for its Bynunah, Abu Dhabi and Falaj 2 stealth class corvettes, the feasibility study will look at ESM upgrades for legacy submarines, as well as new and legacy Italian Navy patrol vessels.

Thales has a long tradition of supplying naval ESM systems around the world, most recently selling its Vigile ESM systems to Oman, Morocco and Indonesia. Now the company is promoting its Vigile ESM family system in Europe for upgrade programs such as the Royal Netherlands Navy's M class frigate. Thales has recently unveiled Vigile LW, a new, light-weight naval radar electronic support measure (RESM) designed for smaller vessels.

With its family of ESM/ECM systems across the Royal Navy fleet, Thales UK is currently providing the RESM and DLS (Decoy launcher System) systems for the Type 45 class destroyers under delivery. In addition to the latest Outfit UAT ESM system, the Type 45 is equipped with the Outfit DLH decoy launcher system. Type 45 will also be equipped with a communications ESM suite provided by BAE Systems Insyste under the Shaman program.

Thales UK is leading the SubMarine Advanced RESM Technology (SMART) program, aimed to upgrade the in-service Royal Navy's legacy Outfit UAP RESM with a new open architecture, digital technology and COTS components. Thales is also proposing a complete range of communications ESM systems, based on the Q family products. Derived from Altesse (ALerT and Surface Ship Evaluation), the Naval CIEW (Communication Intelligence Electronic Warfare) family is based on a new generation of digital wideband receivers enabling the end-to-end digitized collection, exploitation and dissemination of communications ESM and COMINT information. The Spanish Navy has already selected Indra's RIGEL wideband ESM for its latest vessel program acquisition, including new BAM maritime patrol vessel and Juan Carlo I LHD.

In 2008, Saab was awarded its first export surface vessel contract to deliver and integrate SME 100 Radar ESM and laser warning on board the German Navy's mine countermeasures vessels. The SME 100 is part of the Saab ESM/ELINT systems family of surface/submarine SME/UME systems, and together with Germany's MEDAV COMINT specialist, has developed a combined ESM/ELINT and COMINT system for submarine applications, equipping the two Type 209PN submarines for the Portuguese Navy.

GROUND AND COUNTER-IED APPLICATIONS

The Iraqi and Afghanistan theaters, characterized by dense signal environments in urban areas and remotely controlled IEDs, has required new COMINT and EA capabilities down to the soldier level.

Under UK MOD's Project Seer, Roke Manor Research Ltd is delivering man-pack communications ESM and jamming systems for the British land forces. The scalable and networked man-pack solution provided by the company can be configured to meet specific operational requirements. Developed by Roke together with Thales UK addressing NEC requirements and Selex UK providing the electronic attack hardware, the SEER systems began delivery earlier this year to meet the urgent needs of forces deployed in Afghanistan.

Thales Land and Joint Systems has provided a complete suite of COMINT and jammer systems to the French Army, including Linx and SAEC (Station d'Appui Electronique de Contact) ground mobile equipment. This COMINT suite is widely used throughout Europe and around the world. Currently Thales is offering its "Q" family of TRC based receivers, direction finders and communications jammers that cover applications from high-power HF/VHF/UHF jamming to man-portable and vehicular communications and IED jamming. The company is working on a new TRC 6300 product, suitable for armored vehicle, shipborne or airborne applications, which is to be unveiled later this year.

Within the framework of ForzaNEC, the Italian MOD program to provide network enabling capabilities to its forces, Elettronica has been selected as design authority for EW. For the Italian MOD, the company has developed the prototype of a new family of COMINT equipment based on its ELT/332(V) system. The prototype has been successfully tested, and it is intended for delivery to the Italian Army's RISTA-EW Brigade.

Together with HF jammer systems delivered to the German and Netherlands armies and both systems being upgraded (already completed under the German Army's KWS RMB program), Elettronica GmbH has delivered eight ELINT (ELT/889 based) mobile suites and one trainer. Installed on board TPz Fuchs Eloka and successfully deployed in Afghanistan, this suite enables the detection and analysis of radar signals in the 0.1- to 40-GHz frequency range, maintaining a proper and detailed situational picture in a dense electromagnetic environment. Elettronica GmbH has also developed a SHF monitoring system with potential applications in public security and possibly for military use. Other companies involved in the EW ground equipment market are Indra Sistemas with its RIGEL ground based


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products family, UK-based L-3 Communications TRL Technology and Germany-based Plath GmbH, providing SIGINT and COMINT passive and active systems.

Aside from traditional and non-traditional SIGINT systems, IED jammers have become indispensable tools to cope with the most dangerous threats encountered in Afghanistan and Iraq.

European operators and EW manufacturers have followed the evolution of IEDs, initially deploying pre-emptive wide-band jammers, and eventually replacing them with smarter reactive or spot jammers. Thales Land and Joint Systems has developed a reactive spot jammer, the TRC-274 FPJ (Force Protection Jammer). UK-based L-3 Communications TRL Technology provides a range of C-IED products based on the Broad Shield family, while Selex Communications has its Guardian man-portable family.

Ukrainian research institute of Donetsk is also active in this sector, together with Turkish companies Aselsan, Gate Elektronik, Microdis and Autel. Rheinmetall Defence and Diehl BGT Defence have followed a different approach based on the High Power Microwave (HPM) system, a German armed forces sponsored program. The system uses peak voltages to either detonate the IED at safe distance or damage the detonation system. It is effective against remote controlled IEDs and other types of IEDs.

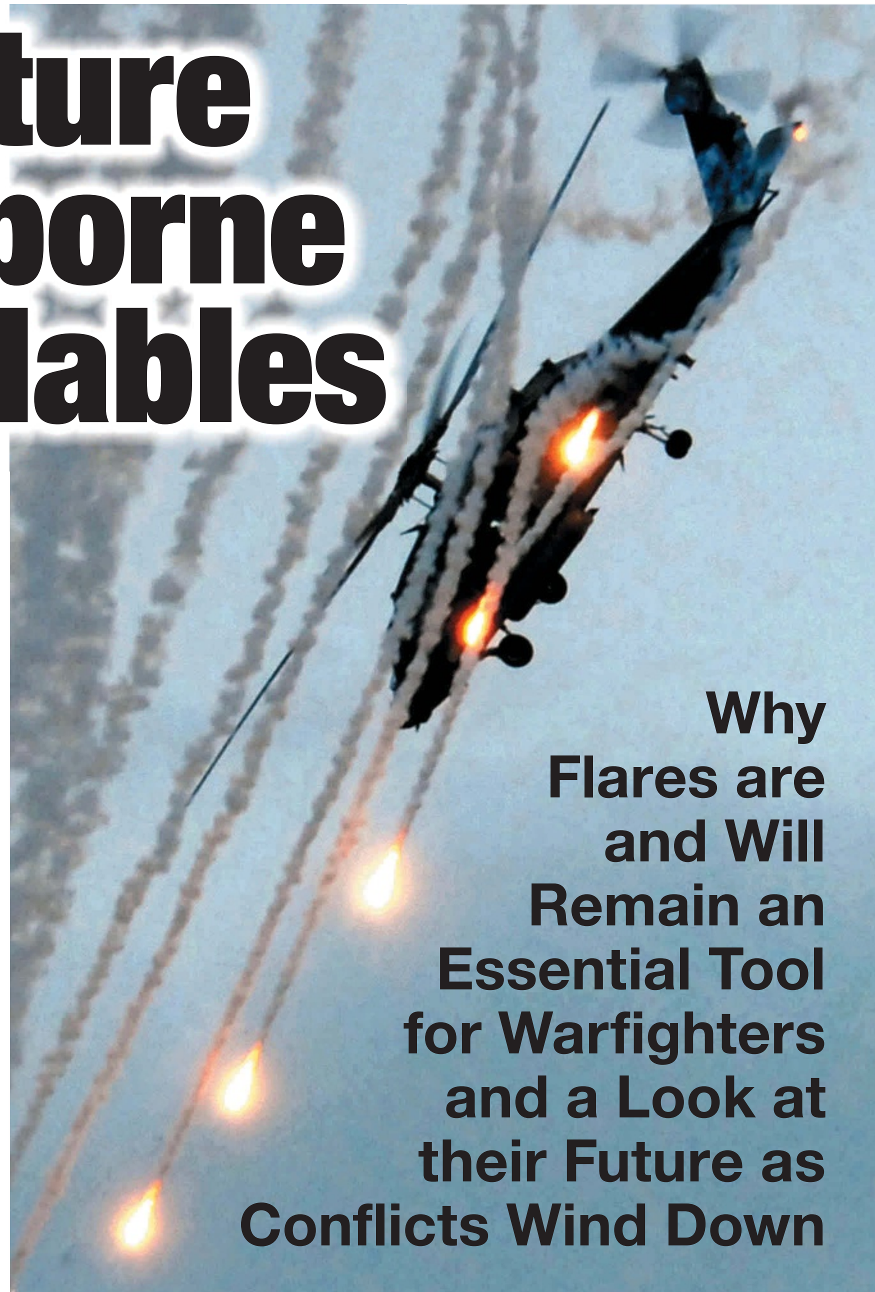
The Italian Air Force has launched a program to equip a C-27J tactical transport aircraft with a counter-IED payload developed in house by the Air Force's EW operational support office, called ReSTOGE. Under the JEDI (Jamming and Electronic Defense Instrumentation), the service has worked together with the experimental wing and Alenia Aeronautica to define the aircraft configuration and flight test it, in order to begin operational trials later this year. The program aim is to counter IED threats in specific areas and routes through fly-over and EW "burn," with a secondary mission being "electromagnetic spectrum intelligence."

LOOKING ABROAD

Europe's support for Iraq and Afghanistan operations has driven its military forces to acquire new EW equipment tailored for these fights. It has led many European EW companies into new product areas, such as IED jammers and directed IR countermeasures systems. EW is better integrated throughout European forces than previously. And the personnel have a valuable understanding of the role that spectrum control and EW plays on the modern battlefield.

The long-term prospects for European EW are less certain, however. The length and scope of Afghanistan and Iraq operations has diverted money from many "conventional" weapons programs and the full impact will be felt for many years to come. In the meantime, Europe's EW industry will need to look abroad to find opportunities (and development partners). Fortunately, European EW manufacturers have in recent years been more innovative, more flexible and more aggressive than their US counterparts in terms of their approach to the international market, perhaps because they have always been more dependent on export sales. That advantage may prove crucial to their long-term success.

The Future for Airborne Expendables



By John Knowles

Sometimes, in the course of a war, a single event can take on massive dimensions. On November 2, 2003, just such an event occurred. That morning, a pair of US Army CH-47 Chinook helicopters were transporting soldiers from a base in western Iraq to Baghdad International Airport. As they passed near a village just south of Fallujah, two missiles (later determined to be SA-7s) were fired at the aircraft from behind. One of the missiles missed, but the second hit one of the Chinooks, which caught fire and crashed. Sixteen of the 42 soldiers and crewmembers onboard were killed.

Helicopters had been shot down in Iraq prior to November 2nd, and more helicopters would be shot down in the months afterward. For the Army, however, this loss was significant because of the high number of casualties. It demonstrated that the Army needed to equip its helicopters with better infrared countermeasures systems. Part of the solution involved buying advanced missile warning systems and countermeasures dispensers. Not too long before, the Army had completed development of the AAR-57 Common Missile Warning System (CMWS) and the Improved Countermeasures Dispenser.

To defeat the IR missiles themselves, however, the Army needed to buy three flares – the M206, M211 and M212 – in large quantities. By late 2005, the Army was moving forward with plans to increase production of these flares from 9,000 units per month to 54,000 units per month in just 90 days. The three companies that manufactured those flares opened up new production lines and began delivering the new quantities to the Army. This is just one example of the significant commitment that flare manufacturers have made to meet their customer's rapidly evolving survivability requirements during the Global War on Terror.

What is interesting is that most aircrews can name the companies that build their aircraft, and they likely know the companies that manufacture its weapons and sensors. But only a few probably know the companies that make the flares that protect them or understand how the DOD and the manufacturer collaborate to develop those flares. Fewer still could explain the unique challenges these flare companies are facing today and in the future. In fact, for such a critical capability,

very little attention is paid to this niche within the electronic warfare market. Yet the lives of so many aircrews and the thousands of troops they transport across the deserts of Iraq and the valleys of Afghanistan are very dependent on the handful of companies that make these flares, so it is worth taking a closer look at this market.

THE INDUSTRIAL LANDSCAPE

The airborne expendables market is dominated by two large manufacturers, with several companies accounting for much smaller shares of the market. The company with the largest market share is Chemring plc of the UK. It owns Chemring Countermeasures in the UK, Chemring Australia Pty Ltd., and Alloy Surfaces and Kilgore Flares in the US. The other large manufacturer is Esterline Corp. in the US. It owns American manufacturer Armtec Countermeasures and UK-based Wallop Defence Systems. Other major flare manufacturers include Alliant Techsystems in the US, Lacroix Defense and Security in France, Rheinmetall Group in Germany and Israel Military Industries (IMI) in Israel.

Although the flare industrial base has never been large, it has seen significant consolidation over the past several years. Beginning in the 1990s, many of the previously independent US and UK flare companies were bought and sold by larger defense corporations. Today, two parent companies (Chemring and Esterline) own several flare subsidiaries and manufacturing locations in each country.

Outside the US and UK, the industrial base has been fairly steady. IMI is owned by the Israeli government. Lacroix is part of Etienne Lacroix Group, a family-owned company. Rheinmetall Defence purchased its flare subsidiary, BUCK Neue Technologien GmbH, in 1998. It has integrated Buck operations into its Rheinmetall Waffe Munition business.

For the moment, it appears that the period of industry consolidation is nearly over, with one or two exceptions. The US and UK governments want to retain at least two flare manufacturers for most of the flare types they use. Likewise, the French, German and Israeli governments want to retain domestic manufacturing capabilities and are unlikely to approve the sale of a flare manufacturer to a foreign-owned company.

Despite the significant sales growth over the past several years, no company has entered the airborne flare market since 2002. The barriers to entry are significant in terms of building safe and efficient manufacturing facilities, developing the specialized technical expertise needed to develop new flare products and securing enough marketshare to remain viable and provide a return to investors.

DEVELOPING NEW FLARES

In a wartime scenario, when flares are procured in large quantities, the flare market has the potential to be very dynamic. Flare solutions can evolve rapidly as new threats emerge and are better understood. Today's preferred flare solution may be surpassed tomorrow by a newly developed flare that proves more effective against a wider variety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of threats. According to one UK industry source, the smarter international customers regularly participate in flare trials and they know the flares they want to buy. These customers will often buy in smaller quantities and they will buy more often in order to take advantage of new flare solutions as they appear on the market.

Today, flare companies on both sides of the Atlantic develop new products in much the same way. The military customer states a new flare requirement; the flare companies design solutions that meet that requirement and then test them against high-fidelity models, such as MOSAIC. Once the flare is performing well against a model, companies can submit the flare prototype to the customer for flight evaluation. In the US, the DOD provides the test aircraft (an F-16, F-15, MH-53, etc.), the seeker vans, which feature real missile seekers, and the range time. Often, these flight tests involve multiple flare types from different companies. (NATO conducts similar trials every two years in Europe under the Trial Embow series, in which several companies participate.)

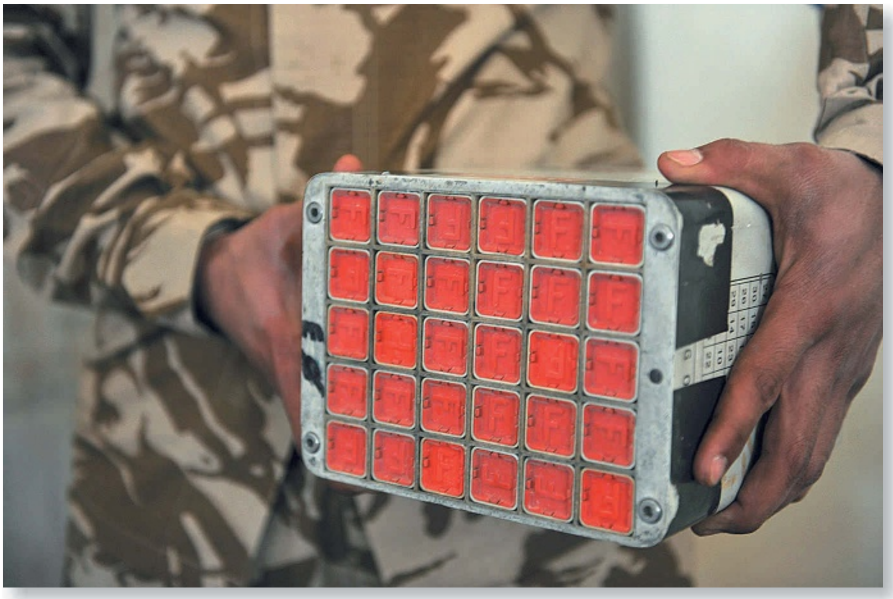
Overall, this procurement strategy has been beneficial to both the military customer and the flare developer. The military customer does not have to manage a flare program and the attendant technical and financial risk. The flare developer often has more latitude to come up with a successful design or to plot a new approach if a particular design is not working. However, this development strategy depends on excellent understanding and dialogue between the military customer, who must clearly state his requirements, and the flare industry, which must develop products to meet those requirements. It is a delicate relationship that must be carefully maintained by both groups if it is to work effectively.

THE GLOBAL MARKET

With the world's largest fleet of fixed- and rotary-wing aircraft, the US is the largest buyer of airborne expendables, representing just over 55 percent of the world market. NATO accounts for about half of the remaining 45 percent, with the rest spread out internationally.

Within the US, the Air Force is the largest flare buyer, followed by the Navy and the Army. In Iraq and Afghanistan, the low-flying helicopters and transport aircraft (vulnerable during take-off and landing) are the main flare users. However, flares are the only IR countermeasure available for today's fighter aircraft. Unlike the case with helicopters and transport aircraft, none of the world's fighter aircraft programs are planning to field a directed infrared countermeasures (DIRCM) capability in the next decade. Even fifth-generation fighters, such as the F-22 and F-35, depend exclusively on flares to defeat IR threats.

Flare spending has skyrocketed since the Global War on Terror began in 2001. Global sales have increased from about $150 million per year in 2002 to an estimated $590 million in 2010. The bulk of this growth results from major increases in US procurement due to ongoing operations in Iraq and Afghanistan. The large numbers of aircraft operating in those theaters, the prevalence of IR threats and the introduction of better missile



warning systems have contributed to an unprecedented demand for flares and other IR decoys.

After several years of dramatic market growth, however, 2010 spending is expected to mark the beginning of a new period of much slower growth. The anticipated withdrawal of US forces in Iraq, which is only partially offset by the surge in Afghanistan, means the market for basic magnesium-teflon-viton (MTV) flares is expected to decline. However, the market for advanced flares is expected to increase. Flares like the MJU-71/B, which is being evaluated under the DODs Defense Acquisition Challenge program, as well as flares for the F-22 and F-35, will be significant for the market in the coming years. In addition, preemptive IR countermeasures solutions, based on special materials products, are also gaining more attention worldwide.

The slight increase in US flare procurement is likely to be complemented by subtle spending increases in Europe, the Asia-Pacific region and the Middle East. This is due in part to NATO involvement in Afghanistan and deliveries of new fixed- and rotary-wing aircraft, which will require purchases of advanced IR decoys and flares.

ADJUSTING TO A NEW MARKET

Today, the manufacturing capacity at US flare companies is greater than it has ever been. To cope with years of growing demand, some companies opened up new manufacturing facilities and others expanded production lines. In the coming years, however, careful management is needed in order to shut down some lines and consolidate production on others without interrupting deliveries. This will require planning and coordination between the manufacturers and the US services that buy most of the flares.

Flare manufacturers outside the US were less affected by the market surge, and they are unlikely to be deeply affected by the anticipated decline in US flare procurement.

Another consideration for US flare manufacturers is how future research and development will be funded. With lower US sales anticipated, US flare companies will have a harder time diverting enough profits to sustain a robust internal research and development programs in the near future. It is not clear how US companies will identify the necessary funding to develop next-generation flares to defeat evolving IR threats.

These are not insurmountable problems, however. US flare manufacturers are careful to point out that the flare community is very small and problems between the services and industry tend to get solved before they reach the crisis stage. In fact, many US industry sources said most of their DOD customers have recently shown much greater interest in communicating and getting ahead of potential problems than in the past.

However, the Air Force and Army typically manage their flare procurement through their munitions depots, rather than buying them through EW channels. By comparison, the Navy buys its flares through an EW program office, which has enabled the Navy to manage flare procurement much more efficiently than its sister services.

IRCM SYNERGY

For many years, the EW community has debated whether flares will be able to defeat advanced imaging IR seekers. Until these types of threats begin to reach the field in significant numbers, the jury is still out.

For most aircrews, however, today's IR threat remains the hundreds of thousands of shoulder-launched SA-7s, SA-14s and SA-16s that are out there in the field. All of these missiles are vulnerable to flares, and because of this flares have a major role to play for years to come.

In fact, many operators have started to look past the "flares versus DIRCM" debate. They are more interested in discovering the synergistic effects provided by advanced missile warning systems, programmable dispensers, laser-based DIRCM systems and advanced flares and IR decoys of all types. Taken together, this is far more effective than a single or partial solutions.

One industry source commented that the near-term challenge has not been the development of advanced IR countermeasures technology. In fact, the advanced solutions are readily available. The real challenge has been to get the missile warning experts, the dispenser experts, the DIRCM experts and the flare experts to sit down and work on solutions together. The military customer has not pushed that collaboration for one reason or another, he said, and the only group that has benefitted is the enemy.

Photos courtesy US Department of Defense.

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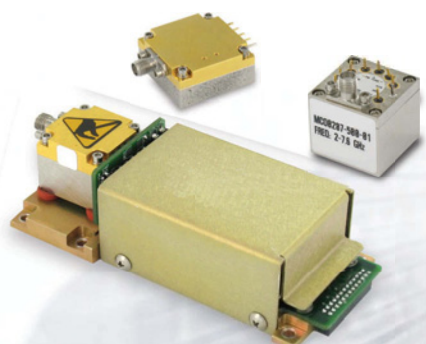

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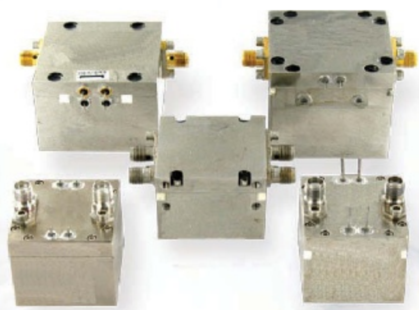

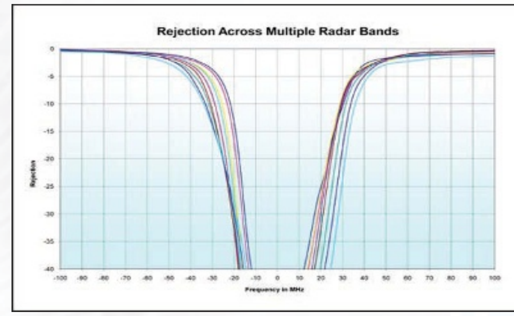

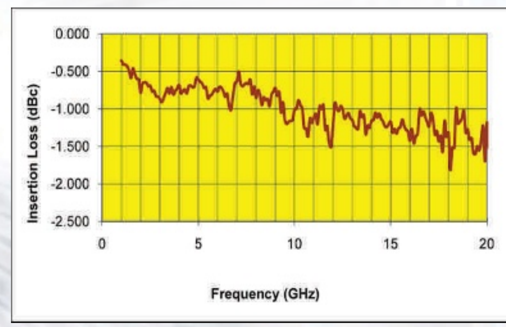

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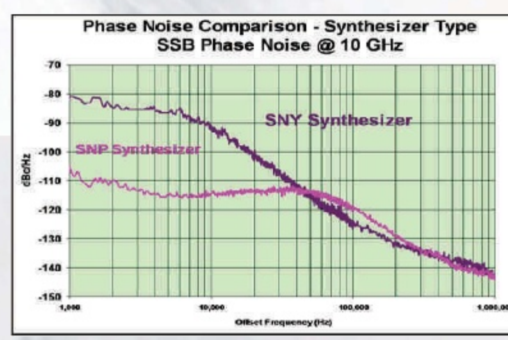

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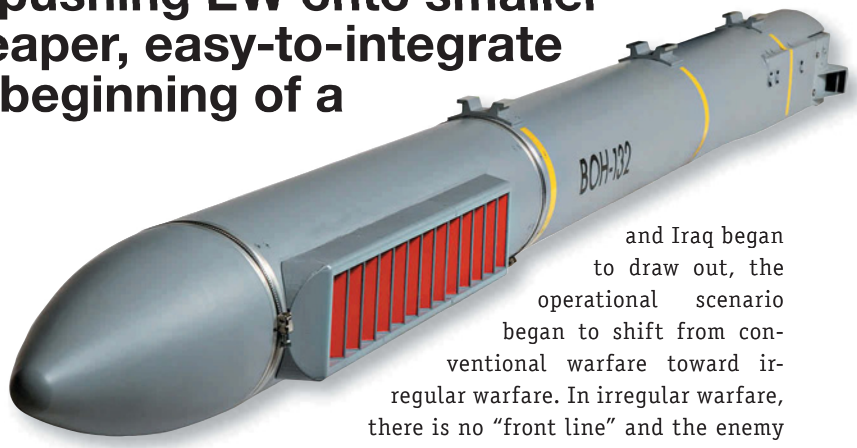
Protecting Low-Cost and Non-Traditional Platforms

The changing threat is pushing EW onto smaller platforms requiring cheaper, easy-to-integrate options. But is this the beginning of a paradigm shift for EW?



By Barry Manz and Elaine Richardson

Electronic warfare (EW) has always been a platform-driven market. Historically, militaries have bought EW systems for their high-value platforms that were most likely to face an adversary's RF- and EO/IR-guided threats. In a conventional warfare scenario, such as the Cold War, EW was primarily acquired for bombers, fighter aircraft, attack helicopters and surface combatants, because they represented the "tip of the spear"– those most likely to directly engage the enemy and become targets themselves. The military buyer allocated approximately 5-10 percent of the platform's total cost to survivability equipment, including EW. That meant that a $40 million fighter aircraft, for example, would typically include $2-$4 million worth of EW and other survivability technologies.

Throughout the Cold War and in the years that followed, military planners used this EW investment strategy to equip their forces for conventional operations. It defined the EW market and the industry that manufactured EW systems – creating a focus on sophisticated EW solutions for big-ticket weapons platforms. When the September 11 attacks occurred, that EW strategy (and the EW market) began to change. As military operations in Afghanistan and Iraq began to draw out, the operational scenario began to shift from conventional warfare toward irregular warfare. In irregular warfare, there is no "front line" and the enemy can attack any platform operating in the theater. Today, that adversary can access very capable commercial technology and exploit it for military purposes, such as using mobile phones to trigger IEDs. He can also buy inexpensive military hardware, such as Man-Portable Air Defense Systems (MANPADS), from a variety of sources. In Iraq and Afghanistan, this has led to a pattern of IED attacks against ground vehicles and numerous helicopter losses to small arms, RPGs and shoulder-launched IR-guided missiles.

These types of irregular warfare threats and tactics have driven military leaders to rethink their platform survivability strategies. In essence, more robust EW capabilities are needed on a much larger portion of the platform inventory, including utility helicopters, ground vehicles, light transport aircraft, small UAVs and even on soldiers. Many of these are low-cost platforms, and they require low-cost EW solutions (again keeping within 5-10 percent of the platform cost). New and emerging operational requirements are beginning to reflect this trend. EW research and development topics are also beginning to focus on maturing small, lightweight, low-cost EW technologies. Interestingly, some EW companies are already offering low-cost EW systems specifically aimed at this emerging market.

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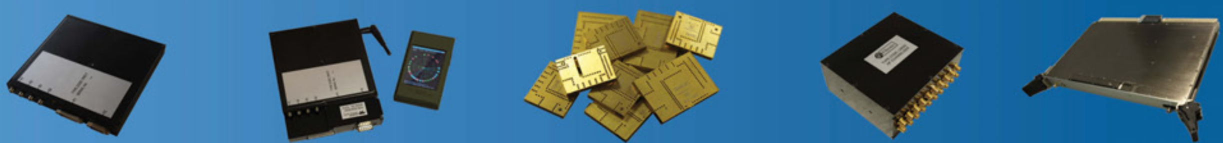

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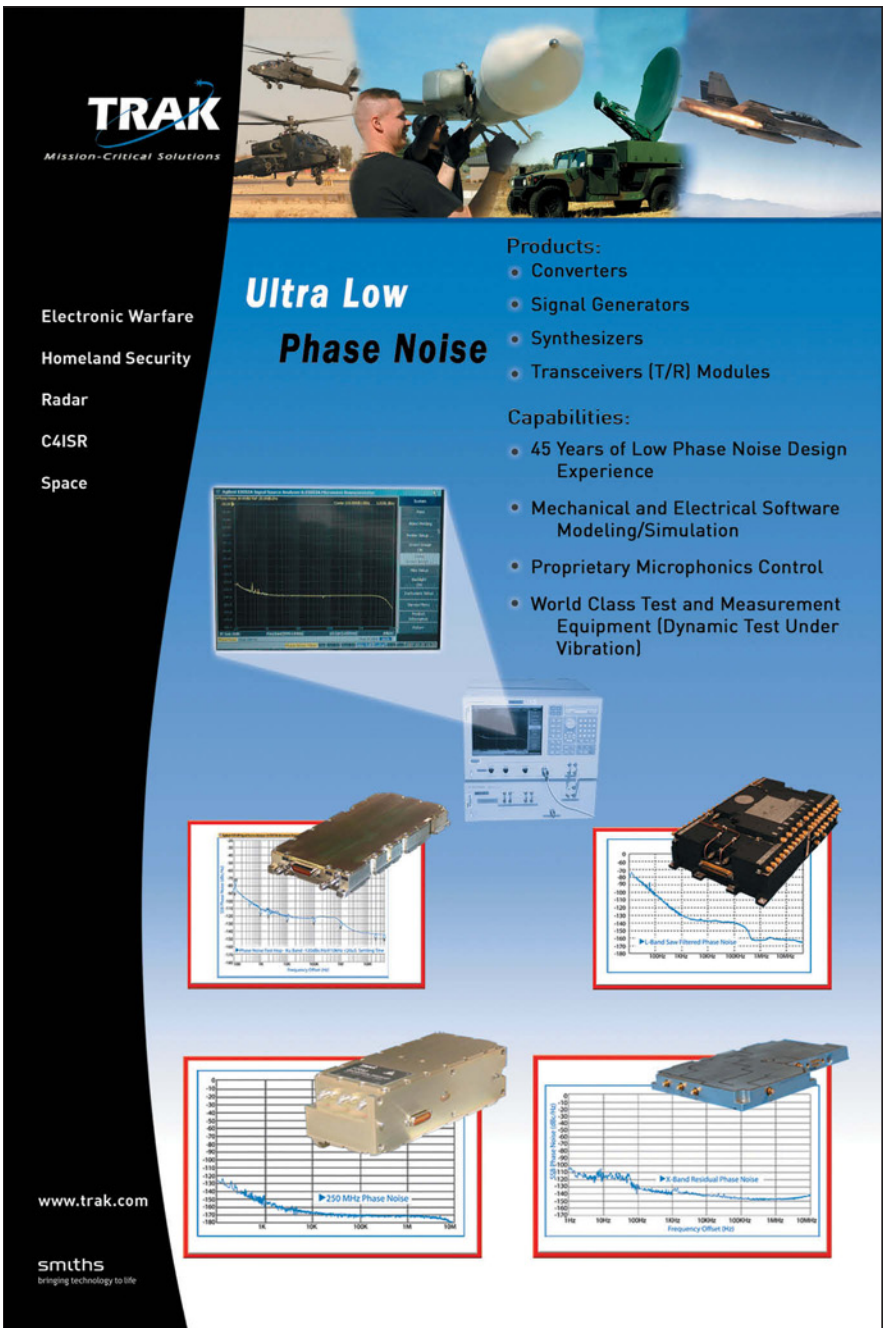
SMALLER OPTIONS

Some military forces have been interested in small, low-cost EW systems for many years. US Special Operations Command (SOCOM) has been particularly proactive in the area of sizing individual EW down to the soldier level. QinetiQ (Malvern, Worcestershire, UK) developed the CELT Warrior, a body-worn radar warning receiver (RWR), which was evaluated for SOCOM under a 2003 Foreign Comparative Test. The compact system measures 23 x 11 x 8 cm and can be mounted as part of a vest pack unit on the individual soldier or hand carried with personal equipment. The unit provides coverage in the 8-18 GHz range with spatial coverage of 60 x 60 degrees.

The FY2011 SOCOM budget requests specific funding for an Advanced Tactical Threat Warning Radio. This effort calls for development of a minimally sized handheld threat warning and communications system. The budget request also mentions a prototype development and integration testing for the Picoceptor and processor for man-portable threat warning – a continuation of a program begun in FY2007. DRS Signal Solutions (Gaithersburg, MD) developed the Picocepter family of small software digital radios for soldier and UAV applications. Covering the 20-MHz to 3-GHz frequency range, a dual-channel system weighs 1.6 lb. The single-channel Picocepter weighs 1 lb.



LOW-COST RWRs

Looking specifically at RWRs, among the electronics payloads on various land, sea and airborne platforms, they are far from the least expensive. They're also far from the least complex, thanks to their high-speed digital circuits, broadband high-performance receivers and advanced signal processing software.

Unfortunately, their cost and complexity mean that even though extremely valuable for situational awareness and threat assessment, RWRs continue to be omitted from UAVs, aerostats, and other platforms of similar size and cost. Making the RWR compatible with these platforms is not trivial and requires a significantly different approach to design and fabrication, but as at least one manufacturer is demonstrating, it can be done.

From a physical and functional perspective, RWRs embody many characteristics that make them the antithesis of what a small, light, power-constricted platform would need. That is, they're large, heavy, power hungry, and need to be kept cool. Nevertheless, they're just as essential in these applications as in their "high-value" counterparts, since they face the same threats and are used in the same places to provide passive target identification and tracking beyond what can be accomplished in the optical domain.

One of the most formidable obstacles to the deployment of RWRs on UAVs, for example, is that the host platform's payload capacity may be only a few pounds and only tens of watts. At the same time, other payloads, such as communications links, electro-optic sensors and synthetic aperture radars, often take priority on UAVs. This makes conventional RWRs compatible only with the largest UAVs, on which there may be available space and power. On smaller aircraft and vehicles, a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RWR may alone exceed the host's entire power budget for self-protection systems.

As is the case in so many applications, the RF and microwave section of a RWR is one of the largest contributors to cost. It is typically composed of multiple "hogged out" aluminum modules based on Microwave Integrated Circuits (MICs) that are cobbled together with a maze of semi-rigid coaxial cable. The collection of modules comprising the RF section must also be housed in an ATR module which itself adds size and weight. Finally, RF and microwave components and modules have largely remained unchanged in both construction and cost for many years, although MMICs and the digital implementation of formerly analog functions continues to provide incremental increases in integration. However, they remain large and inherently difficult to reduce in size and weight, and are not very amenable to accommodating a variety of physical layouts.

The digital portion of a conventional RWR also places demands on the host platform. While benefitting to a greater degree than its RF and microwave counterpart from increases in functional density and greater performance per unit of device area, a "full-boat" RWR requires enormous amounts of processing power. It must collect, process and store the large amount of information captured by the receiver and transmit it in some reduced form to a processing unit. This requires multiple, high-speed, immensely-powerful processors and other digital components that generate large amounts of heat and consume plenty of power. Like RF and microwave subsystems, they also must typically be mounted in a rack-type enclosure and require some form of cooling.

CHANGING THE PARADIGM

Nothing short of a complete rethinking of RWR architecture, components and functionality will be adequate to bring the valuable asset into the world of smaller platforms. One example of such a system is the Phobos RWR developed by Teledyne Defence Ltd (Shipley, West Yorkshire, UK). It combines miniaturization of the RF section with "streamlined" EW signal processing algorithms and other techniques to achieve the final result, which at 3.3 lbs and consuming only 24 W, is at least an order of magnitude lighter and more frugal with power than current RWRs. It is compatible with the typical SWaP requirements of a UAV with a 3- to 6-ft. wingspan and is well suited for smaller UAVs as long as sufficient power is available.

Phobos employs the company's RR017 receiver, which covers 2-to-18 GHz, a single-board computer, high-capacity hard disk, and power supply, which together are called the unit's threat processing unit. The RR017 consists of four RF ports feeding two RF/video channels, and one Instantaneous Frequency Measurement (IFM) unit, both controlled by an FPGA that also generates the Pulse Descriptor Word (PDW) digital output. The unit measures 6 x 6 x 0.75 in., weighs 1.88 lbs and draws 15 W.

The RR017 incorporates high-speed attenuators to extend the dynamic range of the unit within the pulse and automatically selects the largest amplitude channel to feed the IFM. A bandpass filter rejects out-of-band signals and the

input switches can be isolated when an external low-voltage TTL blanking pulse is received. The PDWs are sent to the computer via USB, which is also used for control and status communications.

The threat processor uses a Waveform-Based Processing (WBP) algorithm that simultaneously performs pulse deinterleaving and identification, which is a pattern-correlation process and not a statistical one, such as a Time of Arrival Difference Histogram (TOADH). The result is that the processing capabilities of the computer need not be as potent as those of larger systems.

Track tables are sent via the command and control data link on the host platform to one of two types of interface, one a detailed ESM display suitable for use by an ESM operator and the other a small hand-held polar display carried by soldiers near the UAV. The ESM interface has tactical, tote and detailed display modes. The tactical display can be either a map, polar or graphical display. The tote display has all of the track table information, and the detailed display contains any platform and weapons system data associated with the selected track.

The handheld display is essentially a PDA in a ruggedized enclosure and has quad-band GSM and WiFi transmit and receive capability and a GPS receiver. Track tables can be accessed from the UAV base control via the GSM network or the software can be hosted on existing mission information system terminals with data accessible over the user's existing tactical communications network. In all cases, library data can be generated at a national level, from parametric data in national databases, or generated from the raw collected PDW data, which makes it possible to create library entries in the field.

Teledyne's Phobos unit is indicative of what can be achieved in RWR architecture to meet the needs of UAVs and assorted other aircraft and ground vehicles that cannot accommodate RWRs. Surprisingly, there appear to be few other examples like Phobos currently available on the market. While many of the larger EW system manufacturers have been developing small EW solutions for many years, with some impressive results, few have offered them to the general market. In the US, most EW companies are waiting for large-scale programs, such as the US Army's Integrated EW System (IEWS) to kick off. In the meantime, the potential market for such products is growing quickly, due to the proliferation of smaller unmanned airborne and ground-based vehicles.

IMPROVED TECHNOLOGY

In addition to the development of low-cost EW systems themselves, two other factors are contributing to this emerging market: advanced communications networks and inexpensive platform integration schemes. High-data-rate communications systems and networks are finally reaching the tactical user. Almost every weapons system, down to the individual soldier, now carries a radio that can rapidly move large amounts of information, including data-heavy EW feeds. This means EW situational awareness information can be shared and processed within a unit and it can be sent along to a tactical command post, where it can be fused with data from other units to build a larger RF picture of the battlespace.

In the US, the Army has been pushing this technology as part of the next Joint Counter Radio Controlled Improvised Explosive Device Electronic Warfare (JCREW) system. Expanded technology sought for JCREW 3.3 includes "Situational Awareness Data Fusion," specifically capabilities and techniques for providing situational awareness enhancements by fusing the data from onboard and offboard sensors with JCREW collected RF sensor data.

Desired capabilities for the new JCREW system also include the ability to build in benefits of networked operations. A networked approach would allow for geolocation of all systems, easy adjustment of system operating parameters and could also be used for development of network-based jamming algorithms and topology that allow for specific advancements, such as placement analysis for systems to maximize effectiveness. Networked access to logs and other diagnostics could also give remote users the ability to determine system readiness and perform limited repairs where necessary, reducing manpower needs and support costs.

As you would expect, in the world of low-cost platforms, even the EW integration schemes must be affordable. Switzerland's RUAG Aerospace and Sweden's Saab are offering a quick integration "plug-on device" (POD) for helicopters. Saab calls it the Integrated Self-Protection Pod (ISPP); RUAG calls it the Integrated Self-Protection System (ISSYS) Pod.

Based on Saab's Compact Integrated Defensive Aids Suite (CIDAS), the POD features integrated missile warning and chaff/flares dispensing with options for radar warning, laser warning and GPS navigation. It requires only electrical power connection and feed to a dedicated control display that can be temporarily or permanently mounted on the cockpit dash without being integrated into the avionics system. Limited integration means the POD can be mounted on any available external hardpoint in 15 to 30 minutes. Introduced to the market last year, the POD is planned for helicopter flight tests later this year.

Saab is also introducing the BOH system, which is designed to provide additional advanced countermeasures capabilities in the leanest way possible, by reusing what's already on the aircraft. BOH reuses existing platform hardware and electrical interfaces for various missiles, including the Sidewinder, AMRAAM, ASRAAM and IRIS-T. BOL capability can be incorporated, along with forward firing dispensing capability and missile warning. BOH can be used in place of missiles on a mission-needed basis to reduce susceptibility to radar and IR threats.

LOOKING AHEAD

Emerging EW requirements that are driven by evolving irregular warfare strategies suggest a strong future market for these types of small, low-cost, easily integrated EW solutions. For the EW industry, the trend toward low-cost EW systems means that some companies may re-evaluate their approach to the EW market. In less polite terms, some EW companies may need to shake off "conventional-warfare-itis," something Defense Secretary Robert Gates is battling in the halls of the Pentagon.

For example, when the IED jammer market began to take shape in the 2004-2006 timeframe, many of the major EW systems manufacturers decided not to pursue it for one reason or another. That left the door open for two relatively small EW businesses, EDO Communications and Countermeasures, and a non-profit research center, Syracuse Research Corp., to win two of the first IED jammer contracts awarded by the DOD. Together, those businesses (SRC established SRCTec in 2006, and ITT bought EDO Corp. in 2007.) dominate that billion-dollar market today. The same is true of the components manufacturers who supply IED jammer manufacturers. Many were not "EW suppliers" before 2005.

Today, the EW industry has a better understanding of irregular warfare requirements, and both new and established EW companies are likely to pursue these "low-cost EW" opportunities as they emerge. Many EW systems manufacturers are funding internal research and development projects aimed at the "low-cost" market. They will offer these solutions for programs such as CIRCM, JCREW upgrades or the Army's IEWS program. However, many European companies, such as Saab, RUAG, QinetiQ and Teledyne Defence, are testing the waters of the international market to see what opportunities are available. The net result of these efforts is sure to be more EW on more platforms than ever before. That's an EW solution the warfighter can live with.

Photos courtesy Saab and the US Department of Defense.

TECHNOLOGY SURVEY

Missile Warning Systems

By Ollie Holt

JED last looked at missile warning systems in the May 2008 issue. In that survey, two responses were from suppliers of active RF – pulse Doppler (RF-PD) missile warners and the rest were from suppliers of passive UV or IR missile warners. The current survey saw a similar response, with two active systems and the rest being passive. The survey results also indicate a trend toward staring two-color

Table 1: Comparison of Active and Passive Missile Warning Technologies

Attribute	Advantage	Disadvantage
Time to Go (TTG)	Active (RF-PD) radars can determine the distance and speed of incoming missiles.	Passive (IR) cannot provide range information. Passive (UV) can only provide course range as a function of plume intensity. By using the launch point and stored terrain data with IR or UV sensors, some TTG information can be developed.
Missile Motor Burn	Active (RF-PD) Does not require the motor to be burning for declaration.	Passive (IR) can potentially detect missile kinematic heating along with the missile motor. Passive (UV) typically requires the missile motor to be burning. IR offers better post-burn-out performance than UV.
	Active sensors do not use missile motor plume detection, while a passive sensor requires the missile motor plume but in some cases can also detect kinematic heating of the missile structure post motor burn out.	
Field of View	Passive (UV) requires a less complex set of sensors to provide 360-degree coverage. Passive (IR) is similar to UV, but requires a slightly more complex sensor scheme.	Active (RF-PD) requires an antenna in each quadrant to provide 360-degree coverage.
	All sensor types require a sensor in each quadrant to provide full spatial coverage.	
Angle of Arrival	Passive (UV) provides very good angle-of-arrival information. Passive (IR) angle of arrival performance is a function of the size of the IR array. The larger the array, the better the angle of arrival performance.	Active (RF-PD) will provide quadrant, but to provide better resolution it needs a more complex antenna array.
Weather Conditions	Active (RF-PD) less sensitive to weather conditions.	Passive (UV) sensitive to weather conditions but not sensitive to sun glint. Passive (IR) sensitive to weather conditions and to false alarms caused by sun glint. Also sensitive to manmade IR clutter.
Complexity	Passive (UV) low complexity. Also the lowest life-cycle cost system. Passive (IR) complex processing to prevent false alarms and the sensor needs cooling. (Some new technologies are moving away from the cooling requirement.)	Active (RF-PD) complex transmitter, antenna and receiver system if AOA required. A low complexity configuration could be created with low cost communications components but with reduced performance.
	The passive sensor hardware is relatively simple but the processing is complex to reduce false alarms. While the active system requires antennas and a coherent transmitter and receiver hardware system with the complex processing.	
False-Alarm Rate (FAR)	Active (RF-PD) dependent on altitude, radar cross section of the missile and other RF signals in the environment.	Passive (IR) higher FAR at lower altitudes then UV because of the clutter sources. Requires complex processing to reduce FAR. Passive (UV) lower FAR then IR but still has complex processing to remove false alarms.
	An integrated RF-PD and a passive IR or UV system would provide lower FAR.	
Declaration Range	Passive (IR) atmospheric transmission of IR radiation is better than that of UV. Better performance at higher elevations. Active (RF-PD) is a function of transmitter power and the radar cross section of the missile.	Passive (UV) lower atmospheric transmission of UV radiation.

passive IR sensors, which offer certain performance benefits compared with staring UV sensors. All passive missile warner programs continue to develop and refine declaration algorithms to reduce false alarms.

Current development is mainly focusing on two-color IR sensors with spatial, temporal and spectral processing to reduce the false-alarm rates.

Each of these different technologies – RF-PD, IR and UV – has different advantages and disadvantages. Table 1 lists some of the advantages and disadvantages for the different missile warning technologies.

Current development is mainly focusing on two-color IR sensors with spatial, temporal and spectral processing to reduce the false-alarm rates. There is some additional investigation into un-cooled IR sensors in order to reduce weight, complexity and cost of the sensor. The current IR sensors require cooling with a small cryogenic cooler to cool the sensor array, which has typically been the weak point in reliability of the sensor. Many technical improvements have been made to improve the reliability of the coolers.

One of the major issues with an active (RF-PD) missile warning system is the fact that it is active and provides both notification that the platform is in the area (i.e., beaconing) and a signal for any potential RF threat or combined IR/RF threat to use for homing in a passive mode. The advantage of the passive sensors is they don't provide any advance warning that the platform is in the area while the shortfall is the complexity of the processing to prevent/reduce false alarms. The major technical focus with passive sensors, mostly with the new two-color sensors, is developing algorithms using the missile fly-out spatial, temporal and spectral information that provides good declaration results with low false alarms. Because not all missiles fly the same and burn the same fuels, this becomes a tough technical problem.

An interesting aspect of passive missile warners is the growing list of functions some of them may be able to offer beyond straightforward missile warning. A few of the newer systems can provide small arms and RPG hostile fire indication and source location, as well as rotary wing landing assistance in "brown out" conditions. These types of requirements are gaining more attention due to lessons learned in operations in Iraq and Afghanistan.

JED's next survey, covering radar jammers, will appear in the July 2010 issue. E-mail editor@crows.org to request a survey questionnaire.

TECHNOLOGY SURVEY: MISSILE WARNING SYSTEMS

MODEL	TECHNOLOGY	SPECTRAL BAND/RF FREQ	TIME TO GO	ANGLE	PROCESSING	POWER (W)
Alliant Techsystems inc.; Clearwater, FL, USA; +1-727-572-1900; www.atk.com						
AN/AAR-47A(V)2	passive	UV	*	quadrant	temporal	60 W maximum, 46 W nominal (28 VDC)
AN/AAR-47B(V)2	passive	UV	*	quadrant	temporal	60 W maximum, 46 W nominal (28 VDC)
BAE Systems; Nashua, NH, USA; +1-603-885-1029; www.baesystems.com						
AN/AAR-57	passive	UV	*	*	temporal, spatial and spectral	six-sensor system without anti-ice: 245 W
EADS Deutschland GmbH; Munich, Germany; +49 89 3179 8224; www.eads.com						
MILDS® AN/AAR-60	passive, imaging	solar blind UV	*	yes, very accurate	temporal, spatial	< 14 W per sensor
AN/AAR-60 (V) 2 MILDS® F	passive, imaging	solar blind UV	*	yes, very accurate	temporal, spatial	< 10 W for sensor; < 60 W for processor
MILTAS (Missile & Laser Threat Alerting System)	passive, imaging	solar blind UV	*	yes, very accurate	temporal, spatial	< 30 W for sensor; < 100 W for processor
Elisra; Bene Beraq, Israel; +972-3-6175411; www.elisra.com						
PAWS	passive	MWIR	yes	high DF accuracy	expert system	processor: 100 W; sensor: 30 W
PAWS-2	passive	MWIR	yes	high DF accuracy	expert system	processor: 100 W; sensor: 30 W
TANDIR	passive	LWIR	yes	high DF accuracy	expert system	processor: 30 W; sensor: 5 W
G-FORCE	passive	LWIR/MWIR	yes	high DF accuracy	expert system	processor: 30W/100 W; sensor: 5W/30 W
IAI/ELTA Systems Ltd.; Ashdod, Israel; +972 8 857 2410; www.elta-iai.com						
FLIGHT GUARD® / EL/M-2160V1	active	*	yes	provided, based on using six antennas	digital receivers	350 W
L-3 Communications Cincinnati Electronics; Mason, OH, USA; +1-513-573-6100; www.cinele.com						
AN/AAR-44B Infrared Warning Receiver	passive	*	yes	yes	temporal, spatial, spectral	115 V ac, 400 Hz; 3 phase 155W; +28 VDC: 75W;
MBDA France; 92358 Le Plessis Robinson, France; + 33 (0) 1 71 54 11 73; www.mbda-systems.com						
DDM-NG	Passive	Mid-IR	*	Deg. Class DOA accuracy in a total sphere around A/C	Advanced algorithms providing a high level of classification	*

SIZE (HxWxL inches/cm)	WEIGHT (lb/kg)	PLATFORM	FEATURES
computer processor: 8 x 8 x 10 in.; control indicator: 2 x 5 x 6 in.; sensors: 5 x 5 x 8 in.	30 lbs	air	High PD; low false-alarm rate; dynamic blanking; clutter level indicator; fully integrated laser warning, and extremely high reliability.
computer processor: 8 x 8 x 10 in.; control indicator: 2 x 5 x 6 in.; sensors: 5 x 5 x 8 in.	30 lbs	air	Significantly improved system performance in urban operations; high PD; low false-alarm rate; dynamic blanking; clutter level indicator; fully integrated laser warning, and extremely high reliability.
ECU: 5.5 x 9.8 x 13 in. diameter; sensor: 4.25 in. depth x 3.25 in. face diameter	32.7 lbs	air/grd-mob	Operational.
10.7 × 12.0 × 10.8 cm	2 kg per sensor	air	Four-, five- or six-sensor head configurations possible.
sensor: 12.1 cm diameter x 10.9 cm length; processor: 21.4 x 16.0 x 13.4 cm	<1.6 kg for sensor; <4.5 kg for processor	air	Especially designed for fighter application. Typical system consists of six sensors and one processor. Embedded recording capabili
sensor: 17.0 x 13.0 x 13.5 cm; processor housing: 20.0 x 20.0 x 25.0 cm	<4.0 kg for sensor; <9.0 kg for processor	grd-mob	Especially designed for mobile ground application. Each sensor includes a LWR sensor. Typical system consists of four sensors and one processor. Embedded recording capability.
processor: 13.0 x 19.5 x 37.5 cm; sensor: 12.1 cm diameter x 21.5 cm	processor: 10 kg; sensor: 3 kg	air	Passive (IR) missilee detection; long detection range; low false-alarm rate; high PD; automatic warning; automatic and optimal countermeasures management. Hostile fire detection and warning; optional IR-CENTRIC™ support (situational awareness, panoramic view, collision alert).
processor: 13.0 x 19.5 x 37.5 cm; sensor: 10.2 cm diameter x 12.6 cm	processor: 10 kg; sensor: 2.5 kg	air	See above.
processor: 6.5 x 19.5 x 37.5 cm; sensor: 6.0 x 6.0 x 6.0 cm	processor: 7 kg; sensor: 200 g	grd-mob	See above.
processor: 6.5 x 19.5 x 37.5 cm/ 13.0 x 19.5 x 37.5 cm; sensor: 6 x 6 x 6 cm/12.1 cm diameter x 21.5 cm	processor: 7 kg/10 kg; sensor: 200 g/2.5 kg	grd-fix	See above.
30.7 x 23.9 x 38.1 cm	22 kg	air	Versatile interfaces for present and future countermeasure systems and EW suites.
control and display: 10.2 x 14.2 x 15.0 cm (4.1 x 5.7 x 6.0 in.); processor: 20.0 x 21.2 x 25.2 cm (8.0 x 8.5 x 10.1 in.); sensor: 40.0 x 36.9 cm diameter (16 x 14.75 in.)	overall system: 27.97 kg (61.75 lbs); control and display: 1.13 kg (2.5 lbs); processor: 8.27 kg (18.25 lbs); sensor: 18.57 kg (41.0 lbs)	air	Simultaneous multi-threat capability; variable sensor configuration for hemispheric or spheric field of view; DIRCM interface; multi-spectral discrimination to reject background and countermeasures.
*	*	air	Fish-Eye Optics, Focal Plane Staring Array, Image Processing, Installed on Rafale A/C.

TECHNOLOGY SURVEY: MISSILE WARNING SYSTEMS

MODEL	TECHNOLOGY	SPECTRAL BAND/RF FREQ	TIME TO GO	ANGLE	PROCESSING	POWER (W)
Northrop Grumman; Rolling Meadows, IL, USA; +1-847-259-9500 x4450; www.northropgrumman.com						
AAR-54	passive	UV	*	*	*	sensor: <8 W; electronics unit 34 W; <50 W w/ heater
Saab, Electronic Defence Systems; Järfälla, Sweden; +46 8 580 840 00; www.saabgroup.com						
MAW-300	passive	optical solar blind UV	yes	~1 degree in azimuth and elevation	temporal, spatial	total for 4 x MAW system = 70 W
Thales Airborne Systems; Elancourt CEDEX, France; +33 (0)1 34 81 60 00; www.thalesgroup.com						
MWS-20	active	L	yes	sector	*	700 W
Thales Optronics; Elancourt CEDEX, France; +33 (0)1 30 96 81 50; www.thalesgroup.com						
ELIX-IR	passive	single-color IR band 2	yes	degree class	*	50 W per sensor unit 90 W electronic unit
MIRAS	passive	multicolor IR band 2	yes	degree class	*	45 W per sensor unit 90 W electronic unit

Survey Key – Missile Warning Systems

MODEL

Product name or model number

TECHNOLOGY

Active or Passive

SPECTRAL BANDS

Or operating frequency range

- UV = ultra violet
- MWIR = medium wavelength infrared
- LWIR = long wavelength infrared

TIME TO GO

Is time-to-go available?

ANGLE

"Angle of Arrival" ability

PROCESSING

Versatility of algorithms (temporal, spatial, spectral, etc):

POWER

Dissipated in Watts

SIZE

H x W x L in inches/cm

WEIGHT

Weight in lb/kg

PLATFORM

Listing all that apply

- air = Airborne
- grd-mob = Ground, Mobile
- grd-fix = Ground, Fixed
- shp = Shipboard
- spc = Space

FEATURES

Additional features

- PD = probability of detection
- FAR = false alarm rate
- LWR = laser warning receiver

SIZE (HxWxL inches/cm)	WEIGHT (lb/kg)	PLATFORM	FEATURES
sensor: 3.4 x 3.4 x 4.4 in; electronics unit 8.6 x 6.3 x 4 in.	sensor: 3.85 lb; electronic unit 10.5 lb	air	A system consists of from one to sixUV sensors and one electronics unit (EU).
controller: 16.3 x 12.4 x 19.5 cm; MAW-300 each 13.4 x 13 x 13 cm	controller: 4 kg, MAW-300 2.4 kg each;	air	The combination of detector, optics and filter result in a completely solar blind system, eliminating all solar effects (direct and reflected) by exploiting the spectral characteristics of the atmosphere.
4 antenna: diameter 9.44; height 5.9 each; electronic unit: 13.66 x 7.6 x 6.29	20 kg total	air	On C-130, PUMA /COUGAR/ and Combat SAR CARACAL, plus Head of State Airbus/ Boeing and helicopters. Time to impact, allow to optimize the decoying effectiveness (decoy triggering at the required period of time). Extremely low false-alarm rate.
sensor: diameter 3.9 x 9.1 in.; electronic unit: 4.8 x 7.6 x 14.9 in.	sensor: 2.7 kg electronic unit: 5 kg	air	Missile warning; hostile fire indication; firing post location; flying and landing aid; situational awareness.
each sensor unit: 9.13 x 14.3 x 6.6 in.; 2 to 3 sensors electronic unit: 7.6 x 14.9 x 4.8 in.	sensor: 10 kg electronic unit: 5 kg	air	Developped for fighter and wide body aircraft. To be installed on A400M.

OTHER ABBREVIATIONS USED

- < = greater than
- > = less 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
Lockheed Martin Missiles and Fire Control	www.missilesandfirecontrol.com
Rafael	www.rafael.co.il

July 2010 Product Survey: Radar Jammers

This survey will cover radar jammers. Please e-mail editor@crows.org to request a survey.

SOFTWARE RADIO BOARD

Pentek's 3U VPX 5353 high-speed software radio board features four 200 MHz 16-bit A/Ds supported by a four-channel installed digital downconverter and a complete set of beamforming functions. Designed for processing base-band RF or IF signals from a communications receiver, it includes built-in multiboard synchronization and is an ideal tool for meeting the requirements of real-time software. Multiple 5353's can be linked together through a built-in Xilinx Aurora interface, creating a board-to-board summation expansion chain for larger multichannel systems. Xilinx's Aurora protocol is used to provide an efficient four-lane, 1.25 GB/sec point-to-point data path between boards. A unique fabric-transparent crossbar switch configuration adds gigabit serial data paths for Xilinx Aurora or Serial Rapid I/O applications.

Pentek, Inc.; Upper Saddle River, NJ; www.pentek.com

DATA RECORDER

The new Vortex VR-7310 3U VPX™ data recorder from Curtiss-Wright Controls is a fully rugged conduction-cooled recording engine featuring an on-board XMC/ expansion site, which can support a variety of I/O such as Serial Front Panel Data Port (sFPDP), Gigabit Ethernet (GbE), 10GbE and analog I/O, as well as FPGA processing. The VR-7310 includes eight external 6 Gbps SAS/SATA links that enable direct attachment to eight 1.8-in. or 2.5-in. drives deployed on disk carrier cards or Flash storage devices. The board's AMCC 460SX CPU is supported with 2GB of DDR2 SDRAM memory for recording buffers. The VR-7310 enables system designers to integrate high-volume, streaming data recording in a compact package and can be used in a broad range of space, weight and power-constrained critical applications in manned and unmanned ground, air and sea vehicles, including SIGINT, image processing, FLIR radar, sonar, RF tuners, MRI and cameras.

Curtiss-Wright Corporation; Parsippany, NJ; www.curtisswright.com

MULTI-WAVELENGTH IR DETECTOR

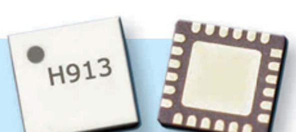
The Altair MWIR-MWIR is a new multiple wavelength IR detector for missile warning systems recently released by Sofradir. This IR sensor provides dual visibility in the 3-4 and 4-5 micron wavebands, allowing users to better identify objects, reducing the number of false threats identified. Altair also enables more accurate temperature measurement of targets and allows users to fuse or compare the image of both bandwidths to improve target identification, because the images will be naturally registered, meaning the two color dots that make up each pixel are able to simultaneously focus on a single location.

Sofradir; Châtenay-Malabry, France; www.sofradir.com

IF BANDWIDTH MINIATURE TUNER

The AKON A20-MX164 is a 0.8-20 GHz pre-channelized microwave tuner featuring a 30 dB dynamic range expander and integrated input switch/limiter. It features an 8-channel filter bank preselector, which eliminates received image frequencies. The tuner is just 7.5 x 4.8 in. and features dual conversion steps to a final IF output frequency of 1 GHz. Output bandwidth is selectable between 500 and 50 MHz and conversion gain is 5 dB, with dynamic range extending to -70 dBm, of which the first 50 dB is spurious-free. The unit has an operating temperature range from -40 to 54 deg. C and is designed for operations in airborne military environments.

AKON; San Jose, CA; www.akoninc.com



SUCCESSIVE DETECTION LOG VIDEO AMPLIFIER (SDLVA)

Hittite Microwave Corporation recently released the HMC913LC4B Successive Detection Log Video Amplifier (SDLVA). Available in a compact 4 x 4 mm surface mount package, the HMC913LC4B operates over the 0.6-20 GHz frequency range and features RF limited input circuitry. This SDLVA is ideal for designers with space and power-constrained applications including EW and ELINT receivers, DF, radar, ECM, IFM systems and missile guidance systems. The HMC913LC4B is capable of processing RF pulses with amplitudes from -54 dBm to +5 dBm with less than 10 ns rise times and with only 25 ns of recovery time. It exhibits frequency flatness of better than ±2 dB at -25 dBm input power, while logarithmic linearity is better than ±1 dB over the full -40 deg. to +85 deg. C operating temperature range and consumes only 290 mW from a single +3.3 V supply.

Hittite Microwave Corporation; Chelmsford, MA; www.hittite.com

SURFACE-MOUNT SYNTHESIZER

EM Research has launched the UPN-7500, a programmable, high-frequency, surface-mount synthesizer designed to withstand shock and high-vibration environments. The UPN-7500 operates from 5500 to 7500 MHz. and is designed to withstand up to 9.26 Grms random vibration and 30 Gs peak pulse of shock. The small, customizable units are ideal for applications involving software defined radios, EW, radar, airborne, satellite communication receivers and any other high vibration environments. The synthesizer features 5 MHz step size, more than 200 µsec settling time at any frequency step, 125 MHz external reference, +3 dBm output power, and low phase noise. The unit typically consumes 115 mA of power and can perform extended operations at a temperature range of -45 deg. to +85 deg. C.

EM Research, Inc.; Reno, NV; www.emresearch.com

EW Against Modern Radars – Part 6

Radar Electronic Protection

Although electronic protection (EP) is one of the subfields of electronic warfare, it is unlike electronic support (ES) or electronic attack (EA) in that it does not typically involve specific EW hardware. It is, rather, a number of features of sensor systems which are designed to reduce the effectiveness of enemy jamming. Thus, we say that EP does not protect your platform, but rather protects your sensors. We discussed EP techniques to protect communication systems in the May to October 2009 "EW 101" columns. Now, we will cover Radar EP.

Table 1 lists the principal radar EP techniques and the EA techniques against which they provide protection.

1: ELECTRONIC PROTECTION TECHNIQUES

Technique	Protect Against
Ultra-low Side Lobes	Radar detection & side-lobe jamming
Side Lobe Cancellation	Side-lobe noise jamming
Side Lobe Blanking	Side-lobe pulse jamming
Anti-Cross Pol	Cross-pol jamming
Pulse Compression	Decoys & Non-coherent jamming
Mono-pulse Radar	Many deceptive jamming techniques
Pulse Doppler Radar	Chaff & non-coherent jamming
Leading Edge Tracking	Range gate pull-off
Dicke-Fix	AGC jamming
Burn-through Modes	All types of jamming
Frequency Agility	All types of jamming
PRF Jitter	Range gate pull in and cover pulses
Home on Jam Modes	All types of jamming

As we discuss each of these techniques, it will be necessary to get into related subjects, such as the way the radar processes data. You will also see that what we are calling "EP techniques" are sometimes incorporated in radars for other reasons and provide anti-jamming protection as an additional benefit. As we go through these techniques, you will note that the amount of anti-jam protection depends on the details of the implementation and that some techniques attack more than one type of jamming.

Useful References

A text book recommended for those who want to go into the math behind electronic protection techniques is *Electronic Warfare in the Information Age* by Dr. Curtis Schleher (1999, *Artech House*, ISBN: 0-89006-526-8). Another text that is very helpful in understanding radar operation is *Introduction to Airborne Radar Second Edition* by George Stimson (1998, SciTech, ISBN: 1-891121-01-4).

Ultra-Low Side Lobes

Figure 1 shows the gain pattern of a typical radar antenna. Note that the angular variation of gain is shown in two views. The top view is a polar plot of gain vs. angle. If you go to an antenna manufacturer's website and look up the gain pattern for a specific antenna you will see a family of curves like this. The curves are generated by placing the antenna in an anechoic chamber and rotating it on a turntable. There is a carefully calibrated transmitting antenna in a conical section of the chamber and all of the chamber's surfaces are covered with radio absorptive material. Thus, the antenna on the turntable only receives direct waves from the transmitter. All reflections from the antenna and elsewhere are absorbed at the chamber walls. If the antenna under test is rotated 360 degrees in the horizontal plane, the resulting received power level is propor-

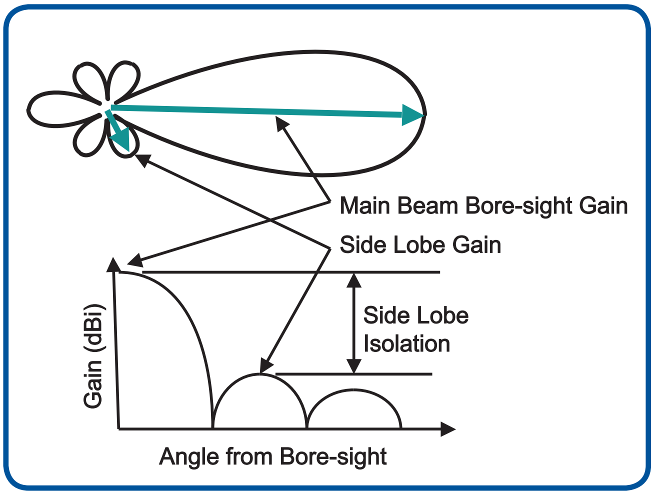


Figure 1: Antenna side lobes allow radar detection and jamming from any direction.

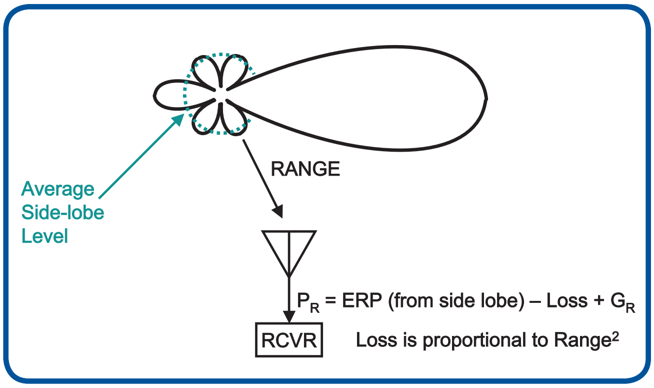


Figure 2: Signals received by an intercept receiver away from the antenna main lobe direction are reduced by the radar's average side lobe isolation.

tional to the antenna gain toward the transmitting antenna. The displayed curve of relative received power is then the horizontal antenna pattern. The antenna can then be reoriented 90 degrees on the turntable and rotated to determine the vertical antenna pattern. The website may have a whole family of curves in various planes around the antenna.

The lower curve in the figure shows angle from the bore-sight on the abscissa and gain on the ordinate. On this curve, the bore-sight gain and the relative level of the first side lobe are defined. The bore-sight and side lobe gains are properly stated in dBi (dB relative to isotropic) and the relative side lobe level is properly stated in dB.

The gain pattern is normally defined relative to the main beam bore-sight gain. The bore-sight is defined as the direction the antenna is intended to point. This is almost always the direction to which the antenna has its maximum gain, either for transmission or reception.

This gain pattern is a sine(x) / x pattern near the bore-sight. There is a null at the edge of the main beam and there are side lobes in all other directions. The side lobes beyond the first one or two are determined by reflections from structure. There is often a large back lobe. The nulls between the lobes are much narrower than the side lobes, so if we consider the average side lobe level, we have a reasonable estimate of the radar antenna transmit or receive gain that will be encountered in an EW interaction away from the radar's main lobe.

There is no crisp definition of "ultra-low side lobes." This merely means that the antenna side lobes are much lower than might be expected from a normal antenna. Dr. Schleher gives a range of values that are reasonable, even though some specific antennas may vary from this. He defines:

- "Ordinary" side lobes as 13 to 30 dB below the peak main beam (or bore-sight) gain with average side lobe peak gain as 0 to -5 dBi
- "Low" side lobes as 30 to 40 dB below the bore-sight gain with peak gain of -5 to -20 dBi
- "Ultralow" side lobes as more than 40 dB below the bore-sight with less than -20 dBi gain.

EW Impact of Reduced Side Lobe Level

In order to detect the presence of a radar that has not yet acquired a target, the receiver (e.g., a radar warning receiver) must have adequate sensitivity (including its antenna gain) to receive the radar signal side lobe signal. The receiver sensitivity in this case demands enough received signal power to determine direction of arrival and support analysis of signal parameters to determine the radar type and operating mode. As shown in Figure 2, the radar ERP applicable to the side lobe intercept problem is the transmitter tube output increased by the average side lobe gain. The signal from the radar diminishes as the square of distance from the radar. Therefore, a reduction of side lobe gain by10 dB (i.e., 10 dB less effective radiated power in the side lobe direction) reduces the detection range by a factor of the square root of 10 (i.e., 3.16) for any fixed receiver sensitivity level. An additional 20 dB side lobe isolation would decrease the detection range by a factor of 10.

As discussed in the December 2009 "EW 101" column, Stand-off jamming is normally performed into a radar's side lobes. As shown in **Figure 3**, stand-off jamming to signal ratio (J/S) is a function of the relative effective radiated power (ERP) of the jammer and radar, the ratio of the 4th power of range to the target (RT) to the square of the distance from the jammer to the radar (RJ), and the ratio of the average side lobe gain (GS) to bore-sight gain (GM) of the radar antenna. Thus, if everything else remains the same, a reduction of side lobe gain of 10 dB will reduce the range (to the jammer) at which a particular J/S can be achieved by a factor of 3.16. An additional 20 dB side lobe isolation would decrease the stand-off jamming range by a factor of 10.

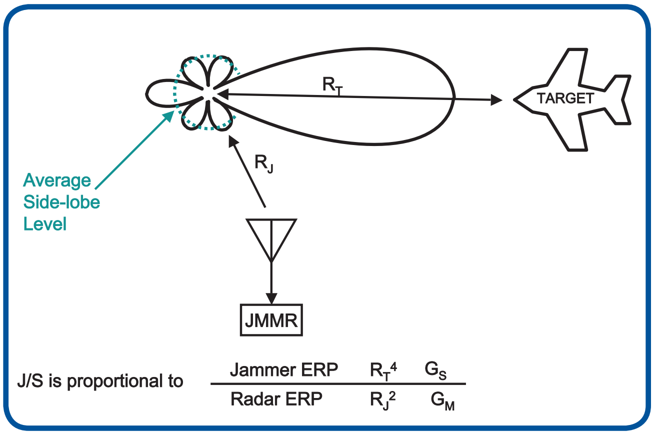


Figure 3: The J/S achieved by a side lobe jammer is reduced by the side-lobe isolation of the radar's antenna.

What's Next

Next month, we will continue our discussion of Radar EP with side lobe cancellation and side lobe blanking. For your comments and suggestions, Dave Adamy can be reached at dave@lynxpub.com.

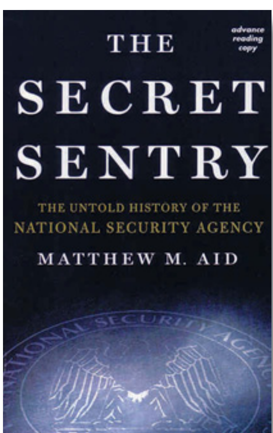
book review

NEW NSA HISTORY PULLS BACK THE CURTAIN

The Secret Sentry: The Untold History Of The National Security Agency, By Matthew M. Aid

By Kernan Chaisson

It's a good sign when a new book on the history of the National Security Agency (NSA) prefaces section after section with "based on recently declassified documents." This is an oft-repeated statement throughout the recently published *The Secret Sentry: The Untold Story of the National Security Agency.* While doing research in 2006 at the National Security Archive at George Washington University, author Matthew M. Aid discovered a massive document declassification program, which added to the two decades he'd already spent researching formerly top-secret documents. Aid also had help from the staff at the National Security Agency for Cryptologic History (CCH) and the National Archives at College Park, MD. The result was the story of the NSA from its birth in the Army through the post-9/11 era.



Aid broke new ground in describing the most important source of intelligence for the US government and source of nearly 60 percent of the President's Daily Brief. Access to new source material made it possible to create a more detailed history of the ultra-secretive agency than previous books have. Not only does he tell the NSA story, he tells it in the agency's own words. A valuable part of the history is the extensive, detailed notes in the back – at 94 pages, they make up nearly one quarter of the book.

Aid begins with historians noting that the initial stages of the Cold War "began well before the end of World War II, with the United States emerging as an atomic super power." He takes the reader through those early times, detailing the Army's Signals Security Agency (SSA) and how its world war experiences morphed into what would eventually become the NSA. He tells how the rapid post-war demobilization took a toll on America's signals intelligence capability. Using the newly declassified memos and documents, the author traces a climb from what was called "Black Friday", October 20, 1948, when "the newly independent US Air Force formally activated the US Air Force Security Service (USAFSS), responsible for COMINT coverage of the entire Soviet air force and air defense system. (But) Washington was slow to provide the necessary resources that the COMINT organization so desperately needed."

The book then tracks SIGINT, COMINT and cryptography's travails until, on May 20, 1949, the Armed Forces Security Agency (AFSA) "was given the responsibility for the direction and control of all non-tactical COMINT and security activities. Fatally flawed from the start, AFSA" appeared set up for failure should a conflict break out; and on Sunday, June 25, 1950, that is exactly what happened.

What follows is a journey in operational detail through the Korean War, from the shaky beginnings to how SIGINT and COMINT matured as a tactical combat tool. But it was not all smooth sailing, and when China entered the conflict there was a significant amount of intelligence data that had been gathered, "but it was ignored or discounted because it ran contrary to the prevailing wisdom of the US Intelligence community," something that rings sadly familiar today.

The story continued until on October 24, 1952, when, at a morning meeting at the White House, President Harry Truman signed an eight-page directive making SIGINT a national responsibility and designating the secretary of defense as the executive agent for all SIGINT activities. In that ten-minute meeting the NSA was born.

The Eisenhower years and the Vietnam era were filled with ups and downs for the agency, with its history richly illustrated with the uncovered memos of the various directors and leaders.

The end of the book discusses the period from Operation Desert Storm to today's combat in Iraq and Afghanistan, as well as the War on Terror. Aid is able to bring some new additions to the story. This includes the problems created for the overworked and under-resourced organization in recent years, troubles to be faced and questions to be answered. He titles the chapter covering from 9/11 through the invasion of Afghanistan "Snatching Defeat from the Jaws of Victory," and closes with one retired NSA official saying, "I guess we are going to have to go back to the 'bad old days' of doing more with less. It was a great ride while it lasted."

The Secret Sentry: The Untold History of the National Security Agency, by Matthew M. Aid is published by Bloomsbury Press, New York, ISBN 978-1-59691-515-2.

AOC

association news

EW PIONEER CARL MILLER PASSES

Dr. Carl William Miller, a pioneer in electronic warfare and other uses of radio technology, passed away March 31 at Woodside Hospice in Pinellas Park, FL. Miller was 89.

Born in Waurika, OK, in 1920, Miller attended college at Oklahoma A&M College (now Oklahoma State University) then went to work in the Naval Research Laboratory, where he helped develop a jamming technology to defeat German guided missiles during World War II.

He worked as a department head at Cornell University, where he had earned his doctorate, and spent many years working for the Air Force, notably at Holloman Air Development Center in New Mexico in the 1950s and 1960s and later spending 14 years at Wright-Patterson Air Force Base in Ohio.

Earlier in his career, Miller worked with NASA, participating in top secret projects that successfully launched monkeys into space and returned them safely – the first time a human-like species had done so.

During his time with the Navy and Air Force, Miller received a medal and numerous letters of commendation from generals for his work in electronic countermeasures. He was also a prime contributor to the highly respected book series, "The History of U.S. Electronic Warfare," which traces EW from its World War II origins through the Cold War and Vietnam to the modern upsurge in interest and technology that established EW as an integral part of defense and security.

Dr. Miller is survived by his wife Mildred and four daughters.

OLD CROW FRANK STEPHENS PASSES

Longtime AOC member Frank Thomas Stephens of Shalimar, FL, died Friday, March 26, 2010, following a four-year battle with cancer. Stephens was 52 years old, born November 2, 1957, in Savannah, GA, to Clifford Drayton Stephens and Jeannette Margaret Rose Wood Stephens.

Stephens served in the US Air Force for 23 years before retiring as a Master Sergeant in 2000. During his Air Force career, he specialized in Electronic Countermeasures (ECM) and Electronic Warfare (EW). After retiring, he joined Jacobs Engineering, where he spent 10 years as a senior engineer and Task Leader on the Operational Test Program for the Lockheed U-2 'Dragon Lady' reconnaissance aircraft. Stephens held a bachelor's degree in Computer Information Science from Troy State University.

He is survived by his wife of 19 years, Susan Lynn Stephens.

Donations in Stephens's memory can be sent to: Shalimar United Methodist Building Fund (www.shalimar-umc.org), Covenant Hospice (www.covenanthospice.org) or The American Red Cross (www.redcross.org).

CHESAPEAKE BAY ROOST HOSTS KEN MILLER

AOC Director of Government and Industry Affairs Ken Miller was the guest speaker at the March Chesapeake Bay Roost Luncheon. Miller spoke on a variety of topics, including the AOC 2010 policy agenda, the Radio Spectrum Inventory and Relocation process, the Comprehensive Electronic Warfare Strategy and the challenges and opportunities for AOC's future. After the presentation, Miller fielded a broad array of questions from luncheon attendees.

The Chesapeake Bay luncheons are held the third Thursday of every month from September to May in the Pioneer Hall of the National Electronic Museum in Linthicum, MD. For more information about the roost and its activities, contact Roost President John Hawkins at Hawkinsje@msn.com.

John Hawkins (right), president of the AOC Chesapeake Bay Roost, thanks Ken Miller, AOC Director of Government and Industry Affairs, for speaking at the chapter's luncheon.

DIXIE CROWS HAVE AWARDED $600,000+ IN SCHOLARSHIPS

In addition to completing its successful 35th Annual Symposium, which welcomed more than 1,300 registrants to Warner Robins, GA, March 21-25, the Dixie Crow chapter surpassed another milestone in its educational giving. Since the inception of the chapter's Education Foundation/ Scholarship Fund promoting continuing education in our local community, Dixie Crows have awarded $615,000 in scholarships. With Adam Delestowicz, Dixie Crow Education Foundation Chairman at the helm, the Chapter currently supports an annual budget of $45,000 distributed annually to our local colleges/universities and to other civilian/military workforce at Robins AFB.

Maj Gen Polly Peyer, WR-ALC/CC, was available during the Dixie Crow Symposium Exhibitor Reception to congratulate all of the recipients. A special thanks to symposium exhibitors and participants that have over the years made the Dixie Crow Education Foundation Scholarship Fund such a success!

Georgia Tech Recipients ($1,000 each)

Joel Revis	Clinton Blackburn
Michael Watts	Virgille Arquisola
Jourdyn Hunsaker	Lee Stokes
Cody Hall	Jonathan Skoczylas
Harold Kimball	Laura Epps
Lee Farris	Dane Kalejta

Current Civilian Work Force and Military Recipients

Terry Ellington	Ron Smith
Nathan Boehm	Santiago Goins

Mason State College Recipients

Sondra Wiseniske, $1,000	William Blunk, $1,000
Tiffany Richards, $2,000	Vincent Vinson, $2,000
Brian Lee, $2,000	

Mercer Engineering Recipients ($750 each)

Jacob Hopkins	James Herring
Clifton E (Chip) Bell	Cody Duane Fowler
Chase Cameron (Chase) Quinton	Michael William Walter
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