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JED

The AOC Electronic Warfare Publication
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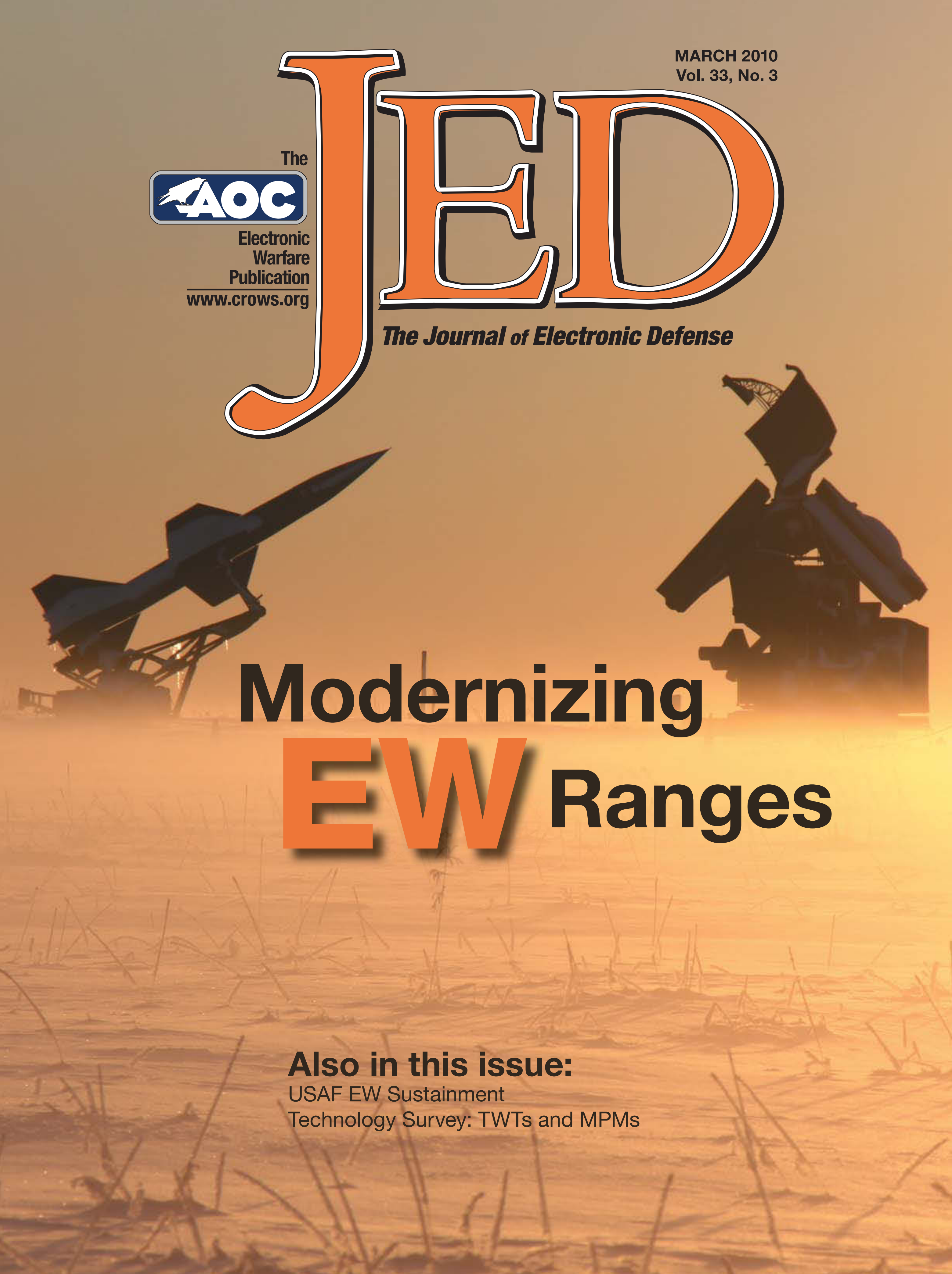
The Journal of Electronic Defense



Modernizing EW Ranges

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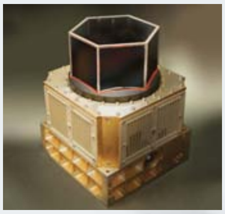

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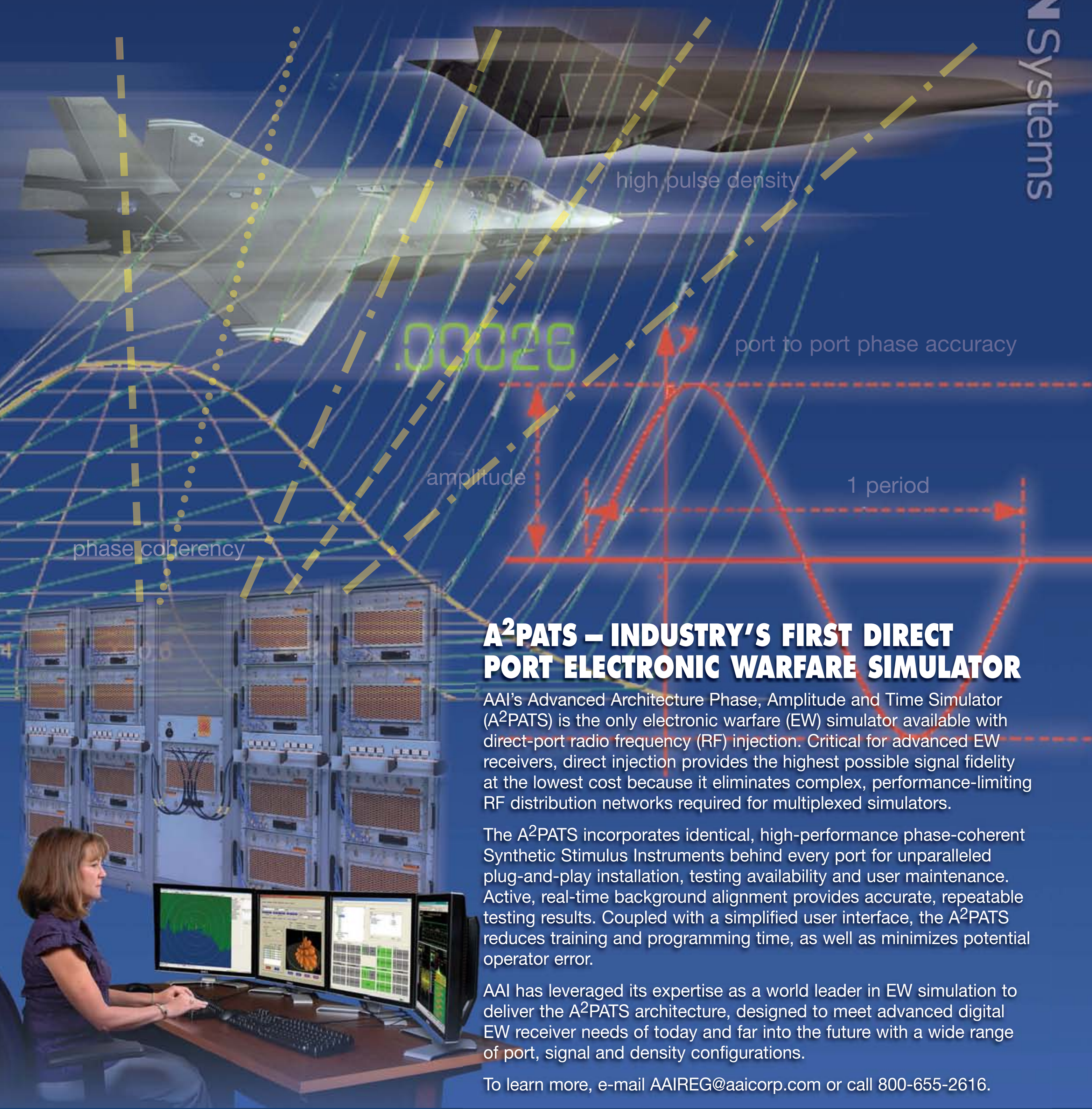

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THOUGHTS ON THE NEXT QDR

Last month, the DOD released the 2010 Quadrennial Defense Review (QDR) and the President's FY2011 budget request. On the whole, these were fairly well received within the EW community. The warfighter's need for EW (especially land and air electronic attack) was cited throughout the QDR (I can't remember past QDRs saying much about EW at all), and the DOD's budget request certainly endorsed that view with broad support for many EW programs.

By themselves, the QDR and the FY2011 budget request are very significant for EW. They are the culmination of many years of tough EW lessons in Iraq and Afghanistan, and they reflect the DOD leadership's much improved understanding of EW in recent years. For the EW community, this is a major achievement, and it proves that leaders will listen if we communicate effectively. I have to confess that until recently I have never thought the QDR was very important, primarily because it didn't seem to have much to say about EW or much bearing on specific EW programs within the DOD budget. This time around, however, the relationship between the two is much clearer.

Now that the EW community is achieving some success in building wider advocacy, we must ask ourselves the question, how do we continue growing broad support for EW over the long term? Where do we go from here? There are many facets to that answer, of course; leadership, training, lexicon, outreach, technology investment and a million other things come to mind. One way to consider this question is to ask another: What should the 2014 QDR say about EW?

I think the 2010 QDR provides an excellent foundation for reaching the next level of understanding and advocacy – the recognition that no fighting force can operate successfully anywhere at any time, unless it achieves effective control of the electromagnetic spectrum. In this context, the 2014 QDR could address EW in the broader concept of electronic support and electronic protect, in addition to electronic attack. Perhaps the next QDR will refer to spectrum control and electromagnetic battle management (EWBM). Who knows?

Whatever the 2014 QDR says about EW, it is important to recognize that it will depend on us, the EW community, to shape those words. EW's current elevated status is not a matter of simple luck. It is the result of the vision and hard work of many in our community. We must continue to refine our vision and broadcast it widely with a sense of purpose. If EW is to serve our warfighters and leaders in the future, it is essential that we continue grow and evolve our EW concepts with a solid understanding of its tactical and strategic importance, as well as the need to continually demonstrate and reinforce that significance to the DOD leadership.

– John Knowles

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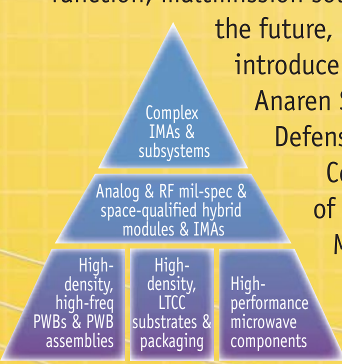

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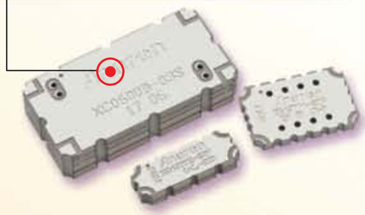

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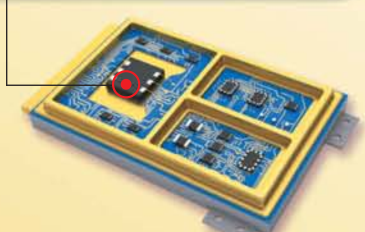

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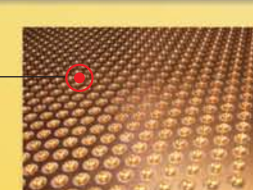

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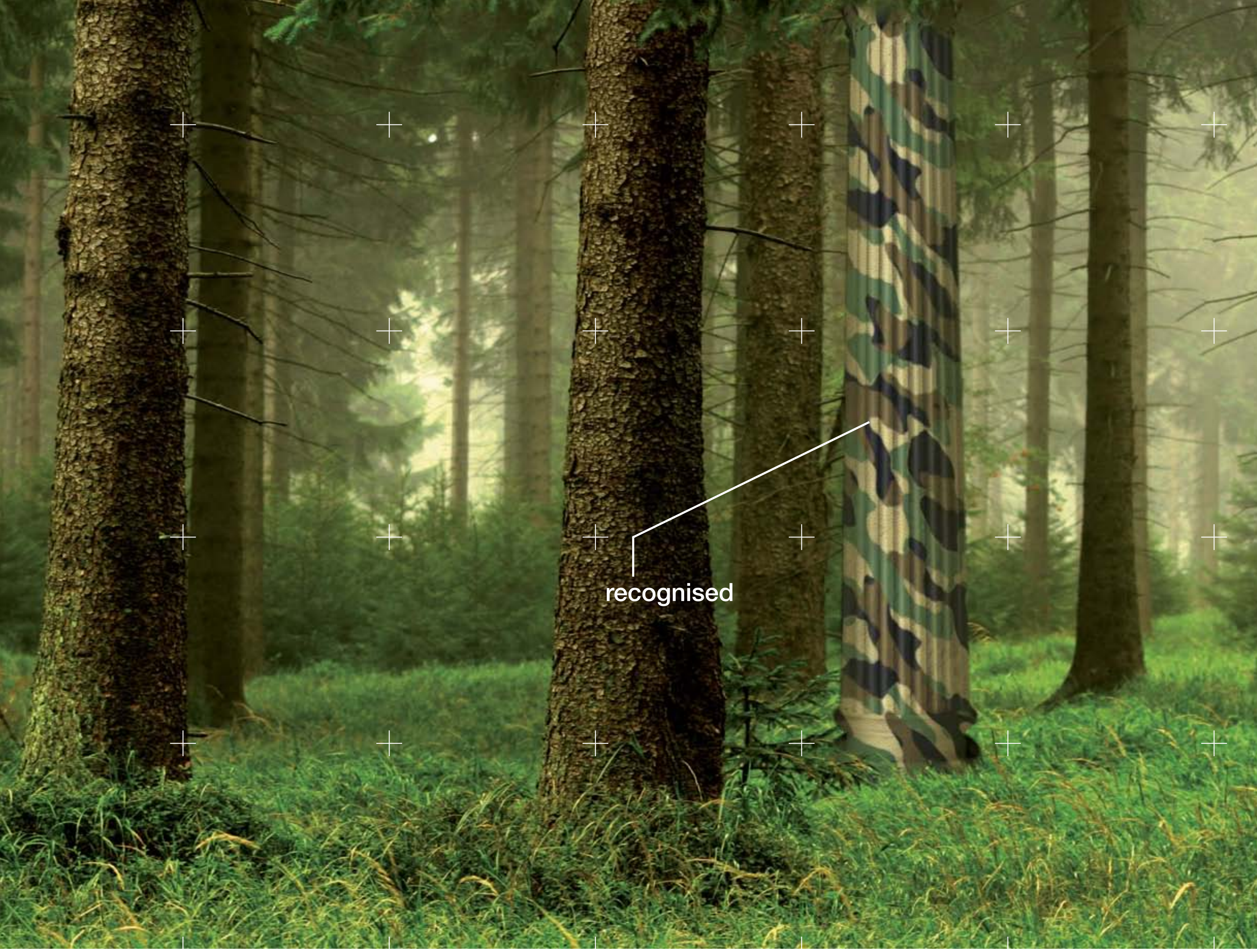

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message from the president

RESOURCING EW THROUGH A COHERENT MESSAGE

Last month, the US government released strategic documents that will impact the Electronic Warfare mission area throughout the Future Years Defense Plan (FYDP). On February 1, the Fiscal Year (FY) 2011 defense budget proposal, the war funding supplemental, and the 2010 Quadrennial Defense Review (QDR) were released. The defense budget proposes $708 billion for FY2011. Although this figure represents a modest 1.8 percent in real growth in US defense funding, the budget did yield a couple of significant funding items for the EW community; $1.1 billion for 12 Growlers in FY 2011 and $2.4 billion for an additional 24 in FY 2012. The Navy will now purchase a total of 114 Growlers and can now recapitalize four expeditionary electronic attack squadrons, which were non-existent under the old program numbers. Also, although the figures were not provided, it looks as if the Air Force will gain an additional EC-130H Compass Call airframe. These EW procurements are good news for the joint warfighter and respond directly to Combatant Commanders' urgent operational requests for additional Joint Airborne Electronic Attack (EA) capability.

Our community (in uniform and out) has worked hard to highlight the importance of Electronic Warfare over the last several years. The procurements above are a direct result of individuals articulating a message that is resonating in larger forums – that *Electronic Warfare is a critical component of warfare in the Information Age.* And we are beginning to see threads of that coherent message emanating across US strategic documents, particularly in the 2010 Quadrennial Defense Review.

The FY2011 budget will begin to implement the recommendations of the QDR, which was completed in January. The QDR is guiding the formulation of the FY 2011-2015 FYDP and will also guide preparation of the DOD budget for FY2012 and beyond. As a result, the FY2011 budget request supports the QDR's call for better EW capabilities for today's warfighters.

With regard to the Pentagon's long-term strategy, initial reports of the QDR suggest that EW may play a prominent role in the Pentagon's future defense strategy. The QDR says, "to counter the spread of advanced surveillance, air defense and strike systems, the department has directed increased investment in selected capabilities for electronic attack." Furthermore, the QDR recognizes "the need to expand our electronic warfare capabilities and enhance intelligence and information operations capabilities. These key capabilities, as well as new technologies being explored, support flexible and effective forces for today's fight and contribute to our readiness for operations across the full range of military operations."

So while it appears as if we are on the right path, our community must retain its coherent message as we address defense budgets across the FYDP. I urge you to stay informed and stay connected with your Association as we move our profession forward!

– Chris "Bulldog" Glaze

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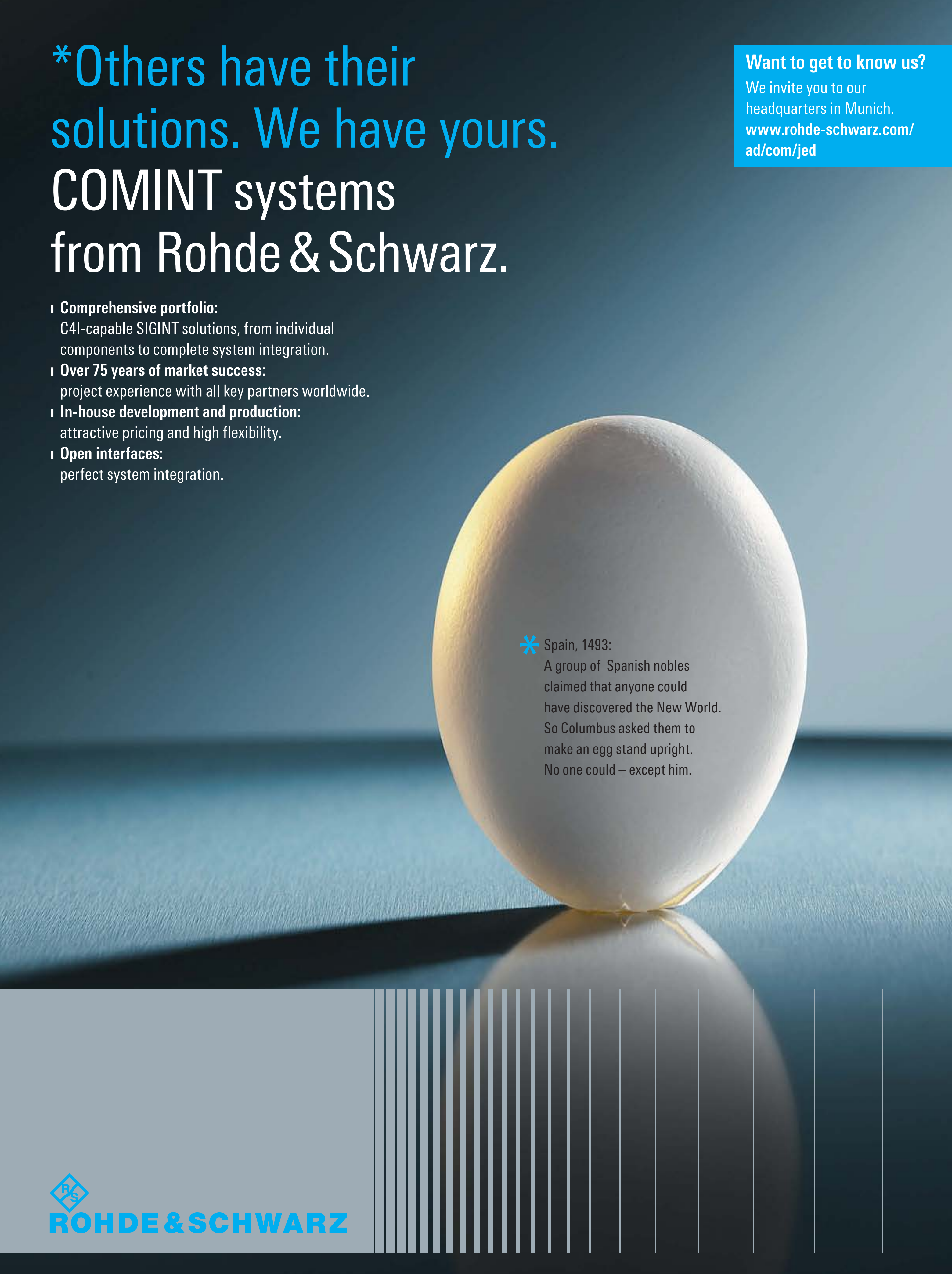
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CHINESE POLICY TIED TO EW ACQUISITIONS

I read your article "All Eyes on China?" ("EW in the Asia-Pacific Region," January 2010) and have some comments. Nicely done.

I believe that the best indication of China's future foreign policy, especially as the foreign policy is reflected in Chinese military developments, is the direction of Chinese EW acquisitions. Said another way, as goes Chinese foreign policy, so goes Chinese EW development. The key statement in your article reflecting my view was, "China is expected to become a major military equipment supplier to many of its allies in the region." Right on point.

China is building a military co-equal to its massive but unequal economic development, and not necessarily for the purpose of projecting military power. My view contrasts with prevailing opinions from our US military leadership. China will protect its global interests, but not at the expense of interrupting the markets that buy Chinese products.

EW systems do not exist for themselves, rather they serve a mission purpose tied to policy. If the Chinese acquire and equip aircraft EW systems in militarily significant numbers for the purpose of manned penetration of adversary airspace, that would be a powerful signal to the US and our allies. There is a difference in aircraft EW systems used in the air defense of national airspace and aircraft EW systems used in manned penetration of an adversary-integrated air defense system.

Subtle, but different. A particularly alarming signal would be if China moved toward an Air Mobility Command structure with modern aerial refuelers and manned penetration supporting EW capabilities. So far that has not happened in militarily significant numbers.

So what does all of this mean?

- China acquires military aircraft EW systems for the purpose of protecting its national airspace and for enabling its military to guarantee China's access to global markets. Not for military power projection in the American sense of power projection. Example, Chinese naval aircraft will not appear over Kingston, Jamaica. However, China's Navy will ensure its export relationship with Jamaica flourishes.
- Chinese leadership does not envision a Chinese version of an Operation Enduring Freedom (Afghanistan).
- China's foreign policy is competitive, not aggressive. Aggressive seeks military domination, competitive seeks economic access. The Chinese are competitive at the moment and are likely to remain so indefinitely.
- The best and most visible indicator of Chinese intentions will be the functionality of EW systems it acquires for Chinese naval aircraft and the types of radars China equips its Navy ships with. Analyzing Chinese aircraft EW functionality will be one of the most important things our intelligence community does in the near term. Example, Chinese development of an E-2C Hawkeye capability mated to an aircraft carrier with refuelable strike fighters would be a powerful indicator of a move toward an aggressive foreign policy. Acquisition of an Aegis radar system for certain Chinese naval vessels indicates a move toward a competitive foreign policy.

It is not that China is flirting with an aircraft carrier that matters; it is the mission capability of the assets aboard the aircraft carrier that are the best indicators of the direction of China.

Thanks again for your article and your scholarship.

Tom Brannon, Electronic Warfare Associates

KEEPING UP WITH THE SPECTRUM

Stellar heads-up editorial message, "Where Has All the Spectrum Gone" (Message From the President, January 2010); have contacted my Representative Walter B. Jones, 3rd District eastern NC and provided him with a snapshot of your four major points and my strongest request to stop HR 3125. Hopefully, I'll get a response and be able to provide him and his staff with more detailed information from your editorial.

As the Operations Director for the Mid-Atlantic Electronic Warfare Range (MAEWR) at MCAS Cherry Point, NC, and being co-located with the Navy Ranges Spectrum Manager, we know full well the impact of everything in your editorial and deal with it on a daily basis. Furthermore, we constantly request frequencies to support events and missions up and down the entire east coast that support the 2D Marine Aircraft Wing and the major naval exercises directed by Commander, Strike Force Training Atlantic.

Cannot thank you enough for informing us in the trenches about legislation that directly undermines our national defense. The *Journal* is our go-to pub for big picture SA. So, THANK YOU and keep it coming!!

Mike Dolan

the monitor
news

ARMY CIRCM PROGRAM GEARS UP

The US Army plans to kick its nascent Common Infrared Countermeasures (CIRCM) program into high gear within the next several months. The service aims to develop a laser-based, directed IRCM system that is light enough to fit on its rotary-wing aircraft, particularly its utility and attack helicopters, as well as on those of the other three services. The key to driving down system weight is to shrink the size of the gimbaled laser pointer-trackers or jam heads, which direct high-intensity modulated beams of IR laser energy at incoming IR-guided missiles to confuse their guidance systems. Two jam heads, typically one on each side of a helicopter, provide near- hemispheric protection.

The CIRCM (pronounced "kerkum") program gained approval from Army and DOD officials in mid-February to move forward. The service's planned next step as this issue went to press was to conduct one or two CIRCM industry days to help refine a draft request for proposals before releasing a final RFP this spring, according to Army LTC Ray Pickering. He is the IRCM product manager at Huntsville, AL, under the Program Executive Office for Intelligence, Electronic Warfare and Sensors at Ft. Monmouth, NJ. He told *JED* that the Army hopes to select two or more competing contractors by October 1 to conduct a Technology Development phase, and subsequently plans to down-select to a single contractor for an Engineering and Manufacturing Development (EMD) phase. The Army's target for the First Unit Equipped milestone is 2017, he said.

Pickering said the Army had gained valuable insights about the maturity of available CIRCM technology from five months of testing CIRCM prototypes developed by several EW companies. That testing concluded in December. Five companies – ATK, BAE Systems, DRS, ITT and Northrop Grumman – participated in the Army's voluntary reliability characterization and jam head performance evaluations.

A key CIRCM requirement, in addition to high reliability and low total ownership cost, is the total system weight, which has not yet been finalized, Pickering said. That weight comprises A-kit and B-kit modifications to an aircraft. The A-kit includes the cables, mounting brackets and other structure required for each different type of aircraft to be wired to accept the B-kit. CIRCM's nominal B-kit consists of two jam heads, two lasers and two jam head control units.

CIRCM's total system weight requirement previously stood at 120 pounds. Pickering said that figure likely would be adjusted because it was difficult to meet for the larger helicopters due to the heavier A-kits they require. For example, the CIRCM A-kit for the Marine Corps' AH-1W helicopter might weigh 10 pounds less than the A-kit for the Army's CH-47 Chinook. The Army was leaning toward having a B-kit weight limitation of 85 pounds, Pickering said, while allowing the A-kit weight to vary based on the size of the helicopter.

Mark Hutchens, CIRCM program manager at BAE Systems (Nashua, NH), argued that total system weight (A-kit + B-kit) was a more relevant requirement for helicopters with little weight to spare, such as the Army's UH-60 Black Hawk and AH-64D Apache helicopters. As he told *JED*, "Every pound counts for those smaller platforms."

Earlier-generation laser-based IRCM systems with much higher weights have been in service on Air Force transport aircraft and on Marine Corps CH-53E and Army CH-47D Chinook heavy-lift helicopters. Northrop Grumman's Large Aircraft IRCM (LAIRCM) system is used on USAF C-17s and C-130 variants. In addition, the Marine Corps began fielding the Department of the Navy LAIRCM variant in early 2009 on its CH-53E helicopters in Iraq and Afghanistan, and its CH-46s and CH-53Ds are slated to follow. Last October, the Army began installing BAE Systems' Advanced Threat IRCM (ATIRCM) system on the Army's CH-47D Chinooks in Iraq and Afghanistan under a Quick-Reaction Capability (QRC) program.

Tom Kirkpatrick, BAE Systems' ATIRCM QRC program manager, told *JED* that the total weight (A-kit + B-kit) of the ATIRCM QRC system being installed on the Chinooks is 330 pounds, including 160 pounds for its two-jam-head B-kit.

The latest version of Northrop Grumman's LAIRCM system uses a jam head called Guardian, which is smaller than its predecessor and entered service on Air Force aircraft a little over a year ago. Carl Smith, vice president of IRCM programs at Northrop Grumman Land and Self-Protection Systems Division (Rolling Meadows, IL), told *JED* that the Guardian jam head weighs 47 pounds. The company's significantly smaller jam head for its CIRCM offering, developed jointly with partner Finmeccanica's Selex Galileo (Edinburg, Scotland), is called Eclipse (see photo). It weighs 20 pounds less than Guardian, Smith noted, and has fewer moving parts, providing higher reliability.


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An advanced technology approach certain to be offered by some CIRCM bidders in lieu of a traditional direct-coupled jam head design to reduce weight is called a fiber-coupled design, or "distributed aperture" IRCM system. It was demonstrated by several of the companies that participated in the Army prototype tests last year, Pickering said. In this approach, the laser, instead of being positioned back-to-back with the jam head, transmits its light energy to the jam head from a distance over a fiber-optic cable. This allows further miniaturization of the jam head and reduces moving parts, increasing reliability. In addition, a single centralized laser can be used to power at least two jam heads, further reducing system weight and enhancing installation flexibility.

The Army previously planned to move directly into EMD for CIRCM with a single contractor. However, because of the higher jam-head weight reductions possible with a fiber-coupled design, Pickering said, the Army decided to remain in a Technology Development phase with multiple contractors to give the fiber-coupled designs some additional time and funding to mature. He acknowledged that those designs carry reliability and performance risks.

BAE Systems' Hutchens noted, "The fiber-coupled designs have had significant contractor and government investment over the last several years. At this point, I believe that increasing their maturity primarily involves issues of simple engineering and packaging that can be wrung out during a Technology Development phase." – *G. Goodman*

MALD-J PASSES DESIGN MILESTONE

The US Air Force's Miniature Air Launched Decoy Jammer (MALD-J) successfully emerged from its critical design review according to MALD developer Raytheon Missile Systems (Tucson, AZ). In completing the review, the Air Force determined that the MALD-J design had reached technical readiness level 7, enabling the program to proceed to the engineering and manufacturing development phase. In December free-flight tests, the MALD-J also successfully flew against representative threats, the company said in a press release. MALD-J is scheduled to reach the field in 2012.

The baseline MALD is currently in production, and international customers have shown significant interest in the program. At last year's Paris Air Show, the company said the UK was planning to evaluate a variant dubbed MALD-V, which is the basic MALD aircraft without any payload. If the program moved to procurement, the UK was presumably interested in supplying its own MALD payload(s). – *J. Knowles*

US NAVY TO BUY MORE GROWLERS

The Department of Defense released its budget request for FY2011 on February 1 and sent it to Congress. The big news in the budget for the electronic warfare community is that senior DOD officials directed the Navy to buy 26

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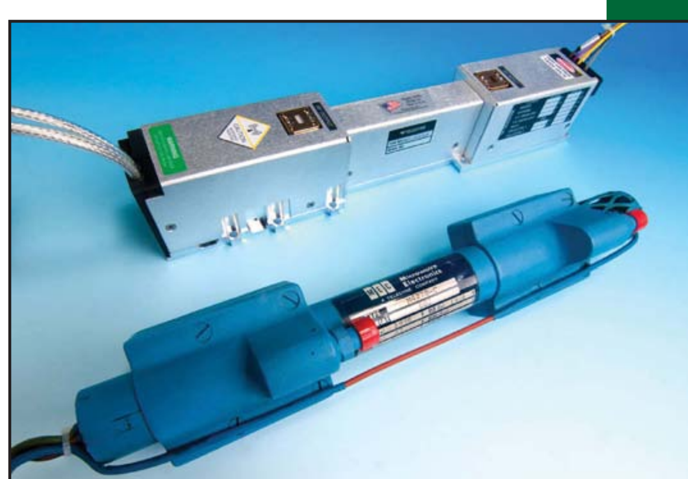

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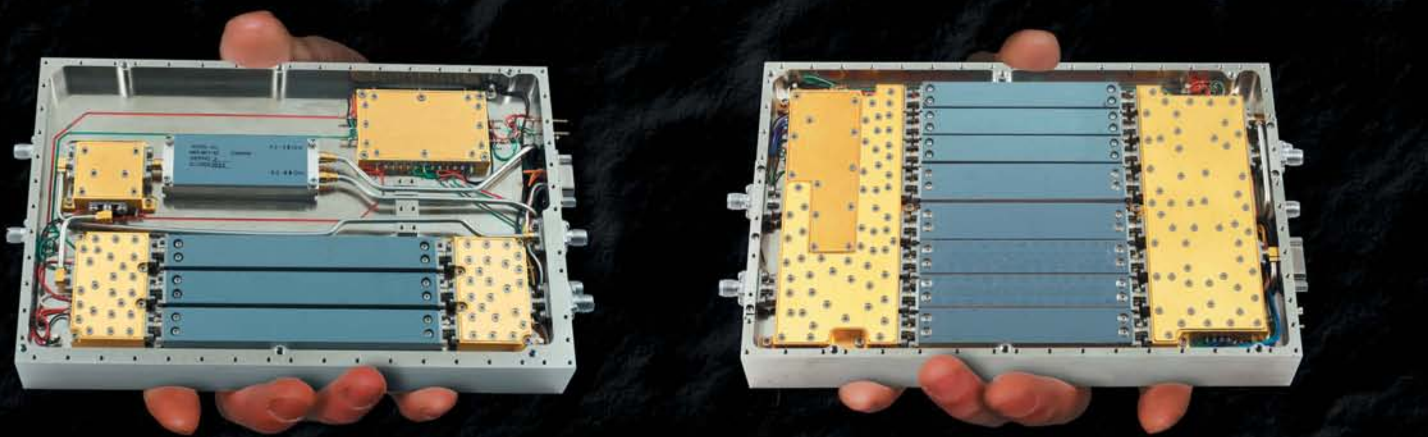

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additional new EA-18G Growler support jamming aircraft – 2 in FY2011 and 24 in FY2012 – beyond the final 10 of 88 the service had planned to order in FY2011. The EA-18G is an electronic attack variant of the two-seat Boeing F/A-18F Super Hornet and is replacing the Navy's carrier-based EA-6B Prowlers. The first Growler squadron became operational last September.

The Navy had planned to only buy enough of the new EA-18Gs to outfit each of 10 carrier air wings with a squadron of five operational aircraft by the end of 2012 and to decommission three other land-based EA-6B "expeditionary" squadrons that have provided jamming support for Air Force combat aircraft overseas. The extra 26 Growlers, to be delivered in 2014, will be used to recapitalize those three expeditionary squadrons and to reactivate a fourth. US regional combatant commanders had requested more jamming aircraft in their overseas theaters, and the Growler was seen as the best option with the Air Force having cancelled its B-52 Core Component Jammer program last year. The Marine Corps plans to continue flying its EA-6B Prowlers for another eight years or so, and there is money in the FY2011 budget request to extend the life of those venerable aircraft.

The next big piece of EW-related news in the FY2011 budget request is that DOD and Navy officials terminated the service's nascent EP-X program to develop a replacement for its aging shore-based EP-3E turboprop signals-intelligence (SIGINT) aircraft in favor of a less ambitious and less risky solution. The latter could involve using a combination of the Navy Broad Area Maritime Surveillance derivative of USAF's high-altitude Global Hawk unmanned aerial vehicle (UAV) built by Northrop Grumman and the Navy's planned new 737-based Boeing P-8A maritime patrol aircraft, with most of the SIGINT data downlinked to shipboard or shore-based processing centers. In the meantime, the Navy is requesting $222 million in FY2011 for upgrade modifications to its EP-3Es.

In other Navy budget news, the Joint Counter Radio-Controlled IED Electronic Warfare (JCREW) 3.3 program to develop a new family of vehicle-mounted, dismounted and fixed-site jammers would garner $56.5 million in FY2011, after an initial $55.6 million in FY2010. The CREW Program Office (PMS 408) at Naval Sea Systems Command (NAVSEA) is the DOD's executive agent for developing and procuring common ground-based CREW systems. PMS 408 awarded ITT and Northrop Grumman JCREW 3.3 development contracts last October.

The Navy requests $51.7 million in FY2011 for continued development of the Joint and Allied Threat Awareness System (JATAS), a new missile warning system for Marine Corps, Navy, and potentially Army rotary-wing aircraft. Naval Air Systems Command (NAVAIR) awarded ATK and Lockheed Martin competing 16-month Technology Development contracts last fall, and will choose one of the companies for engineering and manufacturing development (EMD) this fall. An initial operational capability is scheduled in 2014.

NAVAIR is slated to award up to four Technology Maturation contracts


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by the end of this month for the Next-Generation Jammer (NGJ) program. The program's aim is to provide a replacement beginning in 2018 for the aging ALQ-99 external jamming pods used by the EA-6B Prowler and new EA-18G support jamming aircraft. The program is scheduled to enter a Technology Development phase in late 2011 with at least two contractors and an EMD phase with a single contractor in late 2013. The Navy requests $120.6 million in FY2011 after initial funding of $117.5 this fiscal year.

The Navy requests $61.1 million in FY2011 for its Surface EW Improvement Program (SEWIP) Block 2 system, which is developing an upgraded antenna, receiver and combat system interface for the SLQ-32 EW system on surface combatants. NAVSEA awarded Lockheed Martin the preliminary design contract last September that runs through June, and subsequently will award an EMD contract. Development of SEWIP Block 3 to add an improved electronic attack capability to the SLQ-32 would begin in FY2011, with $4.7 million requested.

The Advanced Anti-Radiation Guided Missile (AARGM), the planned successor to the Navy's High-Speed Anti-Radiation Missile (HARM), is in low-rate initial production (LRIP) by ATK. It is starting a six-month Operational Evaluation that will lead to a full-rate production decision late this year. The supersonic stand-off missile performs suppression/destruction of enemy air defenses (SEAD/DEAD) missions. It is slated to achieve an initial operational capability (IOC) late this year on Navy fighter aircraft, and the service plans to buy 1,871 missiles. AARGM is also being acquired by the Aeronautica Militare (Italian Air Force). The FY2011 R&D request of $7.8 million continues the development of AARGM's capability to attack non-traditional SEAD/DEAD and irregular warfare targets and funds updating of its threat library. – *G. Goodman*

USAF BUYS NEW COMPASS CALL AIRCRAFT

In the Air Force's FY11 Budget Request, it is bolstering its fleet of 14 EC-130H Compass Call turboprop communications-jamming aircraft by converting a WC-130H into a 15th EC-130H over the period FY2011-2013 for $150 million. The FY2011 request totals $176.6 million in procurement funds, the lion's share to upgrade Compass Call mission equipment, and another $20.7 million in R&D dollars to develop improvements in the mission systems. Another $10 million is requested in the FY2011 wartime supplemental budget request to buy Group B hardware kits for EC-130Hs already wired with Group A modifications to accept LAIRCM.

Air Force officials, concerned about the flight hours being racked up by the workhorse Compass Call aircraft in performing non-primary counter-IED jamming missions for Army and Marine ground forces, plan to initiate a program in FY2011 to acquire a new airborne "Electronic Attack Pod." The Air Force would like a low-cost, off-the-shelf, communications jammer – to be carried externally on an undetermined tactical aircraft – that could become operational as early as 2012.

The USAF requests $89.9 million in FY2011 for the jammer variant of its

Miniature Air-Launched Decoy (MALD-J), which is set to enter engineering and manufacturing development. MALD-J will provide "stand-in" jamming close to enemy air defense radars.

The Air Force continues fielding the Large Aircraft Infrared Countermeasures (LAIRCM) system from Northrop Grumman on its transport C-5, C-17 and C-130 aircraft. LAIRCM uses laser-based directional jamming to counter shoulder-fired IR-guided surface-to-air missile threats. The latest version features a smaller laser pointer-tracker turret called the Guardian laser transmitter assembly. Development funding of $17.2 million in FY2011 will continue integration of LAIRCM on C-130Js, EC-130Js and AC-130U gunships as well as hardware and software upgrades to keep pace with emerging threats. LAIRCM installations are funded by the aircraft program offices. For example, in FY2011 the Air Force is requesting about $60 million in the base budget and $224 million in wartime supplemental funding for C-17 LAIRCM installations. The C-5 budget request allocates about $79 million for LAIRCM installations, and the C-130J program office plans to fund them to the tune of $55 million.

The Airborne SIGINT Enterprise program element funds SIGINT development efforts for all Air Force airborne platforms, including the RC-135 Rivet Joint and the RQ-4 Global Hawk, MQ-1 Predator and MQ-9 Reaper UAVs. The total budget request for all activities in FY2011 is $149.3 million. The Air Force wants $27.3 million for SIGINT capability improvements to the RC-135 Rivet Joint, Combat Sent (collects technical data on adversary radar emitters) and Cobra Ball (tracks ballistic missile flights) programs, particularly antenna and electronic intelligence (ELINT) system improvements for Rivet Joint by L-3 Communications Integrated Systems. A separate $15.3 million in funding is requested to support rapid development of incremental capability improvements to the RC-135 family by the Air Force's Big Safari program office (645th Aeronautical Systems Group).

The Air Force is well along in developing a Block 30 SIGINT variant of Global Hawk UAV, which carries Northrop Grumman's Airborne SIGINT Payload (ASIP) and is scheduled to become operational in 2011. Scaled down versions of ASIP have been in development for the Predator (ASIP-1C) and its larger Reaper (ASIP-2C) sibling. USAF FY2011 budget documents indicate that Air Force officials decided to de-scope the ASIP-1C program following recent factory acceptance tests and to focus the service's resources on developing the larger and more capable ASIP-2C for the Reaper. Demonstration flights of a prototype ASIP-2C system are slated to occur early next year, to be followed by an EMD phase to begin in summer 2011. The Air Force requests $29.8 million in Airborne SIGINT Enterprise funds for these activities in FY2011; another $18.3 million is slated to come from the Reaper UAV program itself. General Atomics, which builds the Predator and the Reaper, is integrating the SIGINT sensors on the Reaper. – *G. Goodman*

US ARMY FOCUSES ON EMARSS

The US Army's FY11 budget request reflects changes in its airborne SIGINT

program. Last fall, the Army restructured and renamed its Aerial Common Sensor (ACS) SIGINT aircraft program the Enhanced Medium-Altitude Reconnaissance and Surveillance System (EMARSS). The service requests $88.5 million in FY2011 to rapidly acquire the first three of an adapted commercial aircraft for $21.7 million each under a competitive LRIP contract to be awarded in September 2011, with first delivery in October 2012. EMARSS will carry a communications intelligence (COMINT) collection system, electro-optical/IR video cameras, line-of-sight and beyond line-of-sight communications systems, and a self-protection suite. It will have two operator workstations.

Under the Army's Guardrail Modernization Program, set in motion after the demise of ACS development, Northrop Grumman is extending the service lives of 36 operational RC-12 Guardrail SIGINT aircraft by about eight years and standardizing their configurations and adding new hardware and software to improve their sustainability and mission capability. Flight testing of the first refurbished aircraft is imminent; a total of four aircraft will be delivered by this summer. The Army is seeking $60.1 million in FY2011, $29.9 million in the base budget and $30.2 million in the wartime supplemental. Guardrail is a modified Hawker Beechcraft King Air B200 twin-turboprop with a crew of two and fitted with COMINT and ELINT systems. The total program cost, according to Army budget documents, is $1.5 billion.

The Army is asking for $71.5 million in FY2011 to procure 13 new Prophet Enhanced armored wheeled vehicle-mounted tactical SIGINT systems, the first of which rolled off General Dynamics' production line in December, and six vehicle-mounted Prophet Control systems from L-3 Linkabit. Prophet is the Army's sole organic ground-based COMINT sensor, detecting and locating enemy communications emitters. The funding request includes $6.1 million to buy 18 SIGINT Terminal Guidance systems for Army Battlefield Surveillance Brigade military intelligence battalions. The Army seeks an additional $18.9 million in the FY2011 wartime supplemental request for another 8 Prophet Enhanced and 3 Prophet Control vehicles.

Upgrade kits for 5,133 of its Duke V2 CREW jammers is sought by the Army in FY2011, using $225.7 million requested in the wartime supplemental and $24.1 million in the base budget. The upgrade extends the Duke's frequency range and stand-off jamming range. The Army ordered 16,338 upgrade kits from SRCTec in FY2009-2010. It is competing subsequent awards, with 1,050 to be ordered from the winner in July with FY2010 funds and the 5,133 in October with FY2011 funds. – *G. Goodman*

US ARMY SEEKS INFO FOR CREW SPARES AND SUPPORT

The US Army's Project Manager for Electronic Warfare (Fort Monmouth, NJ) has issued a request for information (RFI) for "CREW system replenishment spares, depot level repairable parts (DLRP) and contractor logistics support and engineering services." Program officials are asking interested companies to respond to one or more options covering various CREW systems for up to five years.

One of the options calls for provision of contractor logistics support and engineering services for approximately 27,000 CREW Duke (V)3 systems, also known as AN/VLQ-12 (V)3. A separate option calls for the same type of support and services for up to 12,500 CREW CVRJ systems, also known as AN/VLQ-12 (V)3. Other options cover 1,678 CREW MMBJ Systems (AN/VLQ-14 (V)1) and 1,500 CREW 3.1 Systems (AN/PLQ-9(V)1).

Responses to the RFI were due last month. It is widely expected that the prime manufacturers of these systems will respond to the RFI. SRCTec (Syracuse, NY), manufactures the DUKE system. ITT Force Protection Systems (Thousand Oaks, CA and Nashua, NH) manufactures the CVRJ and MMBJ. Sierra Nevada Corp. produces the PLQ-9.

The Army said that it expected to award support contracts for these systems no later than August. – *J. Knowles*

IN BRIEF

Capt Candice Sperry, USAF, a weapons officer from the 41st Electronic Combat Squadron (Davis-Monthan AFB, AZ), received the 2009 Air Force Robbie Risner Award, an honor which recognizes her as the service's top weapons officer. She is the first EC-130H Weapons Officer to win the honor, and she is the first ever woman to win. She won as a result of her deployed efforts in electronic attack in Afghanistan.

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ITT Electronic Systems (Clifton, NJ) was awarded a $44.7 million modification to a previously awarded contract from Naval Air Systems Command to exercise an option for the full- rate production of 17 ALQ-214(V)2 on-board jammers for the Navy and the Government of Australia. The jammer is a component of the F/A-18 E/F Super Hornet's Integrated Defensive Electronic Countermeasures (IDECM) suite.

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HEICO Corporation (Miami, FL) announced that its Electronic Technologies Group had acquired dB Control (Fremont, CA), a leading producer of traveling wave tube amplifiers and microwave power modules used in EW and radar applications.

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DRS Defense Solutions (Merrimack, NH) announced that its Intelligence, Communications and Avionics Solutions (ICAS) operation was awarded a $10 million US Army contract to deliver manpack/vehicular tactical SIGINT systems with direction-finding (DF) processing and associated analysis nodes.

✪ ✪ ✪

LaBarge, Inc. (St. Louis, MO) has been awarded contracts worth $1 million from BAE Systems to continue to produce circuit card assemblies for the AAR-57 Common Missile Warning System (CMWS) through March 2011. CMWS is deployed on various US Army and UK helicopters.

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2010 QDR RELEASED

The Department of Defense (DOD) has released its 2010 Quadrennial Defense Review (QDR), which provides strategic guidance for defense planning, including weapons acquisition. While cyberspace operations predictably receive a lot of attention in the new document, the need to bolster US military electronic attack capabilities is mentioned frequently, second only to specific QDR initiatives to increase the numbers of rotary-wing aircraft, Special Operations Forces, and intelligence, surveillance and reconnaissance (ISR) systems, particularly unmanned aerial vehicles.

For example, the document states, "The capabilities, flexibility and robustness of US forces across the board will be improved by fielding more and better enabling systems, including ISR, electronic attack, communications networks, more resilient base infrastructure, and enhanced cyber defenses."

Under the heading "Defeat enemy sensor and engagement systems," the QDR states, "In order to counter the spread of advanced surveillance, air defense and strike systems, the Department has directed increased investments in selected capabilities for electronic attack."

The document also notes, "Enhanced long-range strike capabilities are one means of countering growing threats to forward-deployed forces and bases and ensuring US power-projection capabilities. Building on insights developed during the QDR, the Secretary of Defense has ordered a follow-on study to determine what combination of joint persistent surveillance, electronic warfare, and precision-attack capabilities, including both penetrating platforms and stand-off weapons, will best support US power-projection operations over the next two to three decades. Findings from that study will inform decisions that shape the FY2012-2017 defense program."

Defeating the threat of improvised explosive devices (IEDs) will continue to receive great emphasis, the QDR says. "Doing so necessitates a multipronged approach that includes synchronizing counter-IED efforts Department-wide, providing specialized training, attacking the networks that make and deploy IEDs and defeating the devices themselves. Airborne EW assets in particular have been in high demand in Iraq and Afghanistan in the fight against IEDs and will be valuable in future conflict environments as well … We must assume that the IED threat will evolve and persist even as better countermeasures are developed."

The DOD is taking several steps to strengthen US military capabilities in cyberspace, the QDR notes. These include developing a more comprehensive approach to DOD operations in cyberspace; developing greater cyber expertise and awareness; centralizing command of cyber operations; and enhancing partnerships with other agencies and governments. "Strategies and policies to improve cyber defense in depth, resiliency of networks, and surety of data and communication will allow the DOD to continue to have confidence in its cyberspace operations."

"DOD must actively defend its networks. A failure by the Department to secure its systems in cyberspace would pose a fundamental risk to our ability to accomplish defense missions today and in the future. To ensure unfettered access to cyberspace, our mission-critical command-and-control systems and networks must perform and be resilient in the face of cyberspace attacks."

The DOD is taking steps to identify those mission-critical systems and networks, examining how best to further protect them and exploring ways to develop operational approaches and logistics that better address potential vulnerabilities.

The need for acquisition reform, a major thrust of Defense Secretary Robert Gates tenure, receives some strong language in the QDR. "Over several decades and across multiple administrations, the Pentagon's acquisition system has developed major problems that hamper our ability to acquire critical platforms and capabilities in a timely manner and at acceptable cost. First, the requirements for new systems are too often set at the far limit of current technological boundaries. Such ambition can sometimes help produce breakthrough developments that can significantly extend America's technological edge. But far too often the result is disappointing initial performance followed by chronic cost and schedule overruns. The Department and the nation can no longer afford the quixotic pursuit of high-tech perfection that incurs unacceptable cost and risk. Nor can the Department afford to chase requirements that shift or continue to increase throughout a program's life cycle.

"The conventional acquisition process is too long and too cumbersome to fit the needs of the many systems that require continuous changes and upgrades – a challenge that will become only more pressing over time. The Department will improve how it matches requirements with mature technologies, maintains disciplined systems engineering approaches, institutionalizes rapid acquisition capabilities, and implements more comprehensive testing. We must avoid sacrificing cost and schedule for promises of improved performance."

– G. Goodman


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INDIA HOLDS FIRST EW CONFERENCE

By all accounts, the first iteration of the EW India 2010 Conference, held in Bangalore last month, was a success. More than 90 technical papers were presented during the two-day event, and the show floor featured companies from the US, Europe, Israel and, of course, India.

The event, organized by the Defence Avionics Research Establishment (DARE) and the Shephard Group, attracted a large audience, mostly from within India. Officials from Bharat Electronics Ltd. (BEL), India's largest defense electronics manufacturer, said that EW was increasingly accounting for a larger share of the company's earnings. Over the next decade, the company expects revenue from EW programs to total approximately Rs 22,500 crore (US $4.8 billion). About $1.7 billion of that total could be contracted in the next two years. Approximately 800 of the company's employees work on EW programs. BEL officials also said the company is establishing a research center in Bangalore that will employ 20 engineers who will focus on developing EW and electro-optic technologies.

Also at the conference, officials from the Defence Electronics and Research Laboratory (DLRL) announced development of a new satellite with SIGINT capabilities. Developed jointly by DLRL and the Indian Space Research Organisation (ISRO), the satellite is scheduled for launch into low-earth orbit in 2014.

During the event, local EW officials announced the formation of a new India chapter of the AOC. AOC Executive Director Don Richetti attended the ceremony and formally welcomed the new chapter. – *JED Staff*

FRENCH ARMY SELECTS EW FOR HELOS

France's military procurement authority, Délégation Générale pour l'Armement (DGA), has awarded a contract to Thales Airborne Systems (Elancourt Cedex, France) for delivery of eight multi-spectral self-protection suites. The suites will be installed on five EC725 Caracal helicopters currently under production for the French Army's Special Operations Squadron.

The EW suite will comprise Thales' Sherloc SF radar warning receiver and MWS-20 Damien pulse-Doppler missile warning system, the RALM laser warning receiver from Selex Galileo and the ELIPS-NG chaff and flare dispenser from MBDA. Thales will integrate the EW suite and install it on the helicopters.

The French Army ordered the five EC725 helicopters in 2009. They will join eight other French Army EC725s operated in the special operations support role. The French Air Force also operates six EC725s, which are configued for combat search and rescue missions. Bth EC725 variants have played an important role in Afghanistan operations. – *J. Knowles*

In Brief

- **The Government of Pakistan** is planning to acquire an *Oliver Hazard Perry-Class* Frigate from the US via Foreign Military Sales (FMS) channels for $78 million. The deal reportedly will include the ship's SLQ-(V)2 EW system.
- **Saab** has selected the SKYWARD B IR search and track (IRST) system from Selex Galileo for its Gripen NG fighter aircraft. This follows the 2009 selection of Selex's Raven ES-05 active electronically scanned array radar for the Gripen NG.
- **The Royal Australian Air Force** (RAAF) has opted to delay its decision to upgrade 12 of its new F/A-18F Super Hornets to the EA-18G "Growler Lite" configuration, according to a February 18 article from *Flight International*. The RAAF passed on an opportunity to buy the ALQ-218 ESM system for 12 of its 24 new Super Hornets, which are currently in production. It can revisit the decision anytime in the future, but installing the capability on the production line was understood to be the least expensive option.
- **The Indian Armed Forces** released three new joint operational doctrine publications last month. The three documents are titled, "Joint Doctrine for Electronic Warfare," "Joint Doctrine for Sub Conventional Operations," and "Joint Doctrine for Maritime Air Operations." Gen Deepak Kapoor, Chief of the Army Staff and Chairman of the Chiefs of Staff Committee, announced the release at a ceremony in Delhi. "The Joint Doctrines collectively aver that it may be more appropriate to call the battlefield of future as battle space, since wars would be fought not only in air, on land and sea but also in cyberspace, on electronic fronts, along information highways and media fronts," said a press statement. The three doctrine publications were written by the Doctrine Directorate of Headquarters Integrated Defence Staff.
- **BAE Systems Australia** expects to achieve a major milestone in its Nulka decoy program, soon, when it produces its 1,000th unit. The decoy is used by approximately 130 ships in the Royal Australian Navy, Canadian Navy and US Navy.

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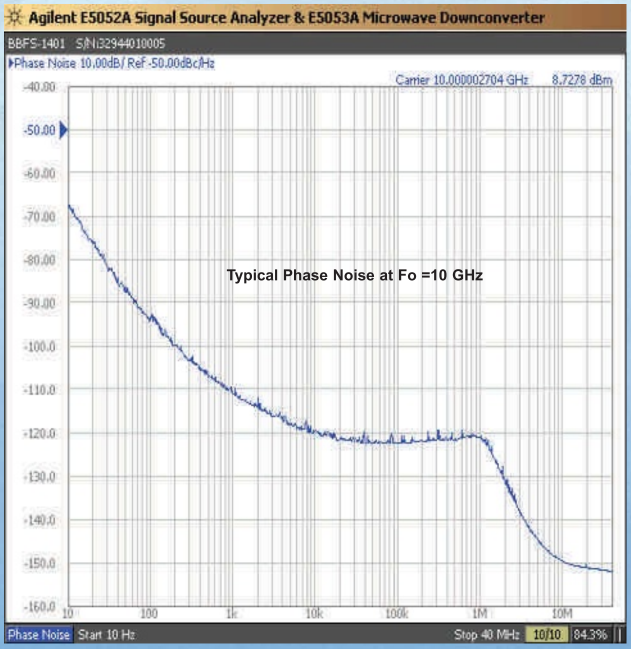

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Modernizing EW Ranges

A personal view from an EW training environment provider

By Wing Commander PJ Wallace MA RAF

There are many out there who would question the requirement to modernize EW ranges and training facilities. After all, provision of a comprehensive EW training capability can be difficult to source, and often necessitates a significant investment in personnel, time and funds. Adding fuel to the fire, it is no secret that on current operations, such as Afghanistan, we face asymmetric threats that do not always require the use of some of our traditional EW capabilities! Indeed, one of the many lessons identified in Kosovo was that older generation SAM systems can have a significant impact on air operations. So what is the requirement for upgrading EW ranges? What are we expected to train against? It is notoriously difficult to predict and, therefore, plan for, the next big combat op, so surely it is easier to simply focus on the here and now? Focusing on the "known knowns" as Donald Rumsfeld would say.

As we all know, past wars alone should not drive the future. Yet, as we look forward, if aircraft and aircrew are required to rely more and more on sophisticated self-defense capabilities, then we need to provide those warfighters with a realistic way to learn how to use them effectively. It is paramount that we afford the best protection to all our warfighters, not just in the provision of equipment but also training. This has become increasingly important as we rely less and less on organic Suppression of Enemy Air Defenses (SEAD) assets to defend us.

Whenever anyone discusses EW facility "modernization," the debate inevitably turns to high-tech threats such as the S-400 system, but is that really what we need to train our manned platforms against? If so, can we acquire it or emulate it? Or should we focus on the highly mobile, less modern but widely proliferated threats. After all, a 2001 TRADOC report stated that SA-6 and SA-8 proliferation had extended to more than 20 countries; that figure is unlikely to have reduced. The fact that some nations have funded upgrades to these systems makes them hard to ignore.

HOW MUCH IS ENOUGH?

Whatever the threat, at the end of the day, we also have to consider our training requirements carefully. How much training is enough? To what fidelity do we need to train? Do we pay for expensive real systems or accept that emulators can satisfy the "enough" caveat? Real threats undoubtedly add authenticity and credibility but are expensive; however, emulators are also credible and, generally, more reliable. The trade between real and emulated threats is more complicated when considering how to provide a representative modern integrated air defense system (IADS), particularly if land and air space is at a premium, as it is in many parts of Europe.

The answer to the dilemma probably lies in the articulation of the required training output. Provision of a training environment to allow warfighters to familiarize themselves with EW equipment will drive you to a different solution than if the need is to provide an immersive mission rehearsal environment. In the near future, systems such as the Northrop Grumman Joint Threat Emitter (JTE) will, undoubtedly, add value to EW facility development but it may not meet the needs of all platforms. The only certainty is that if you ask aircrew which they would prefer to train against, the answer will almost certainly be REAL systems!

When considering the "how much training is good enough?" question in terms of frequency, complexity and authenticity, there is clearly a requirement to become more expeditionary – taking the threat training scenario to where the warfighter needs it. Not just because modern systems are increasingly mobile but also because, if crews are subject to the same training environment over and over (whether live or virtual), they will become familiar with the scenarios and may be exposed to negative learning.

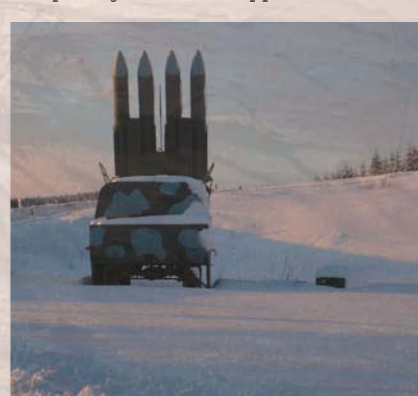
KEEPING WARFIGHTERS GUESSING

This issue is well recognized in the UK. Over the last two years, RAF Spadeadam – the UK EW Training Facility based in northern England – has worked in partnership with Computer Application Services Ltd (CAS) to develop an ability to place its threat capabilities (whether real, emulated or simulated) at multiple locations throughout the UK for major exercises. In the absence of an array of acquisition radars, Spadeadam uses a bespoke system known as the Spadeadam Integrated C3 System (SPICCCS). SPICCCS uses 3G/GPRS mobile phones, together with laptops, modems, GPS and Secondary Surveillance Radar (SSR) feeds from ATC radars in the exercise area of interest to generate a pseudo-IADS.

This allows aircraft to be identified and tagged, and for the various threats to be cued onto their respective targets. Progress of any engagement can be monitored and recorded and then sent to the crews after each mission. This works well for RF engagements, but it can also be linked to the IR threat capabilities that RAF Spadeadam possesses, providing a comprehensive and re-configurable threat environment. It can even be adapted for use in time-sensitive-targeting (TST) scenarios. Although it is not an instrumented capability, it certainly meets the "how much is enough" standard. It also presents the facility with an opportunity to incorporate a degree of improvised explosive device (IED) training into the facility, and to encourage widespread multi-layered joint training.

SUPPORTING FUTURE PLATFORMS

While it is fair to argue that we may not wish to modernize all ranges to replicate the most modern SAM systems, we do need to look at providing capabilities that meet the needs of more modern aircraft. The capabilities of AESA radars, and the step change in future aircraft performance, may lead us to need a completely different approach to some aspects of EW training in the future, or at least in respect to certain aircraft platforms. Undoubtedly, there will be an increasing emphasis on synthetic training in the future; something that makes absolute sense for academic training. However, we also need to be able to replicate the operational environment that allows the inter-dependencies between individuals, formations and the enemy to be tested. At the end of the day, crews need to be taught to beat the whole system, not just elements of it. The key to this aspect of the debate on how best to balance live EW training with synthetic will be a full understanding of the minimum level of live training required to prevent operational skill fade, together with a true definition of the ability of future simulation environments to fully immerse warfighters in a scenario. Being shot at by a surface-to-air missile is a highly personal, adrenaline-rich and sensory-saturating experience!



MULTI-USE

When warfighters discuss EW facility modernization, the focus is generally on replicating an operational environment for high-end training. This is an appropriate aspiration, but in the same way that multi-role aircraft have greater utility, we also need to consider multiple roles for EW facilities. There is a clear requirement to support other government departments, particularly in support of defense of our sovereign territories. However, there may also be an opportunity to expand linkages to industry, supporting technology maturation and end-to-end testing, where appropriate. This aspect, together with the ability to conduct genuinely flexible, complex joint training for all the armed services, make facilities such as RAF Spadeadam an attractive model for EW facility development.

THE FUTURE ENVIRONMENT

It is difficult to predict our future threat environment. Indeed, 10 years ago, who would have predicted the nature and size of the expansion of NATO? NATO expansion may present a mid-term opportunity. Several countries that are now NATO members are experts in the maintenance and operation of many SAM systems that are prevalent around the world. While not necessarily meeting all of our needs for modernizing EW facilities, enlisting their support may help us to improve our ability to deliver and maintain a credible EW capability. It may also provide us an unexpected opportunity to better understand some of the cultural and psychological differences in warfare approach that other nations employ.

MODERN OR LEGACY?

Rightly, we have to satisfy the public, our military leaders and our governments that we are procuring training equipment that is cost-effective in providing relevant training to our warfighters. In the near-term, we must remain focused on fully supporting and protecting our colleagues in the conflict in Afghanistan. In the future, we will need to provide a flexible series of training capabilities that will address the needs of legacy systems as well as our new, and as yet unproven, systems. We also need to be prepared for the unexpected. A 2009 University of Oslo study to predict the 20 most likely countries where conflict may break out in 2015 cites countries as diverse as Pakistan, Indonesia, Chad, Sudan, Nigeria and Angola. Although no one expects to get involved in military operations in these countries, the majority listed are unlikely to field high-end EW capabilities in the near to mid term, supporting the view that we need to remain focused on lower-end threats.

FINDING A PRAGMATIC EW TRAINING SOLUTION

To address all options, the answer may lie in systems such as JTE, in synthetic environments, in relatively simple C3 systems such as SPICCCS, or in a combination of all of them. An incremental approach is likely to be the most pragmatic solution. The only things that are certain is that air and ground space will increasingly become a premium; we will have to be able to train for all eventualities; and we will have to be very cost effective. Whatever the future, it is essential that we make the right decisions, based on a full cost-benefit analysis. Fiscal-based decisions are attractive in the short term but could prove shortsighted in the long term.

Wg Cdr PJ Wallace is the Station Commander of RAF Spadeadam in the UK. He has served as a Buccaneer and Tornado GR1/GR4 Navigator/WSO, participating in missions over Iraq and Kosovo. He has also served in a variety of EW-related positions in the RAF and the MOD, and as an exchange officer in the US. His previous assignments include the Directorate of Joint Capability EW policy post in the MOD; as the Coalition Warfare Operations Officer in the J-UCAS/N-UCAS programs; and as a CENTCOM staff officer.

Photos courtesy RAF Spadeadam.

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EW Ranges:
"Shooting Down" the Good Guys

By John Knowles

EW test and training ranges have long lived with the requirement to do more with less. Aircrews training at these ranges certainly want more realism. This basic desire translates into a substantial requirements list, calling for high-fidelity threat emitters capable of accurately simulating multiple threat systems; emitters that will react to jamming like a real threat, and a training environment with excellent tracking capabilities, so that aircrews can see when they are "killed" and understand why. What pilots really want to fly against is a real enemy integrated air defense system (IADS), and some of the better ranges certainly do feature real SA-6s, SA-10s, etc. But realism comes with a price tag, and as Wing Commander Wallace points out in the previous article, training ranges must strike a balance between "good enough" and "affordability." On an EW training range, that balance comes down to the skill of the range operators and the equipment – the threat emitters, the command and control system and the debriefing capability – that create a realistic threat environment.

In the past, the threat simulation, the scoring, the C2 and the debrief were often handled by different systems. Often, the threat emitters did not have the capability to detect or react to jamming, which limited the sense of realism for the aircrews. (As one industry source explained, no one wants to train against a "death ray" threat that continues tracking a target when the threat is being jammed.) The C2 system could be ambiguous, and scoring was usually somewhat subjective, based primarily on the threat operator's poorly documented claim of a "kill." (This often led to heated debates between aircrews and threat operators.) Debrief sessions were mostly verbal rather than visual, which did little to re-enforce the EW tactics. In short, without threat realism and unambiguous recordings of the engagements, it was difficult to convince skeptical aircrews which techniques and tactics worked against a particular threat and which did not.

Today's ranges have succeeded in overcoming many of these past shortfalls, with high-fidelity, reactive threat emitters (including real threats in some cases), definitive scoring, precise C2 and debriefings that are often ready as soon as the aircrews land (while the experience is still fresh in their minds).

THE RANGES

EW test and training ranges comes in all shapes and sizes, with varying degrees of live and virtual integration. The main factors are the size of the range and the threat environment they offer. The DOD operates some of the largest and most well equipped test and training ranges in the world, such as the Nellis Range, the Fallon Range, the Joint Pacific Alaska Range Complex (PARC) and the China Lake test range and the Eglin test range, to name a few. Outside the US, Canada has built the Cold Lake Air Weapons Range (CLAWR); the UK operates the Spadeadam Range. These types of ranges are well suited for large-scale exercises and coalition training. For more frequent EW training, many countries use smaller ranges equipped with a limited number of live and simulated threats. Turkey for example, has been operating the Konya range with the help of local EW company HAVELSAN for more than a decade. In 2008, the government opted to purchase SA-10, -12 and -15 air defense systems for Konya, which already operated several single-digit threats. New EW training capabilities are being planned or built in other countries, such as Australia, Saudi Arabia and South Korea.

Two main factors are driving more countries to build their own ranges. First, many countries are buying advanced EW equipment for a larger portion of their aircraft fleets. This inherently drives EW training requirements for aircrews, who need to refine their skills, as well as for squadrons, which need to develop effective tactics. Secondly, the cost of building an advanced air training capability is becoming more affordable. Not only is commercial technology making threat emitters, command and control systems, and debrief systems more cost effective, it is also enabling all of these capabilities to be integrated into a much smaller, mobile footprint.

At the same time, the concept of the "training range" is changing. The need to set aside hundreds of square miles for a dedicated training space is no longer essential for building an EW training capability. Air combat training has been moving toward "rangeless" concepts for many years, and the ground-based elements of "untethered" EW training are beginning to follow suit.

THREAT EMITTERS

As with the EW market in general, the biggest customer in the threat emitter market is the US. Aside from operating multiple large ranges that provide squadrons intense but infrequent training, the DOD also owns dozens of smaller training sites that offer less dynamic, but more regular EW training. Collectively, these ranges are populated with hundreds of threat emitters – some old and some relatively new. In the US, the DOD continues to maintain several legacy systems, such as the MUTES and Mini-MUTES, the Modular Threat Emitter and the Tactical Radar Threat Generator, most of which were bought in the 1980s and 1990s. These systems are not necessarily high-fidelity threat emitters, and newer EW systems equipped with digital receivers will likely disregard them as "threats." But these legacy threat emitters are quite numerous and relatively inexpensive to maintain. These qualities suggest they will not be retired quickly, as they are still valued for providing a fair degree of threat density at the ranges.

Moving forward, however, the DOD wants to "neck-down" its threat emitter inventory, and it is focusing its development and production dollars on three major programs – the Joint Threat Emitter (JTE), the Unmanned Threat Emitter (UMTE) and the Manportable Aircraft Survivability Trainer (MAST). Each of these programs offers unique capabilities, tailored for specific types of aircraft or missions.

JTE

The JTE is the newest RF threat emitter on the market. Development began in 2002 under a US Air Force contract to Modern Technologies Corp. (Dayton, OH) and teammate Northrop Grumman Amherst Systems (Buffalo, NY). Designed around Amherst's Combat Electromagnetic Environment Simulator (CEESIM), the JTE program is focused on providing much better threat fidelity than many older threat emitters offer, an important factor for stimulating advanced EW systems that use digital receiver technology. The JTE program is following a block approach, under which the first iteration (Block 0 Kit 1) provides a basic capability that will be modified in subsequent program increments. This configuration includes three subsystems – the Receiver Transmitter Group (RTG) unit (also known as the Threat Emitter Unit), the Tactical Computer Console (TCC) unit (also known as the Command and Control Unit), and the Remote Power Unit (RPU) – that can be configured for mobile or fixed-site operation. The RTG units can be programmed to represent up to six different threats at a time and operate three of those threats simultaneously. It also provides realistic aircraft tracking simulation and video feedback debriefing, which enables aircrews to better understand how they performed against specific threats.

JTE Block 0 Kit 1 simulates the full performance envelope (in terms of both high-fidelity RF signals and full engagement range) of single-digit RF SAM and anti-aircraft artillery (AAA) threats. A subsequent upgrade, known at the JTE Wideband Kit, expands the RTG unit's capability to replicate the signals of advanced double-digit threats, but not at their full operational range. This Wideband Kit, which comprises five transmitters, can be swapped out with the RTG Block 0 Kit 1 to provide the additional capability.

Since entering production in April 2007, the DOD has bought 15 RTG units and 7 TCC units from Northrop Grumman. Two of these TEUs have been equipped with the Wideband Kit. More JTE sales (US and international) are certainly expected in the coming years, as the performance of the initial production units is evaluated within the range community. In January, the Air Force's Range Threat System Program Office (RTSPO) at Hill AFB, UT, issued a sources-sought synopsis outlining production plans for up to 35 Block 0 Kit 1 RTG units, 15 Wideband Kits and 20 TCC units over a five-year period.

Meanwhile the Air Force also is planning the JTE upgrade path. The RTSPO has been developing a phased acquisition strategy for JTE Increment 2 (JI2), which would focus on adding SA-15b capability. At a minimum, the JI2 should simulate the SA-15b's target acquisition and phased array tracking radars. Future increments could address additional advanced threats and possibly add an IR threat simulation capability.

UMTE

The UMTE, manufactured by DRS Technologies, is one of the few legacy threat emitters the DOD is planning to retain in its inventory over the long term. In many ways, the UMTE blazed a trail for the JTE in terms of the functionality it provides in a single system. In 2000, the Air Force funded a major upgrade – the UMTE Modernization Program – which added communications links, IR cameras and countermeasures receivers. Over the past several years, some UMTE units have undergone additional upgrades that enable them to simulate advanced double-digit threats at their full engagement range. These are being used primarily for tactics development against these threats.

MAST

The Man Portable Aircraft Survivability Equipment (ASE) System Trainer (MAST) is a relatively new development in the EW training community. IR and UV stimulators have been used for decades, primarily to test passive missile warning systems installed on aircraft. However, this concept is transitioning to the training world, largely due to the significant threat posed by Man-Portable Air Defense Systems (MANPADS) in current operations. The MAST is a collaborative effort between Joint Forces Command and the Army's Program Executive Office for Simulation, Training and Instrumentation (PEO STRI). In its outward appearance, the 35-lb MAST looks like a MANPADS. The user aims the MAST at a target aircraft, tracks the target via the device's thermal imager and "fires." The MAST uses light emitting diode technology, developed by its ESL subsidiary in the UK, to replicate the signature of a MANPADS missile launch and stimulate the missile warning system on the target aircraft at ranges between 0.5 and 5km. It can stimulate a variety of UV missile warners, such as the AAR-47, -54, -57 and -60.

In order to replicate the performance of an actual MANPADS, the MAST incorporates a "live virtual seeker" that replicates the difficulty of acquiring a target and launching a missile. It also features a day/night recording capability for aircrew debriefing and is compatible with the Multiple Integrated Laser Engagement System (MILES) training equipment.

The DOD is expected to buy approximately 180 MAST units through 2016, with PEO STRI acquiring 120 and Joint Forces Command ordering 60. (The total requirement is expected to reach 300 units over the long term.) The DOD plans to deploy MAST to more than 30 training centers and ranges. In 2009, PEO STRI selected AAI Corp. (Hunt Valley, MD) for the MAST production contract.

THE FUTURE OF "LIVE" EW TRAINING

Operations in Iraq and Afghanistan have challenged many of our assumptions about EW in recent years, and this extends to EW training. The concept of airborne EW training that focuses almost exclusively on an IADS is giving way to a much more integrated air-ground training concept, in which aircraft are supporting ground forces in the counter-IED fight and each domain has an effect on the other in terms of EMI, fratricide and access to the electromagnetic spectrum. Operationally, this raises considerable challenges, and those challenges will need to be part of future joint EW training exercises.

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USAF EW Sustainment

The 542d Combat Sustainment Group Keeps up with Demand and Leverages New Technology to Maintain and Improve Legacy Systems

By Elaine Richardson

In recent years, a key factor in the sustainment of US Air Force electronic warfare (EW) systems has become the sheer numbers. With retirement dates for many of the service's aging aircraft pushing out indefinitely, the challenge for the 542d Combat Sustainment Group, which handles a large portion of legacy system EW sustainment from its primary location at the Warner Robins Air Logistics Center at Robins Air Force Base, GA, has been maintaining the more than 70 products – representing 90 ongoing upgrade or sustainment programs and more than 30 types of software code – on every model of US Air Force aircraft.

In addition to sustainment, the 542d has both procurement and ops support functions, including efforts for rapid reprogramming for ongoing operations. "Why are there 500 people at Robins Air Force Base doing EW?" asked Col Stan VanderWerf, commander of the 542d CBSG. "Because we do all three."

When *JED* did its last major feature on US Air Force EW sustainment in 2008, the 542d was celebrating the successful use of new technology – specifically the integration of advanced technology from the F-35 Joint Strike Fighter's ASQ-239 Barracuda EW system into the B-52's ALQ-155 system, resulting in both reduced costs and increased reliability. The group was also looking toward full start up of the EW Life Cycle Management Group (LCMG), a new concept bringing together cross-service expertise at different levels – from a Technical Advisory Group (TAG) at the 06 level from every USAF major command (MAJCOM) to a senior Advisory Group (SAG) at the 2-star level – to focus the USAF's EW goals and budget requests and to better allow for prioritization of projects.

Now, two years into the EW LCMG, Colonel VanderWerf said this level approach to USAF EW "has absolutely made a difference."

"We collaborate. We find out who has investment money to upgrade their platform. Hey, could that be useful on another airplane? We try to find out better ways to use those dollars," VanderWerf said. "The voice of the SAG and the TAG speaks to the corporate process in the Air Force about what the best investment strategy is for electronic warfare. And the SAG is listened to by the investment structure within the Pentagon. Because what happens is when we come out of our SAG meetings all of the MAJCOMs are speaking with one voice. There's no bickering. It goes in as a single voice and it really has power."

As a part of this process, the MAJCOMs have been willing to delay or modify their investment strategies for the good of the Air Force overall because they see what others need and are working on, VanderWerf noted.

"The key to this is that we now look at electronic warfare in the Air Force at an enterprise level. This forces and encourages the communication across the Air Force for electronic warfare," VanderWerf said. "And then people go back to their MAJCOMs and say, we have this issue we haven't thought about, we need to work that in, or we need a little more investment money here to modify that, and it really makes a difference."

In addition, VanderWerf said, the structure has made a difference for USAF EW funding. "The claim has been made – and I believe it's true – that in the 2010 POM [Program Objectives Memorandum] and the 2011 APOM [amended POM] we received more investment dollars in electronic warfare in the Air Force than we've received in a long, long time. Probably more than a decade – maybe more than two decades. And the prospects for the 2012 POM are very high," he said.

"The investment strategies are better. The investment dollars are better. The collaboration on how to train is better," VanderWerf said. "We talk about issues, like are we training our electronic warfare officers as best as we can. Not only the amount of training but is the quality of the content what it needs to be. So we actually are very, very engaged on these types of detailed questions within those meetings."

INFUSING NEW TECHNOLOGY

In looking at the 542d's overall EW system portfolio, VanderWerf notes that while some of the 70 products are very active, others require only simple changes, such as improvements in reliability or replacement of obsolete parts. Of the 90 plus ongoing sustainment or upgrade programs presently being run by the 542d CBSG, some are very simple and others rise to the size of acquisition category (ACAT)-level programs.

However, even with improved investment funding, the Air Force still faces a major challenge in the overall expense involved with sustaining such large numbers of systems. But the 542d is continuing to find ways to use already developed technology for the F-22 and JSF to upgrade legacy systems.

"What we've been able to work out is as long as you minimize aircraft integration issues and instead work on the cards that are inside the boxes, this is where we have found a huge amount of value in translating technologies from one platform to another," VanderWerf said. "It's really in the technology that's inside the box."

In addition to the earlier completed ALQ-155 upgrade, they're also nearing completion of a new ALR-69A Radar Warning Receiver. And though that process went through some schedule and budget issues – VanderWerf notes that they've all been overcome. The system, which has completed some low-rate initial production deliveries, still needs to complete operational test and evaluation and then it will depend on what the customer ultimately wants to buy.

"It's like most programs. Usually there's something that's a big challenge and the ALR-69A had that. But we've been through that and we've fixed those issues," VanderWerf said. "Hats off to Raytheon for helping us work through that and to my own team because they have worked hundreds upon hundreds of issues. I won't get into the specifics, but it is more than just your standard ALR. It's a very, very capable system."

And because of the experience with the ALR-69A, VanderWerf said, his team will be better able to tackle changes to other systems, such as current product changes being made to the sensors on the ALR-56C and ALR-56M RWRs.

"Some of what we've been doing in other areas we are translating – if not the actual specific technologies, then conceptually those kinds of technologies into these products as well," VanderWerf said. "But the digital RWR gives you a whole lot more opportunities in the realm of processing. That kind of technology reduces the risk, down the road, of having to do hardware changes and converts that into a software environment, which is a whole lot easier to deal with. When you're building a system where you can do more of the changes in software, that is exceptionally valuable."

Also in the works are changes to the ALQ-131 self protection jammer pod. Northrop Grumman Electronic Systems (Baltimore, MD) had already announced a mid-life upgrade for the pod, though VanderWerf notes that the 542d is trying "to deliver as broad a range of possible solutions for our customers.

"We have several ideas that we've moved forward in, some of which we've actually done some hardware and software work on, that we are offering to our customer," VanderWerf said. "We're at a point where we're working with our customer to get a final determination about how they want to proceed. And based on what they want to do with the product will drive whether we want to do concept A or concept B or concept C."

In terms of the status of the ALQ-184 electronic attack pod, VanderWerf noted that some of the options for the ALQ-131 also include the ALQ-184. "When our customer gives us the OK to press forward, we're going to go ahead and do it," VanderWerf said.

"And all of those options are good examples of bringing new technology or latest technology into our legacy system to get them to the hands of the warfighter," said Mike Barks, director of the EW software division at Robins. "It's all going to depend on what the user wants to do."

In addition to using new technologies, the 542d is actively preparing for new systems that will shift from development to sustainment in the coming years, most notably the Large Aircraft Infrared Countermeasures (LAIRCM) system, scheduled to transition from development at Wright-Patterson Air Force Base, to sustainment at Robins in 2012.

And though EW sustainment at Robins has been heavily RF-based, VanderWerf noted that the group has been handling more IR business.

"The legacy of the organization really started as an RF organization, but really it's not just RF. We have IR sensors that we are the sole managers of. Do we have as much in the way of IR countermeasures systems as we do RF countermeasures systems? No, but we definitely are moving into or have moved into IR," VanderWerf said, specifically noting work on the ALE-47. "And LAIRCM is officially coming here in 2012 and that includes the Air Force support for the Navy systems, so the Navy is also relying up on us."

INTERNATIONAL GROWTH

Robins has also seen significant growth in its portfolio of Foreign Military Sales (FMS) work – 12 different systems for 29 countries representing $700 million in sales.

"Over the last 18 months it's grown substantially," VanderWerf said. "We're talking about double-digit percentage growth – 20 to 30 percent."

VanderWerf describes the FMS work as an "appropriate" strategy for EW in terms of assisting US partners and improving the ability of US coalitions.

"I can definitely say the IR protection we put on wide-body aircraft for multiple countries has actually vaulted them into the fight," said Court Smith, director of international EW programs for the 562nd Combat Sustainment Squadron. "Now they're fighting right alongside of us."

"It's an excellent point, VanderWerf said "Then it becomes a force multiplier for our benefit, in addition to having coalitions."

Dixie Crow Symposium 35

The Dixie Crow Symposium is March 21-25 at the Museum of Aviation at Robins Air Force Base. Last year, more than 1,300 registrants attended, making this the second-largest EW event of the year. For more information visit www.dixiecrow.org.

ATTENTION: Defense Professionals



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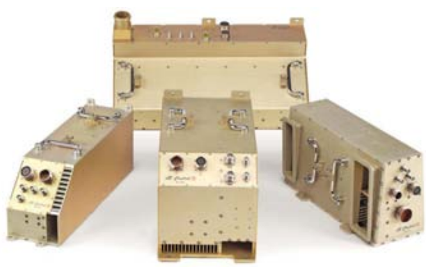

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TECHNOLOGY SURVEY

TWTs and MPMs

By Ollie Holt

JED's last survey on power amplifiers, which included traveling wave tubes (TWTs) and microwave power modules (MPM)s, appeared in April 2008. In this month's issue, *JED* chose to review the current state of power amplifiers with a focus on TWTs and MPMs used for EW applications and look at their capabilities and limitations. The April 2008 survey focused mostly on solid state power amplifiers. Since the April 2008 survey, very little has changed in TWT and MPM amplifier technology other than some improvements in efficiencies, reliability and increased power output levels. Most of the TWT power amplifiers listed in this survey were developed for radar, radar jamming or communication applications.

The TWT was originally developed by British scientists in 1942-43 in support of creating higher power radar systems for use by the military in World War II. The TWT enabled the radars to transmit at higher RF power levels, enabling the radars to achieve longer detection ranges. The British passed this TWT technology to its US ally.

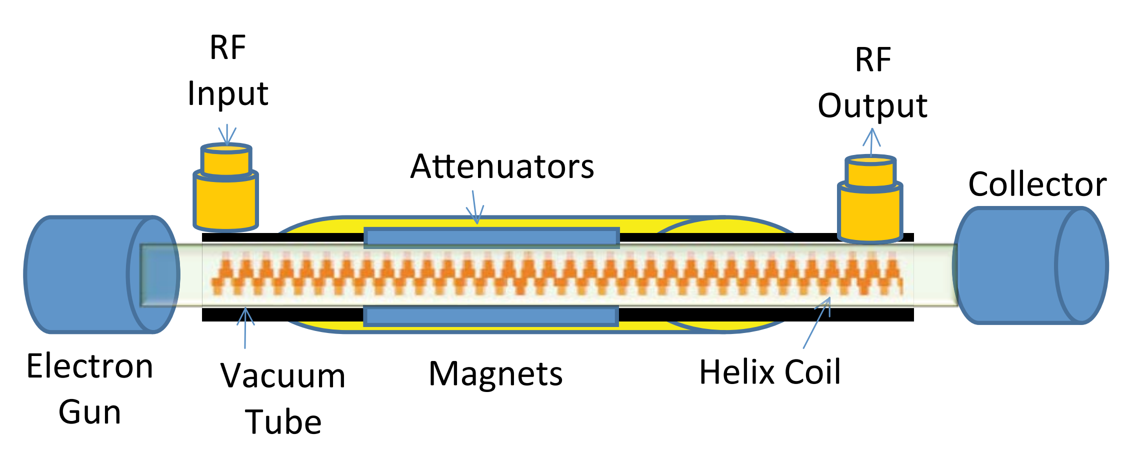

Figure 1: Helix TWT Block Diagram

Figure 1 is a crude block diagram of a Helix TWT. A Helix TWT looks like a long vacuum tube. The electron gun on the left, which is similar to the cathode of a vacuum tube, emits electrons down through the helix wire directed towards the collector. The magnets (yellow tube in **Figure 1**) form a containment field focusing the electron beam down through the helix coil at the collector. The helix coil extends from the RF input to the RF output couplers. The RF input device is a directional coupler, which is used to induce the RF signal to be amplified into the helix coil. It is a directional coupler used in order to direct the input signal toward the collector, not toward the electron gun. As the RF signal travels along the helix coil toward the collector, the electromagnetic field created by the RF current in the helix interacts with the electron beam traveling through the center of the helix, causing a phenomenon called velocity modulation. The electron beam induces more current into the helix as the signal flows through the helix toward the collector causing amplification of the RF signal. The RF output is another directional coupler positioned near the collector. The coupler removes the amplified RF signal from the TWT. The attenuators are used to prevent reflected RF waves from traveling back down the helix toward the electron gun.

Helix TWTs like the one described above are limited in maximum output power by the current-handling capability of the helix coil. The thickness of the helix wire defines the amount of heating that can occur within the TWT. Overheating (higher power) of the helix wire will cause it to change shape and will impact performance. Thicker helix wire can be used but performance is still limited to about 2.5 kW output power. Thicker wire is harder to machine into the correct shape and retain performance. To increase the output power of a TWT, the helix coil is replaced by a series of coupled cavities spaced along the electron beam to create a helical waveguide. This increases the output power capability to around 60 kW. This type of TWT is referred to as a Coupled Cavity TWT. Most of the TWTs listed in the survey responses are Helix.

Developed in the 1980s and 1990s, the MPM is a hybrid device, combining solid-state and vacuum-tube components. They are typically smaller than a TWT and are used in a wide variety of commercial and military applications. Although TWT's are still the dominant power amplifier device used in EW systems, the use of MPMs is growing.

The survey requested performance information on different parameters that could impact the power amplifier's performance in a desired application. Some of the parameters are operational frequency range, gain or output power, efficiency and dBc. Operational frequency range is almost self explanatory; it just defines the lower to upper frequency range the TWT was designed to operate. Gain defines the increase in power that can be achieved from the input to output power level. The output power defines the maximum output power expected at the maximum gain.

Efficiency is defined as the Power Added Efficiency. Power Added Efficiency is defined as the output power (RF) minus the input power (RF) divided by the DC power. In high-gain systems, the results are about the same as Efficiency (output power {RF} divided by Input Power {DC}), but in low-gain systems the Efficiency can be very different. Also take note that in this survey the input power (DC Power) is average power input. For a pulsed system, the Power Added Efficiency is calculated using the input power DC when the pulse is created, not the average input power DC.

dBc or dB relative to the carrier is a measure of how much higher the carrier (desired) signal is with respect to harmonics or spurious signals created within the device. For most applications the larger this value, the better the performance.

The number of companies manufacturing TWTs and MPMs for EW applications is fairly small. Nine companies (nearly all of the TWT/MPM manufacturers supplying the global EW market) responded to our survey.

JED's next survey, covering Missile Warning Systems, will appear in the May 2010 issue. E-mail editor@crows.org to request a survey questionnaire.

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TECHNOLOGY SURVEY: TWTs and MPMs

MODEL	TYPE	OP FREQ. RANGE	INPUT POWER (W)	OUTPUT POWER/GAIN	EFFICIENCY (%)
CPI; Palo Alto, CA, USA; +1-650-846-3900; www.cpii.com					
VTF-6132	TWT	2-8 GHz	450 W	100 W CW/28 dB	*
VTM-5114	TWT	6-18 GHz	500 W	1.0-1.25 kW Peak/38 dB	*
VTM-6199	TWT	7.5-18 GHz	510 W	95-140 W CW/38 dB	*
VTF-6130	TWT	2.0-6.5 GHz	650 W	100-200 W CW/26 dB	*
dB Control; Fremont, CA, USA; +1-510-656-2325; www.dBControl.com					
dB-3749	TWT	6-18 GHz	300 W Typical	1000 W Peak at 6% Duty	20%
dB-4118	MPM	6-18 GHz	300 W Typical	100 W CW	20%
dB-4210	MPM	2-7 GHz	450 W Typical	200 W CW	20%
dB-3758	TWT	X Band or Ku Band at 1-3 GHz Bandwidth	250 W Typical	1000 W Peak at 6% Duty	20%
dB-4102/4103-S	TWT	18-26 GHz and 26-40 GHz	150 W Typical	40 W CW/Pulse	20%
e2v; Chelmsford, Essex, UK; +44 (0)1245 453607; www.e2v.com					
Flagship 4.8kV Mini TWT, Model N20181	TWT	4.5-18 GHz	580 W Max Prime Power	160 W (100 W minimum across the full band)/67 dB (45 band edges)	40% (18% band edges)
High Power 6.2kV Midi TWT, Model N10110	TWT	6-18 GHz	1000 W Max Prime Power	260 W (180 W band edges)/65 dB (38 dB band edges)	26% (18% band edges)
Standard 4.5kV Mini TWT, Model N20160	TWT	4.5-18 GHz	470 W Max Prime Power	140 W (50 W at 4.5 GHz, 100 W at 18 GHz)/60 dB (36 dB band edges)	36% (11% band edges)
Low Power 4.5kV Mini TWT, Model N10172	TWT	4.5-18 GHz	430 W Max Prime Power	125 W (25 W at 4.5 GHz, 75 W at 18GHz)/53 dB (33 dB band edges)	32% (6% band edges)
L-3 Communications EDD East; Williamsport, PA, USA; +1-570-326-3561; www.l-3com.com/edd					
TXI-1002	TWT-based Transmitter	I Band, 10 GHz	2 kW Max	500 W	25%
L-3 Communications EDD West; San Carlos, CA, USA; +1-650-591-8411; www.l-3com.com/edd					
L6134	TWT	6-18 GHz	430 W	53 dBm	>40%
M1201	MPM	2-6 GHz	375 W	49 dBm	40%
M1225	MPM	6-18 GHz	425 W	52 dBm	30%
M1300	MPM	26-40 GHz	350 W	48 dBm	>30%
M1282	MPM	26-40 GHz	350 W	48 dBm	>30%

LEVELS (dBc)	RELIABILITY	SIZE (HxWxL inches)	WEIGHT (lb/kg)	FEATURES
*	*	1.65 x 1.6 x 11.4 in.	2.0 lbs	*
*	*	1.75 x 2.0 x 12.8 in.	2.7 lbs	*
*	*	1.25 x 1.9 x 10.0 in.	2.0 lbs	*
*	*	1.78 x 1.8 x 13.4 in.	2.3 lbs	*
-10 dBc Harmonics; -55 dBc Spurious	>10000 Hours for Military Airborne Environment	17.7 x 6.5 x 5 in.	33 lbs	Used in airborne EW systems. Qualified for military airborne environment.
-10 dBc Harmonics; -55 dBc Spurious	>10000 Hours for Military Airborne Environment	11 x 8 x 1.6 in.	6 lbs	Built-in pulse modulation capability at 250 kHz PRF. Used in Electronic Countermeasure (ECM) systems.
-5 dBc Harmonics; -55 dBc Spurious	>10000 Hours for Military Airborne Environment	13.75 x 7 x 2.5 in.	12 lbs	Used in Electronic Countermeasure (ECM) systems.
-12 dBc Harmonics; -60 dBc Spurious	>10000 Hours for Military Airborne Environment	12 x 9.6 x 4 in.	17 lbs	Used in Airborne Radar Applications (SAR, Multi-Mode, etc). Excellent phase noise and spurious, digital control. Built-in cooling.
-20 dBc Harmonics; -50 dBc Spurious	>10000 Hours for Ground Mobile Environment	18.5 x 12 x 10 in.	60 lbs	Environmentally sealed unit used in ground-mobile EW systems. Built-in cooling and remote control feature.
0 dBc at 4.5 GHz; -10 dBc at 9 GHz	Typical EW Environment 9000 Hours MTBF	1 x 1 x 9.5 in.	320 g	Optional - Focus Electrode, TNC or Waveguide OP
-2 dBc at 6 GHz; -7 dBc at 9 GHz	Typical EW Environment 9000 Hours MTBF	2.5 x 2 x 13 in.	1.4 kg	Optional - Focus Electrode
2 dBc at 4.5 GHz; -14 dBc at 9 GHz	Typical EW Environment 9000 Hours MTBF	1 x 1 x 9 in.	300 g	Optional - Focus Electrode, SMA, TNC or Waveguide OP
3 dBc at 4.5 GHz; -8 dBc at 9 GHz	Typical EW Environment 8000 Hours MTBF	1 x 1 x 8.5 in.	300 g	Optional - Focus Electrode, SMA, TNC or Waveguide OP
-30 dBc	10000 Hours	16 x 24 x 24 in.	250 lbs	Turnkey TWT-based transmitter for radar simulation and training used on JTE, Mutes and Mini-Mutes mobile platforms.
Harmonic -6 dBc; Spurious -60 dBc	>9700 Hours	1.5 x 1.5 x 10 in.	< 2 lbs	Production released item available as a stand-alone TWT, packaged with a pre-amp driver (option), and fully integrated (option) into an MPM. Consult factory with special power or frequency requirements.
Harmonic -7 dBc; Spurious -45 dBc	>12000 Hours	1.25 x 7 x 10.75 in.	< 8 lbs	Production released item, multiple packaging/ power options available including active cooling heat exchanger system. Consult factory for special power or frequency requirements.
Harmonic -4 dBc; Spurious -45 dBc	12000 Hours	1.40 x 7.75 x 8 in.	< 6.5 lbs	Production released item, multiple packaging/ power options available including active cooling heat exchanger system. Consult factory for special power or frequency requirements.
Harmonic -15 dBc; Spurious -30 dBc	12000 Hours	1.40 x 7.75 x 8 in.	< 7.5 lbs	Totally self contained with integral cooling, multiple packaging/power options available. Consult factory for special power or frequency requirements.
Harmonic -15 dBc; Spurious -40 dBc	12000 Hours	1.25x 7.5 x 8.5 in.	< 6 lbs	Production released item, multiple packaging/ power options available including active cooling heat exchanger system. Consult factory for special power or frequency requirements.

TECHNOLOGY SURVEY: TWTs and MPMs

MODEL	TYPE	OP FREQ. RANGE	INPUT POWER (W)	OUTPUT POWER/GAIN	EFFICIENCY (%)
MITEQ, Inc.; Hauppage, NY, USA; +1-631-439-9469; www.miteq.com					
MT4100-535-2.5/7.5	MPM	2.5-7.5 GHz	3000 W	500 W (57.0 dBm)/60 dB	17%
MT4100-450-2/8	MPM	2-8 GHz	3000 W	370 W (55.7 dBm)/60 dB	17%
MT4100-300-6/18	MPM	6-18 GHz	1900 W	250 W (53.7 dBm)/60 dB	13%
MT3100-INS-50-18/26.5	MPM	18-26.5 GHz	600 W	40 W (46.0 dBm)/46 dB	7%
MT3100-INS-50-26.5/40	MPM	26.5-40.0 GHz	600 W	40 W (46.0 dBm)/56 dB	7%
MT3100-INS-40-18/40	MPM	18.0-40.0 GHz	600 W	33 W (45.2 dBm)/56 dB	7%
Teledyne MEC; Rancho Cordova, CA, USA; +1-916-638-3344; www.teledyne-mec.com					
MEC 5196	TWT	2.0-8.0 GHz	1850 W	450 W/26 dB min/46 dB max	26%
MEC 5411	TWT	6.5-18.0 GHz	1400 W	300 W/35 dB min/45 dB max	25%
MEC 5496	TWT	26.5-40.0 GHz	500 W	100 W/35 dB min/50 dB max	20%
MTG 3041	TWT	2.0-8.0 GHz	750 W	2000 W/38 dB min/58 dB max	24%
MTI 3444	TWT	6.5-18.0 GHz	950 W	1580 W/43 dB min/46 dB max	14%
Thales Electron Devices; Velizy-Villacoublay, France; +33 (0)1 30 70 36 40; www.thalesgroup.com					
TH24445B	MPM	4.5-18 GHz	*	100 W	30%
TH24475	MPM	2 GHz in 13.5-18 GHz	*	110 W	30%
TH4443E	TWT	4.5-18 GHz	*	8 kW/400 W	30%
TH4428	TWT	18-40 GHz	*	200 W	30%
TH4428	TWT - Helix TWT	18-40 GHz	*	80 W	30%
TMD Technologies Ltd.; Hayes, Middlesex, UK; +44 (0)20 8573 5555; www.tmdtechnologies.co.uk					
PTX8340	MPM	2.0-8.0 GHz	*	100 W	*
PTX8200	MPM	4.5-18.0 GHz	*	100 W	*
PTX8207	MPM	4.5-18.0 GHz	*	140 W	*
PTX8320	MPM	26.0-40.0 GHz	*	50 W	*
Triton Services Electron Technology Div.; Easton, PA, USA; +610-252-7331, www.tritonetd.com					
F-2454	TWT	2.3-7.0 GHz	750	200 W	30
F-2491	TWT	2-6 GHz	660	100-250 W	30
F-9106A	MPM	6-18 GHz	365	50-100 W	33
F-9107A	MPM	2-6 GHz	390	75-100 W	33
F-2153	TWT	2-4 GHz	*	1500 W	*

LEVELS (dBc)	RELIABILITY	SIZE (HxWxL inches)	WEIGHT (lb/kg)	FEATURES
-60 dBc Spurious/-4 dBc Harmonic	35000 Hours	8.75 x 19 x 24 in.	90 lbs/41 kg	Atten, meters, Ethernet, etc
-60 dBc Spurious/-4 dBc Harmonic	35000 Hours	8.75 x 19 x 24 in.	90 lbs/42 kg	Atten, meters, Ethernet, etc
-60 dBc Spurious/-4 dBc Harmonic	35000 Hours	5.25 x 19 x 24 in.	65 lbs/30 kg	Atten, meters, Ethernet, etc
-60 dBc Spurious/-8 dBc Harmonic	35000 Hours	11.8 x 9.6 x 20.5 in.	47 lbs/21.4 kg	Atten, meters, Ethernet, etc
-60 dBc Spurious/-8 dBc Harmonic	35000 Hours	11.8 x 9.6 x 20.5 in.	47 lbs/21.4 kg	Atten, meters, Ethernet, etc
-60 dBc Spurious/-8 dBc Harmonic	35000 Hours	11.8 x 9.6 x 20.5 in.	47 lbs/21.4 kg	Atten, meters, Ethernet, etc
*	40000-120000 Hours MTBF (depending on the environment)	approx. 4 x 4 x 24 in.	9.0 lbs/4.1 kg	ITAR
*	40000K-120000 Hours MTBF (depending on the environment)	approx. 4 x 4 x 24 in.	9.0 lbs/4.1 kg	ITAR
*	4000-10000 Hours MTBF (depending on the environment)	approx. 4 x 4 x 24 in.	7.5 lbs/3.4 kg	ITAR
*	40000-120000 Hours MTBF (depending on the environment)	approx. 4 x 4 x 24 in.	8.0 lbs/3.6 kg	ITAR
*	40000-120000 hours MTBF (depending on the environment)	approx. 4 x 4 x 24 in.	7.0 lbs/3.2 kg	ITAR
*	*	1.38 x 9.1 x 9.84 in.	6.4 lbs	*
*	*	1.38 x 9.1 x 9.84 in.	6.4 lbs	*
*	*	1.2 x 1.8 x 8.7 in.	1.6 lbs	*
*	*	1.65 x 1.61 x 9.4 in.	1.6 lbs	*
*	*	1.65 x 1.61 x 9.4 in.	1.6 lbs	*
*	High	280 x 200 x 32 mm	3.5 kg	CW/pulsed
*	High	260 x 200 x 32 mm	4.0 kg	CW/pulsed
*	High	260 x 200 x 32 mm	4.0 kg	CW/pulsed, low noise
*	High	250 x 200 x 40 mm	4.0 kg	CW/pulsed
-60	*	2.6 x 2.75 x 14.0	2 lb/0.9 kg MAX	3 minute warm-up, 5-stage collector, shadow grid any duty + CW conduction cooled, up to 70,000 ft altitude
-60	*	2.0 x 2.0 x 12.5	3.2 lb/1.45 kg MAX	3 minute warm-up, 3-stage collector, non-intercepting grid any duty + CW conduction cooled, up to 70,000 ft altitude
-40	*	2.5 x 6.2 x 7.1	6.0 lb/2.7 kg	2 minute warm-up, CW operation, self-contained air cooling, up to 40,000 ft altitude, prime power 28 VDC
-40	*	2.4 x 5.0 x 11.5	8.0 lb/3.6 kg	2 minute warm-up, CW operation, self-contained air cooling, up to 40,000 ft altitude, prime power 28 VDC
-40	*	2.4 x 3.6 x 17.25	7.5 lb/3.4 kg	3 minute warm-up, 4% duty max, air cooled, up to 60,000 ft altitude

Survey Key – TWTs and MPMs

MODEL

Product name or model number

TYPE

TWT or MPM

- TWT = travelling wave tube
- MPM = microwave power module

OP. FREQ. RANGE

Operating frequency range in KHz, MHz or GHz

INPUT POWER

In Watts

OUTPUT POWER/GAIN

P1 dB or gain in dB

EFFICIENCY

Power Added Efficiency in percent

LEVELS

Harmonic and spurious levels in dBc

RELIABILITY

Mean time between failures in thousands of hours

- MTBF = mean time between failures

SIZE

H x W x L in inches

May 2010 Product Survey: Missile Warning Systems

This survey will cover passive and active missile warning systems. Please e-mail editor@crows.org to request a survey.

WEIGHT

Weight in lb/kg

FEATURES

Any power-up cycle required, amplifier class, special cooling requirements and breakdown voltage

- PRF = pulse recurrence frequency
- SAR = synthetic aperture radar
- TNC = Threaded Neill Concelman
- SMA = sub-miniature type A
- CW = continuous wave
- RF = radio frequency
- ITAR = International Traffic in Arms Regulations

OTHER ABBREVIATIONS USED

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

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

OTHER COMPANIES

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

Company Name	Website
NEC	www.nec-mwt.com

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EW Against Modern Radars – Part 4

Jamming Mono-Pulse Radars

By Dave Adamy

Last month, we discussed the angle deception of radars that must determine the angular position of a target from multiple pulse returns. Now we consider mono-pulse radars, which get angular information from every pulse return. Mono-pulse radars determine target angle by comparing signals in multiple receiving sensors. **Figure 1** shows only two sensors, however actual mono-pulse radars have three or four sensors to allow two-dimensional angle tracking. The sensor outputs are combined in sum and difference channels. The sum channel establishes the level of the returned signal and the difference channel provides angle tracking information. Note that the difference response is typically linear across the 3 dB width of the sum response. The guidance input is the difference response minus the sum response.

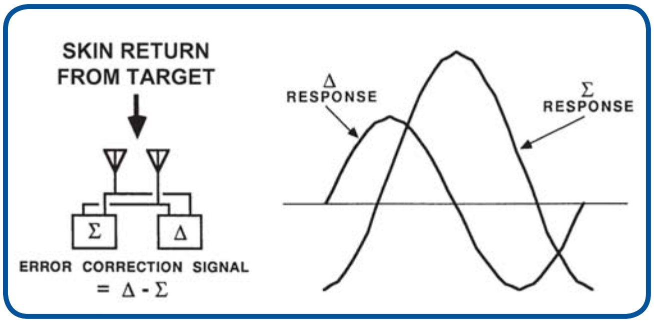

Figure 1: Mono-pulse radars derive angle information from each pulse by use of multiple sensors.

Jamming techniques shown in the last two columns actually improve the angle tracking effectiveness of mono-pulse radars by increasing the signal strength received from the target location. However, there are several techniques that do work against mono-pulse radars. These include the following:

- Formation jamming
- Formation jamming with range denial
- Blinking
- Terrain bounce
- Cross polarization (Cross-Pol)
- Cross eye

Formation Jamming

If two aircraft fly formation inside the radar's resolution cell as shown in **Figure 2**, the radar will be unable to resolve them, seeing in effect a single target between the two real targets. The difficulty with this technique is that it can be very challenging to keep both aircraft within the resolution cell.

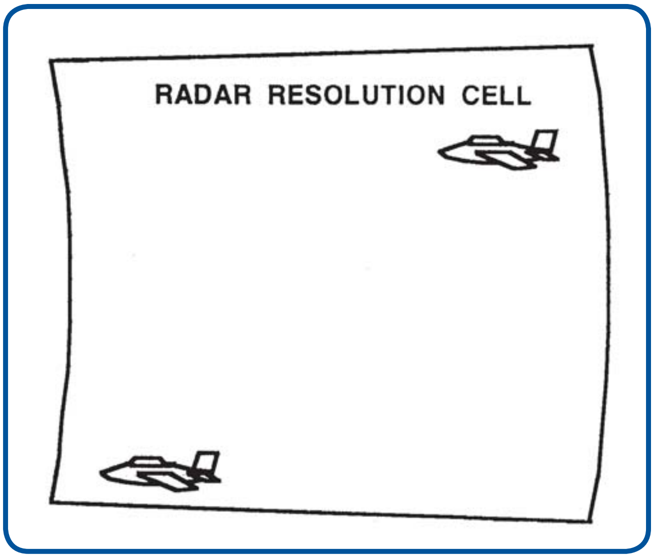

Figure 2: Formation jamming involves flying two aircraft within the radar's resolution cell. The radar will "see" only one target halfway between the two real targets.

The width (i.e. cross range) dimension of the resolution cell is:

W = 2 R sin (BW/2)

Where W is the width of the cell in meters, R is the range from the radar to the target in meters, and BW is the 3 dB beam width of the radar antenna.

The depth (i.e., down range) dimension of the cell is:

D = c (PW/2}

Where D is the depth of the cell in meters, PW is the radar pulse width in seconds, and c is the speed of light (3×10^8 meters per second).

For example, if the target is 20 km from the radar, the radar pulse width is 1 microsecond and the radar antenna beam width is 2°, the resolution cell is 698 meters wide and 150 meters deep. **Figure 3** compares the dimensions of the resolution cell for this radar at various radar to target ranges.

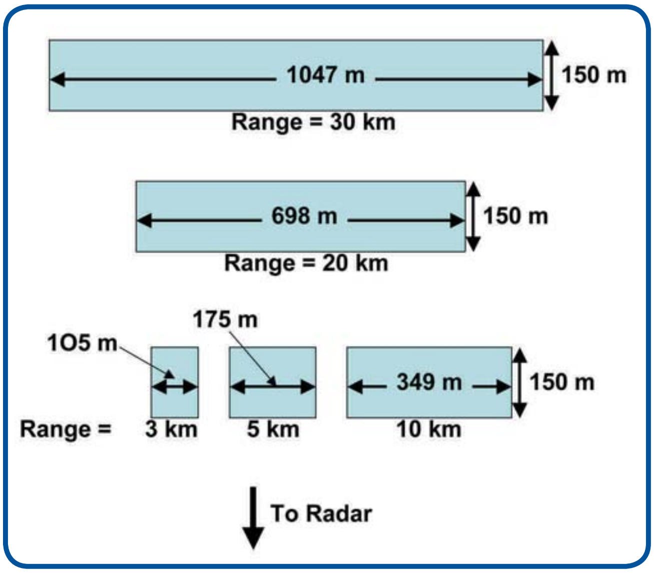

Figure 3: The shape of the radar's resolution cell varies significantly with the radar to target range. This is for 1 μ sec PW and 2 degrees BW.

Formation Jamming with Range Denial

Self protection jamming, because it is emitted from the radar's target, enhances the mono-pulse radar's angle tracking. However, it can deny the radar range information. If both aircraft jam with approximately the same power as shown in **Figure 4**, the radar will be unable to resolve the two targets in range, so they will be required to station keep only within the cross range dimension of the resolution cell to prevent the radar from resolving its two targets. At long ranges, the resolution cell is much wider than its depth, so this technique can simplify station keeping.

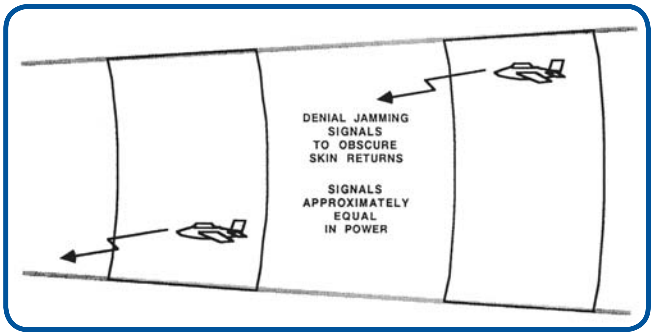

Figure 4: If each aircraft jams equally to deny the radar range information, the two aircraft must only hold formation within the cross range dimension of the radar resolution cell.

Blinking

If two aircraft in the radar's resolution cell alternate their jamming at a moderate rate (.5 to 10 Hz) as in **Figure 5**, an attacking missile will be guided alternately to one or the other. As the missile approaches the two aircraft, it will be retargeted with an increasingly large angular offset. Because the missile's angular guidance is limited in loop bandwidth, it will be unable to follow one of the target changes and will fly off to one side.

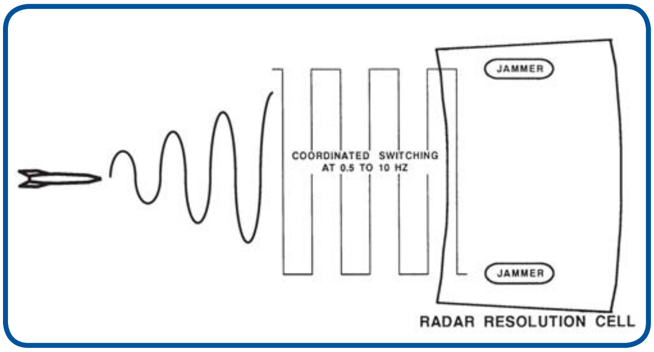

Figure 5: Blinking jamming involves sequencing jammers on two aircraft to force the tracking radar to switch between targets until the missile guidance is over stressed.

Terrain Bounce

If an aircraft or missile rebroadcasts a radar's signal with significant gain from an antenna pointed down toward the water or land over which it is flying (as shown in **Figure 6**), the mono-pulse tracker will be caused to track below the protected platform. This will make the weapon miss the target.

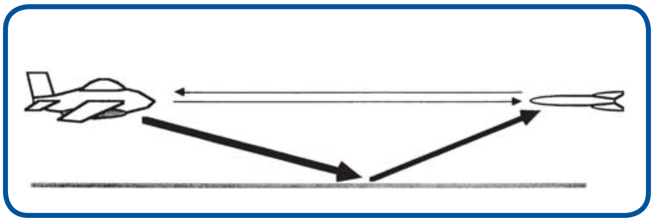

Figure 6: Terrain Bounce jamming reflects a strong return signal from the earth or water causing the radar to track below the target.

What's Next

Next month, we will discuss Cross-Pol and Cross-Eye jamming. For your comments and suggestions, Dave Adamy can be reached at dave@lynxpub.com.

AOC association news

CHESAPEAKE BAY EXPLORES NASA'S ORION PROGRAM

The speaker for the January Chesapeake Bay Roost monthly luncheon was Dr. Paul Mahata, the president of University Consultants. He spoke on the subject of "Risk Profile for NASA's Crew Exploration Vehicle (CEV), aka Orion."

On January 14, 2004, the President of the United States of America announced a new vision for the civil space program based upon exploration of the moon. Following that, the President's Commission on Implementation of a US Space Exploration Policy released a report addressing a "Journey to Inspire, Innovate and Discover."

Dr. Mahata presented a review of the process used to develop the risk profile for the Crew Exploration Vehicle – NASA's replacement for the Space Shuttle, with the capability to travel beyond the low-Earth orbit and the moon. Since many major systems must interact effectively for a successful launch and exploration, the CEV is considered a system of systems (SOS) by NASA.

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 (near BWI airport). For more information about the Chesapeake Bay Roost and its activities, contact Roost President John Hawkins at Hawkinsje@msn.com.

John Hawkins (right), president of the AOC Chesapeake Bay Roost, shakes hands with Dr. Paul Mahata, president of University Consultants, Inc., at the roost's January luncheon.

GOLDEN GATE CHAPTER VISITS DB CONTROL

The Golden Gate Chapter met at dB Control's 40,000 square-foot secure facilities in Fremont, California on January 12, 2010. After a brief networking session with food and beverages provided by dB Control, Meppalli Shandas, their VP of Technology and a 2008 inductee into AOC's EW Hall of Fame delivered a presentation on EW applications of TWT amplifiers and microwave power modules.

AOC attendees also had the opportunity to tour the facility and to discuss the future of the military industry with dB Control CEO Joseph Hajduk, whose industry viewpoint articles recently appeared in *Military Embedded Systems*, *Microwaves & RF*, *Microwave Product Digest* and *US Tech*.

Meppalli Shandas, dB Control VP of Technology, gives a presentation to the Golden Gate Chapter.

BILLY MITCHELL CHAPTER HOSTS UT PROFESSOR

At its January luncheon the Billy Mitchell Chapter hosted Dr. David Akopian, associate professor of electrical engineering at University of Texas at San Antonio (UTSA). Dr. Akopian spoke on assisted-GPS, smartphones, wireless device growth, and research and progress in being able to get more accurate GPS positions inside buildings and urban canyons, keeping the chapter's attention for more than an hour.

Dr. David Akopian, associate professor of electrical engineering at University of Texas at San Antonio, gives a presentation to the Billy Mitchell Chapter.

Billy Mitchell Chapter President Greg Radabaugh prepares to present a gift to luncheon speaker Dr. David Akopian.

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