DECEMBER 2010
Vol. 33, No. 12

The AOC
Electronic Warfare Publication
www.crows.org

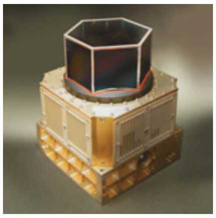
JED
The Journal of Electronic Defense

2011 EW/SIGINT Resource Guide

Also in this issue:

EW Battle Management

Technology Survey: Laboratory EW Simulators



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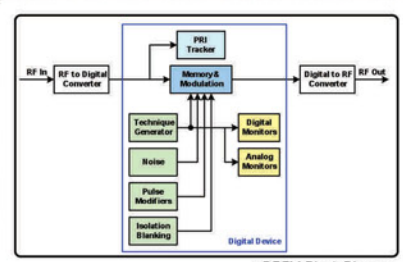
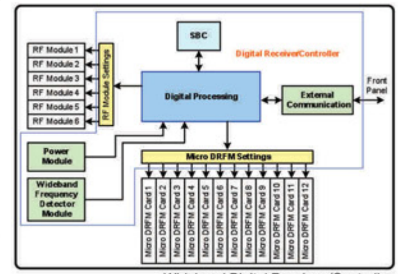
  - Range, Doppler, Amplitude, Phase, Noise, Arbitrary Waveform Generation

MoDREx Sub-assemblies



µDRFM Block Diagram



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CONNECTING EW TO THE BATTLESPACE

Back in the spring of 1997, I had the opportunity to fly down to Fort Hood, TX, to write about a simulated helicopter training exercise organized by the US Army. The main purpose of the exercise was to demonstrate how the Army could link its new aviation trainers (located across various Army bases) and perform collective real-time training in an synthetic environment that included "human operated" virtual threats, such as the ZSU-234s and SA-8s, via a link to the Missile and Space Intelligence Center in Huntsville, AL.

There was another aspect to this training demonstration that focused on EW. (This was the main reason that *JED* was invited to attend the event.) The aviation trainers in the demonstration were using the real RWR hardware from a prototype ALQ-211 jammer, which was then in development for the Army. The ALQ-211's RWR information was distributed over a battle network via the SINCGARS radio, and the Army helicopter crews were correlating with their own RWR data, fusing it, and gaining much better situational awareness.

This was not the first time EW nodes had been networked in a live or virtual environment, but it was the first time I had seen it in action and the possibilities really captured my imagination. I have often wondered how much that experiment back in 1997 (and subsequent demonstrations) changed the thinking of the Army's intelligence and electronic warfare (IEW) community. The Army never bought the ALQ-211 for its helicopters, but the idea of networking EW "nodes" certainly evolved at labs like the Army's Intelligence and Information Warfare Directorate (I2WD). Today, the DOD is pushing ahead into EW battle management, and it is no surprise that labs, such as the I2WD, the Naval Research Lab and the Air Force Research Lab, are focusing on the technologies that will make EW battle management a core operational capability in the coming decade.

This month's *JED* features an excellent article by Glenn Goodman about EW battle management and the influence it is having on the Army's emerging programs, such as the Integrated Electronic Warfare System (IEWS). Each service is taking its own approach to EW battle management, but the basics are similar across the DOD. If we connect the numerous EW nodes that are already in the battlespace, we can build a better situational awareness picture for the platforms, as well as the operational commanders. On the jamming side of the equation, the primary benefits are more efficient jamming and improved survivability. In an operational scenario, the best-positioned platform can jam the right threat at the right time with the optimal effective radiated power and jamming techniques. For other units in the area, this reduces electromagnetic fratricide and improves interoperability. For the commander, this "smarter" approach eases the overall congestion in the electromagnetic battlespace, which is a rapidly growing problem.

Everyone, from the "trigger puller" to the theater commander, benefits from networking and managing the many EW "nodes" in the battlespace. As a result, the "tip of the spear" is about to become much sharper. – *John Knowles*

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DECEMBER

Electronic Warfare Symposium
December 1-2
Swindon, Wiltshire, UK
Clearance: Secret Four Eyes
www.cranfield.ac.uk

International Defence Exhibition and Seminar (IDEAS) 2010
December 6-10
Karachi, Pakistan
www.ideaspakistan.gov.pk

Worldwide EW Reprogramming Conference
December 15-16
Orlando, FL
www.crows.org

JANUARY

41st Annual Collaborative EW Conference
January 25-27
Point Mugu, CA
www.crows.org

AFCEA West 2011
January 25-27
San Diego, CA
www.afcea.org

FEBRUARY

Aero India 2011
February 9-13
Bangalore, India
www.aeroindia.in

Low Probability of Intercept Conference
February 15-17
Monterey, CA
www.crows.org

IDEX
February 20-24
Abu Dhabi, UAE
www.idexuae.ae

MARCH

Avalon 2011
March 1-6
Geelong, Victoria, Australia
www.airshow.net.au

Joint Advanced Electronic Attack Conference
March 14-15
Nellis AFB, NV
www.crows.org

Training in the Contested EMS Battlespace
March 16-18
Nellis AFB, NV
www.crows.org

Dixie Crow Symposium
March 20-24
Warner Robins, GA
www.dixiecrow.org

APRIL

FiestaCrow 2011
April 11-14
San Antonio, TX
www.fiestacrow.com

LAAD Defence and Security 2011
April 12-15
Rio de Janeiro, Brazil
www.laadexpo.com

AAAA Symposium
April 17-20
Nashville, TN
www.quad-a.org

MAY

IDEF 2011
May 10-13
Istanbul, Turkey
www.idef11.com

Shephard/AOC EW 2011
May 25-27
Berlin, Germany
www.shephard.co.uk

AOC events noted in red. For more information, visit www.crows.org.


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DECEMBER

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Alexandria, VA
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JANUARY

Radar Electronic Warfare
January 3-7
Shrivenham, UK
www.cranfield.ac.uk

Basic Radar Concepts
January 11
Denver, CO
www.pe.gatech.edu

Advanced Essentials of EW
January 18-21
Point Mugu, CA
www.crows.org

FEBRUARY

ELINT and Modern Signals
February 8-11
Monterey, CA
www.crows.org

Digital Radio Frequency Memory (DRFM) Technology
February 22-24
Atlanta, GA
www.pe.gatech.edu

MARCH

Modeling & Simulation of RF Electronic Warfare Systems
March 7-11
Swindon, Wiltshire, UK
www.cranfield.ac.uk

Electro-Optic and IR Sensors
March 7-11
Swindon, Wiltshire, UK
www.cranfield.ac.uk

Modeling and Simulation
March 14-15
Las Vegas, NV
www.crows.org

RF Test and Measurement
March 15
Swindon, Wiltshire, UK
www.cranfield.ac.uk

IR/Visible Signature Suppression
March 22-24
Atlanta, GA
www.pe.gatech.edu

Introduction to Radar and EW
March 22-25
Alexandria, VA
www.crows.org

Modeling & Simulation of RF Electronic Warfare Systems
March 22-25
Atlanta, GA
www.pe.gatech.edu

Introduction to Intelligence, Surveillance, Reconnaissance (ISR) Concepts, Systems, and Test & Evaluation
March 29-April 1
Atlanta, GA
www.pe.gatech.edu

APRIL

Fundamental Principles of EW
April 4-7
Alexandria, VA
www.crows.org

Basic RF Electronic Warfare Concepts
April 19-21
Atlanta, GA
www.pe.gatech.edu

Directed Infrared Countermeasures: Technology, Modeling, and Testing
April 19-21
Atlanta, GA
www.pe.gatech.edu

Essentials of Electronic Warfare
April 26-29
Crane, IN
www.crows.org

AOC courses are noted in red. For more info or to register, visit www.crows.org.


TAKING YOUR MISSION TO
THE PEAK OF SUCCESS

message
from the president

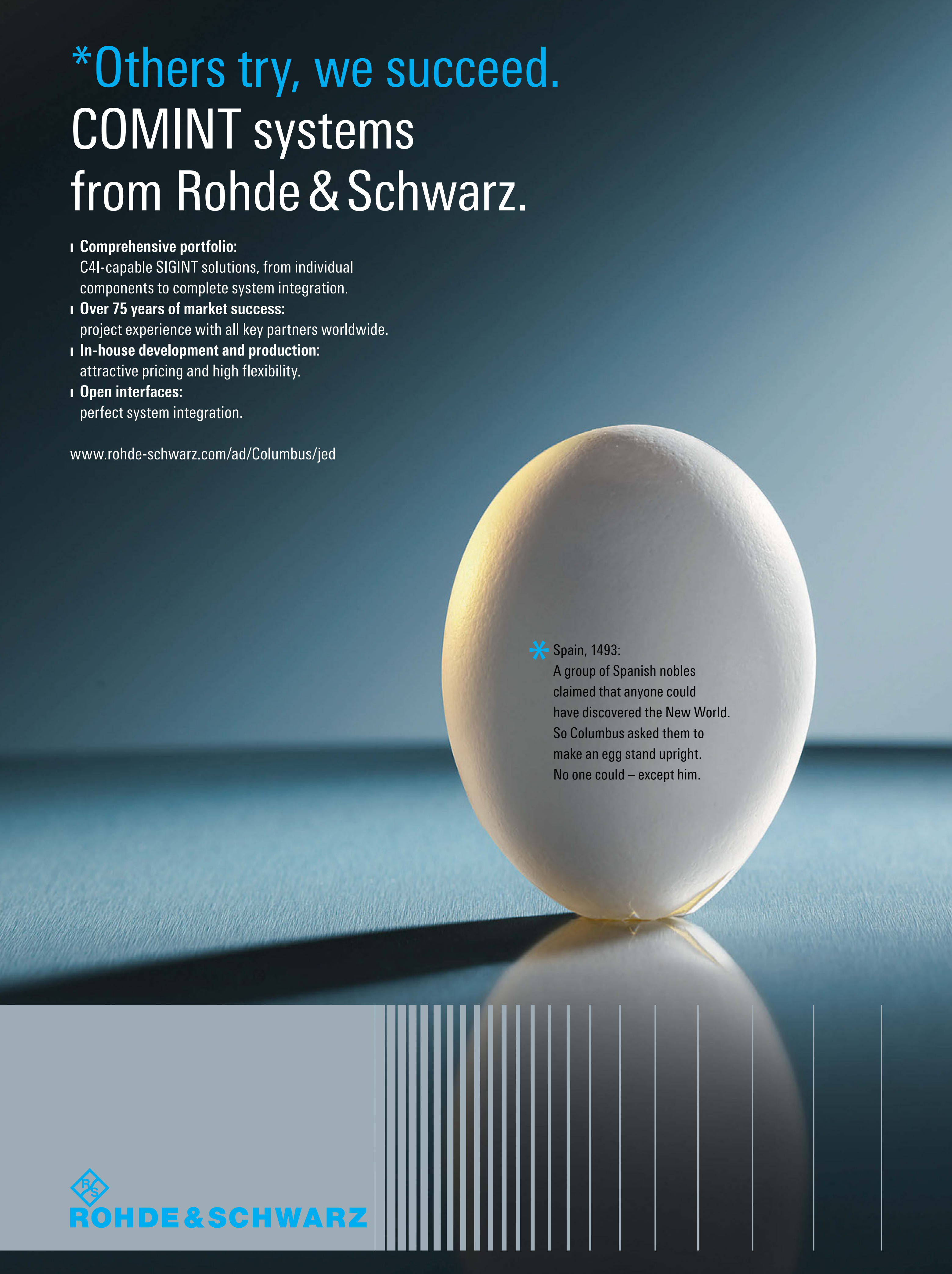
THE SHAPE OF ELECTRONIC WARFARE TO COME

This month I want to present you with some thoughts, ideas, and some questions that probably are outside your day-to-day thinking when it comes to EW. I'd like you to consider some questions: "How did we end up with the EW we have?" "Is it adequate today?" "Has it evolved beyond a 'black box?'" And, finally, "is the electromagnetic spectrum that EW operates in really an environment?"

Modern military history is replete with events where EW made a difference between winning and losing. EW "black boxes" proliferated in World War II, the Cold War and numerous regional conflicts. At the height of the Cold War, ADM Thomas Moorer, Chairman, Joint Chiefs of Staff (1970-1974), said, "If there is a World War III, then the winner will be the side that can best control and manage the electromagnetic spectrum." What a visionary, especially when EW at the time was perceived mainly in terms of "black boxes" that rolled off factory floors into aircraft and onto ships. The directions provided to operational users were, "turn it on in combat," and "replace and fix broken black boxes afterwards" – a fairly simplistic approach to operational employment. The military has gone through transformational changes since the end of the Cold War, and you have to ask the question, "Why hasn't EW?" I was taught that EW is like a chess game – move followed by counter-move. Today's chessboard is a whole lot different. So, is a "black box" EW mentality still adequate? The evidence is mounting that it is not.

After the Cold War, the "peace dividend" resulted in significant policy, doctrinal and organizational military changes. EW was profoundly affected – leadership retired and was not to be replaced; EW struggled to keep up with improvements to existing threats; and new threats emerged. However you look at it, EW and the job it must do have changed over the past quarter century.

As today's global economy forces reduced military spending in many countries, will the force multiplying effect that EW provided in the past resurface? As an EW practitioner, no matter where you contribute, take a moment to reflect and ask yourself, "Is the EW I grew up with still adequate? Is it more than a 'black box'? Is EW what must be mastered in order to win in the future as Admiral Moorer predicted in 1974? Is the shape of EW to come going to be applied to an "electromagnetic environment that must be won"? – *Walter Wolf*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* Spain, 1493:
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CIRCM RFP EXPECTED SOON

The US Army could begin soliciting proposals next month for the Technology Development phase of its Common IR Countermeasures (CIRCM) program. Last month, Lockheed Martin Missiles and Fire Control threw its hat in the ring, becoming the fifth company to announce it would submit a bid for the program.

Under the CIRCM program, the US Army wants to develop a laser-powered directed infrared countermeasures (DIRCM) system that can be installed on all of its light, medium and heavy helicopters. Current DIRCM systems, such as the ALQ-212 from BAE Systems and the AAQ-24 from Northrop Grumman, are relatively large and can only be carried on heavy helicopters. In addition to seeking a small, lightweight CIRCM system, the Army wants the jammer to feature a modular open system architecture, a high reliability rate and a low life-cycle cost.

Several industry teams are chasing the CIRCM program, which is valued in the billions of dollars. Lockheed Martin will lead a team that also includes DRS Technologies' Reconnaissance, Surveillance and Target Acquisition (RSTA) group and Daylight Solutions. DRS Technologies will supply a new pointer-tracker assembly and Daylight Solutions will provide a mid-IR quantum cascade laser. Lockheed Martin's Missions Systems and Sensors (MS2) business is part of another CIRCM bid led by ITT Electronic Systems. ITT has participated in a number of demonstrations over the past couple of years to validate the maturity its CIRCM solution. BAE Systems is offering its Boldstroke DIRCM system, which is part of a new family of Boldstroke aircraft survivability equipment for helicopters. Northrop Grumman and

Selex Galileo have formed a team that will bid a solution based on the Eclipse pointer tracker and the Viper laser. Raytheon Missile Systems is also chasing the CIRCM TD program with its Scorpion DIRCM system. The company recently won a $5 million Defense Acquisition Challenge contract, with some of the work focusing on integration of a quantum cascade laser into the company's Quiet Eyes Laser Turret Assembly.

The growing list of bidders is a good sign for the CIRCM program. A decade ago, only two companies – BAE Systems and Northrop Grumman – were offering DIRCM solutions, and no company could have met the CIRCM requirement for a reliable, lightweight, open-architecture solution.

For CIRCM bidders, the main question now is exactly when the Army will release the final RFP. The Army released a draft RFP earlier this year. A September amendment to the draft RFP stated that program officials would accept industry questions about the draft RFP until mid-December. Once that deadline passes, program officials could release the final RFP at any time. Most industry sources expect a final RFP in the next two months. However, one Pentagon source said Army and OSD acquisition officials may want to take one last hard look at the program before it gets the green light. The recent Congressional election has changed the balance of power in Congress and has added to growing pressure on the DOD to make cuts in acquisition programs. In addition, the Legislature is not expected to pass the FY2011 defense budget until the new Congress convenes in January. If the new Congress decides to reprioritize the budget or make significant cuts, the DOD could be forced to downsize, delay or cut the CIRCM program (among others) from the FY2011 budget. At the moment, the program has the support of the Army and such actions appear unlikely. However, in the context of the ongoing FY2011 budget deliberations, the CIRCM program is seen as vulnerable mainly because it is not yet on contract. – *J. Knowles*

USAF PONDERS NEXT PHASE OF JTE PRODUCTION

The US Air Force has issued a request for information (RFI) for the follow-on production phase of its Joint Threat Emitter (JTE) program.

Under JTE, the Air Force is modernizing its EW training ranges by replacing older threat simulators with new equipment. JTE comprises two main elements – Threat Emitter Units (TEUs) and fixed and mobile Command and Control Units (C2Us) that remotely control the TEUs.

During the first phase of the JTE program, known as JTE Increment 1 (Block 0, Kit 1), MTC Technologies and teammate Northrop Grumman Amherst Systems designed and developed the JTE and produced 16 units. However, that original phase of the program did not meet the DOD's entire JTE requirement. The Air Force now wants to buy the remaining systems to meet the full requirement, and the Range Threat System Program Office (RTSPO) at Hill AFB, UT has issued an RFI to help refine its acquisition plans.

According to the RFI, the Air Force plans to award a five-year, firm-fixed price contract to buy 7-15 TEUs, three mobile C2Us and two fixed-site C2Us. RTSPO has updated the JTE System Performance Specification and the JTE Statement of Objectives documents. However, the RFI notes that the Air Force does not own certain JTE technical information and software, such as the TEU signal generator (CEESIM) software; range data integration processor components of the C2 subsystem software; mission situation awareness terminal components of the C2 subsystem software; and the transmitter controller software. Any potential JTE production contractor will need to obtain access to this information, which is owned by Northrop Grumman. Because of this, the RFI's primary function is to determine if the JTE follow-on production phase should be conducted as a full-and-open competition or awarded as a sole-source contract to Northrop Grumman.

The contracting point of contact is Rodney Miller, (801) 586-5835, rodney.miller@hill.af.mil. The Air Force plans to award the JTE follow-on production contract in early 2012. – *J. Knowles*

ASIP INTEGRATION ON PREDATOR UAV MOVING FORWARD

The US Air Force's Aeronautical Systems Center (Wright-Patterson AFB, OH) has announced plans to award a contract to General Atomics (San Diego, CA) for integration and testing of the Airborne Signals Intelligence Payload-2C (ASIP-2C) on an MQ-9 Reaper UAV.

The ASIP, developed by Northrop Grumman originally for the U-2 and the RQ-4 Global Hawk, is now being developed in a scaled-down, 2C version for the smaller MQ-9. As the ASIP-2C's flight test phase approaches, the Air Force is preparing for it. The planned contract to General Atomics will cover full integration of the ASIP 2C and its antenna array onto an MQ-9, as well as end-to-end testing of the sensor. This work includes modifying an MQ-9 and four Ground Control Stations, as well as building installation kits. It also requires development of an MQ-9 ASIP system integration lab (SIL) for end-to-end ground testing prior to flight tests.

Subcontracting opportunities are available, according to an Air Force notice. The point of contact is Jennifer Hoskins, (937) 656-4235, Jennifer.hoskins2@wpafb.af.mil. – *JED Staff*

SOCOM SEEKS NEW LOW-VISIBILITY FLARE

The US Special Operation Command (USSOCOM) and the US Army Contracting Command have announced that they will host an industry briefing in January to discuss future business opportunities regarding a covert IR decoy program.

Known as the Reduced Optical Signature Emissions Solution (ROSES) program, the goal is to develop a new spectrally matched, low-visibility IR countermeasures flare to protect SOCOM aircraft from a wide variety of IR-guided threats. SOCOM's fixed- and rotary-wing aircraft often fly "low and slow" nighttime missions alone (without support aircraft) and well within the engagement envelope of ground-based IR missiles. A key aspect of these missions is to remain as stealthy as possible, and covert flares are a critical capability in this regard. A false alarm from a missile warner can trigger flares. Conventional flares burn very brightly and can reveal the presence of the aircraft and ultimately compromise a mission. However, covert IR decoys are not visible to the human eye, even against a dark nighttime sky.

Current SOCOM flare solutions include Advanced IR Countermeasures Munition decoys, as well as the XM-216 flare from Israel Military Industries. However, SOCOM wants to buy new flares that offer improved covert performance and effectiveness against evolving IR threat technology. To help industry understand its IR decoy needs, SOCOM is sponsoring the ROSES Industry Days at Picatinny Arsenal, NJ, on January 5-6. The event will include classified and unclassified threat briefings to domestic and foreign companies, respectively, as well as a ROSES program and requirements overview. The event also will include opportunities for flare manufacturers to conduct briefings to ROSES program officials. The industry day registration deadline is December 15. The point of contact at the Army Contracting Command is Kristen Kachur, (973) 724-3217, kristen.kachur@us.army.mil. – *J. Knowles*

SOCOM ISSUES RFI FOR ACOUSTIC HOSTILE FIRE INDICATOR

SOCOM has issued a request for information (RFI) to determine the availability and development status of acoustic technologies capable of performing hostile fire indication (HFI) on its rotary-wing aircraft.

SOCOM wants information about systems that can detect, identify and provide angle-of-arrival information for hostile fire sources, including assault rifles, large-caliber anti-aircraft artillery, unguided rockets and rocket-propelled grenades. Once alerted to hostile fire, aircrews can perform evasive maneuvers.

SOCOM is using the RFI to assess the "technical, manufacturing and integration maturity" of available acoustic HFI


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technologies and systems. SOCOM wants solutions that have achieved a score of 8 in terms of Technical Readiness Level (TRL), Manufacturing Readiness Level (MRL) and platform-based Integration Readiness Level (IRL).

SOCOM is also considering other HFI programs, including a multi-spectral capability that could be integrated into the AAR-57 Common Missile Warning System and a Multi-Function Threat Detector Joint Capability Technology Demonstration. However, an acoustic HFI system may provide the best near-term solution.

The RFI point of contact is Patricia Kleiman, (973) 724-9591, patricia.a.kleiman@us.army.mil. – *J. Knowles*

IN BRIEF

ITT Force Protection Systems (Thousand Oaks, CA) received a $29.1 million contract option from Naval Sea Systems Command (NAVSEA) to support the system development and demonstration (SDD) phase of the joint Counter Radio-Controlled Improvised Explosive Device EW (CREW) 3.3 system of systems. Under a separate contract, the company received a $16.7 million award to manufacture 425 Band C upgrade kits for vehicle-mounted CREW 2.1 systems currently being used in Afghanistan operations. Deliveries are scheduled to run through June 2011.

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The **National Air and Space Intelligence Center** (Dayton, OH) is expected to issue a solicitation later this month for its Signals Intelligence Engineering and Support Services (SESS II) program. The work includes technical SIGINT analysis to determine the performance characteristics of foreign radars, telemetry systems, data links and other "systems of interest." The point of contact is Eben Greybourne, (312) 886-3811, eben.greybourne@gsa.gov.

✪ ✪ ✪

The Naval Strike and Air Warfare Center at NAS Fallon, NV, has opened its new training department, the **Airborne Electronic Attack Weapons School** (AEAWS) and begun validation with the EA-18G Growler aircraft. The AEAWS will provide training to the fleet's EA squadrons, similar to the EA-6B Prowler training program, but incorporating training from the Top Gun program.

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GaN Corp. (Huntsville, AL) received a $27 million contract covering test support services for the US Army Operational Test Command's Intelligence Electronic Warfare Test Directorate. Work will be performed at Fort Huachuca, AZ, and should be complete by May 31, 2015.

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URS Corp. (Crane, IN) has received a contract to provide engineering, technical and program management support for the Naval Surface Warfare Center, Crane, IN. The two-year contract has a maximum value of $45 million and includes research, design, development, acquisition, prototyping and life-cycle support for Navy and DOD EW systems.

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Overlook Systems Technologies, Inc. (Vienna, VA) has been awarded a contract to provide technical support to the US Strategic Command's Joint Navigation Warfare Center (JNWC) at Kirtland AFB, NM. The work, which will be done with teammate SAIC, will address JNWC strengths and vulnerabilities in positioning, navigation and timing dependent systems, "while developing tactics, techniques, procedures and mitigation strategies to enable combat effectiveness." The contract, which includes a base year plus four one-year options, will not exceed $64.7 million.

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A joint **Northrop Grumman**/US government team received the 2010 David Packard Excellence in Acquisition Award for the development and demonstration of the APG-81 active electronically scanned array radar for the F-35 Joint Strike Fighter. The radar provides a "quantum leap" in electronic protection (EP) performance against enemy jammers.

✪ ✪ ✪

Booz Allen Hamilton (McLean, VA) was awarded a $9.5 million contract from the US Air Force to create proactive radar electronic protection techniques using multi-input, multi-output and waveform density.

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Col Philip J. Zimmerman has taken over command of Marine Corps Air Station Cherry Point, NC. Colonel Zimmerman, a Naval Flight Officer who has previously served as an electronic countermeasures officer on EA-6B Prowler aircraft, has served multiple tours at Cherry Point in all four of the Marine Corps' Prowler squadrons.

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Herley New England (Woburn, MA) has received a $3 million contract from an undisclosed US prime contractor to produce diplexers and attenuators for use in radar warning receivers.

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Lockheed Martin (Bethesda, MD) received a $230,000 contract from the US Air Force to define requirements for a high-power microwave weapon to disrupt enemy electronic systems without endangering personnel. The Non-Kinetic Counter Electronics Capability (NKCE) contract includes development of an operations concept, as well as a mission planning strategy. Findings are scheduled to be delivered to the Air Force during first quarter 2011.

✪ ✪ ✪

Maxtek Components Corporation (Beaverton, OR), a Tektronix company, has announced that it will now be known as **Tektronix Component Solutions**. The change leverages the Tektronix brand name in the test and instrumentation field.

washington report

DOD RELEASES SMALL BUSINESS SOLICITATION

The DOD has "pre-released" its first Small Business Innovative Research (SBIR) solicitation of FY2011. The list of topics includes several electronic warfare (EW) and signals intelligence (SIGINT) projects for the Army, Navy, US Special Operations Command and the Defense Advanced Research Projects Agency. The DOD typically awards hundreds of SBIR study contracts every year, most of which are for less than $100,000. Some projects receive funding for follow-on phases that include prototype hardware or software development. Because the research often addresses risk reduction for future EW and SIGINT efforts, it often provides insight into some of the key challenges to be addressed in future programs.

The Army portion of the SBIR solicitation features a pair of topics related to directed IR countermeasures (DIRCM). Topic A11-025, titled, "Laser Beam Delivery Sub-System for Multi-Band Mid-Infrared Laser," describes the Army's considerable investment in Mid-IR lasers and calls for development of "a corresponding high efficiency beam delivery system," according to the solicitation. A related effort, the "Mid-Infrared Laser Beam Combining Module for Infrared Countermeasure Application" (Topic A11-029), seeks to develop "a highly reliable, lightweight and compact module that combines a large number of mid-infrared diode lasers into a high power output beam." The point of contact for both topics is Manickam Neelakandan, (732) 532-3578, manickam.neelakandan@us.army.mil.

Another Army effort is titled "Asynchronous Network Signal Sensing and Classification Techniques" (Topic A11-028). According to the solicitation, "The objective of this research is to leverage the new or existing wireless sensor networks to achieve a technological breakthrough in signal sensing and automatic modulation classification (AMC) of weak signals that cannot be detected using traditional single sensor methods." The point of contact is Metin Ahiskali, (443) 861-0521, metin.ahiskali@us.army.mil.

The Navy also appears to be focusing on directed infrared countermeasures (DIRCM) technologies for a future phase of its Surface Ship EW Improvement Program (SEWIP). One effort related to SEWIP is titled "Low Light, Short Wave Infrared, Solid State Photodetector" (Topic N111-032). This research aims to develop "a low light capable solid state photodetector with low excess noise, very high gain and a large dynamic range (single to multi-photon) up to a cut-off wavelength of 2.2 microns." Another project, titled "High Throughput, Waveguide Based, Non-Mechanical Laser Beam Steering" (Topic N111-039), addresses development of "novel, ultra-low size, weight and power devices for electro-optic laser beam steering over a large field of regard with high optical throughput and low-unit cost." The topic later states, "The goal is a simple, cost effective, low SWaP EO laser beam scanner with a large field of regard (>50 degrees), fast scan rate (>2 kHz) and high optical throughput (>80%) for eye-safe wavelengths (1.5 -1.8 microns) and large beam diameters (>1 cm)." The point of contact for both topics is Dean Putnam, dean.r.putnam@navy.mil.

Naval Air Systems Command's Advanced Tactical Aircraft Protection Systems Program Office (PMA-272) is sponsoring an effort titled "Electromagnetic Absorbing Chaff" (Topic N111-013). Its description states, "Innovative changes to chaff technology, by researching and developing materials that actually absorb, and phase-shift electromagnetic propagations, effectively denying enemy use of a given frequency, are needed. Radio frequency (RF) absorbing materials, also known as metamaterials (MM), can be tailored to absorb in any frequency, denying threat use." Applications include battle space control of communications, denial of global positioning systems (GPS) devices, and deception of active missile seekers.

NAVAIR's EA-6B Program Office (PMA-234) is sponsoring another EW-related other project, "Thermal Management of Highly Integrated Radio Frequency (RF) Electronics" (Topic N111-023). This effort, which could benefit the Next-Generation Jammer program, will investigate novel materials and structures "to improve the heat dissipation capability of air cooled AESA systems at C, X and Ku bands. Heat dissipation improvements may be achieved at the chip, module and system level." The NAVAIR point of contact is Janet McGovern, navair.sbir@navy.mil.

US Special Operations Command is seeking proposals for a "Helicopter Hostile Fire Indication Sensor" (Topic SOCOM11-001). The sensor will be integrated into the "AVR-2B laser threat detector or a stand-alone miniature sensor that integrates back into the helicopter's EW suite." Questions can be sent to SOCOM at socomsbir@brtrc.com.

The Defense Advanced Research Projects Agency is sponsoring an effort titled "VHF/UHF Emitter location from Micro Unmanned Aerial Systems" (Topic SB111-004). Under this project, DARPA will seek to develop and demonstrate a tactical emitter-location system that could be flown on a miniature unmanned aircraft system (UAS) and detect and locate VHF/UHF emitters in real-time." The point of contact is Lyndall Beamer, (571) 218-4557, lbeamer@darpa.mil.

The full list of SBIR topics is available on-line at www.acq.osd.mil/osbp/sbir. Proposals are due January 12.

– J. Knowles

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world report

UK MOD SELECTS TEAM FOR PROJECT SHEPHERD

The UK Ministry of Defence has selected Team Excalibur as the preferred bidder for a new program to upgrade the Defence Electronic Warfare Center (DEWC) at RAF Waddinton. DEWC is the UK's joint-service EW operational support and reprogramming center.

Project SHEPHERD, previously known as the country's Defense Electronic Warfare Center Improvement Programme (DEWC IP), will upgrade the UK's joint-service Defence EW Database and provide a suite of EW operational support tools to allow the MOD to provide critical data as part of the country's intelligence, surveillance target acquisition & reconnaissance (ISTAR) capability. The upgrade is considered a "step-change" for the MOD's automated end-to-end capability and will improve the ability to provide effective front-line data.

Team Excalibur, led by the company Logica, also includes UK-based MASS (a Cohort plc company), which will provide advanced data management for the upgrade and US-based SRC, Inc., which is providing specialized data analysis tools. The upgrade will also include process management, workflow and reporting tools to provide operational efficiencies and integration across the DEWC.

During the early phases of the Project SHEPHERD competition, Team Excalibur was one of five teams awarded project concept/assessment studies to help define upgrades to the DEWC's EW databases. In the final phase of the competition, Team Excalibur squared off against another team led by Systematic Software Engineering Ltd. *– E. Richardson*

INDIA PLANS EW TEST RANGES

India plans to build two new EW test ranges – one for radar-based EW systems and one for communications-based EW systems – as part of the country's plans to develop its EW infrastructure.

According to published reports from the AOC India Chapter's National Electronic Warfare Workshop (EWWI-2010) last month, the country plans to build one range – to test non-communication EW systems – as part of an existing 4,000-acre aeronautical test range in Chitradurga in Karnataka for testing non-communication EW systems. A second range, which will be used to test communications EW systems, will be integrated into to an existing 8,000-acre range in Tandur in Andhra Pradesh (roughly 135 km from Hyderabad). Currently, the Indian MOD relies on a range with limited EW test capabilities at the centrally located Gwalior Air Force Base in Madhya Pradesh. Gwalior is used for training, testing and large exercises, such as the COPE INDIA events conducted with the US.

Speaking at EWWI-2010, Dr. Prahlada, Chief Controller, R&D (Ae & SI) for the Defence Research and Development Organisation (DRDO), stressed the importance of EW, noting that the country's present EW systems have been integrated with MiG-27 fighters and would be integrated into the MiG-29 fighters next year. In 2012, he said India plans to fly a domestically developed, fourth-generation EW system.

The two new ranges are slated to be operational in the 2012-2013 timeframe. The country plans to invest Rs 200 crore (2 billion Rupees or about US$43 million) into each of the two ranges. *– JED Staff*

IN BRIEF

- The **United Arab Emirates** has requested the purchase of 30 AH-64D Block III Apache helicopters, as well as 30 Block II lot 10 Apaches remanufactured to the Block III configuration from the US via Foreign Military Sales channels. The sale, worth $5 billion, would include 70 each of the ALQ-144A(V)3 infrared jammer, the APR-39A(V)4 radar signal detecting sets, the ALQ-136(V)5 radar jammer and the AAR-57(V)3/5 Common Missile Warning Systems. The USA has wanted to upgrade the EW on its Apaches for over a decade, but the program's importance has been overshadowed by the larger F-16 Block 60 program.
- The government of **Oman** has requested the purchase, via Foreign Military Sales channels, of logistics support and training for one C-130J aircraft from the US. The package, worth $76 million, also includes one AAQ-24(V) Large Aircraft Infrared Countermeasures (LAIRCM) System, seven AAR-54 missile approach warning systems, two ALR-56M radar warning receivers and two ALE-47 countermeasure dispensing sets. Northrop Grumman will provide the AAQ-24 and AAR-54. BAE Systems manufactures the ALR-56M and Symetrics manufactures the ALE-47.
- **EWST** (Farnborough, UK) has received a $3 million contract for a configuration of the company's RSS 8000 radar simulator, as well as a $1.5 million contract for upgrade and spares on a previously delivered system. Both contracts were from unnamed international customers.
- **Tata Advanced Systems** (New Delhi, India) has acquired 74 percent of HBL Elta Avionics Systems Pvt., Ltd. (HELA) from HBL Power Systems. HELA, a joint venture of HBL and Israel-based ELTA Systems, provides radar, communications, EW and surveillance systems to Indian defense forces. ELTA Systems maintains ownership of the remaining 26 percent of HELA.

Electronic Warfare

US Army's Next-Generation EW Gets

By Glenn Goodman

The US Army has an ambitious vision for its planned next-generation ground-based Integrated Electronic Warfare System (IEWS), development of which is slated to formally begin in Fiscal Year 2012. (See October *JED*, "What's Next in IED Jammers?" on page 40.)

The Army is eager to move beyond the limited capabilities of its more than 45,000 Counter Radio-Controlled Improvised Explosive Device EW (CREW) jammers. Their single mission has been protection of vehicle convoys and foot patrols from the lethal roadside bombs planted by insurgents in Iraq and Afghanistan. The CREW systems detect and block the radio-frequency (RF) communications signals emitted by the bombs' triggering devices, such as cell phones.

Meeting CREW force-protection requirements will remain a high-priority subset of IEWS. However, the Army wants its new ground-based EW system to provide a broader capability for electronic attack (EA) of an adversary's communications links, particularly mobile phones, to disrupt his command and control. This counter-C2 mission will require wider frequency coverage and greater jamming power and range than the current predominantly vehicle-borne CREW "boxes." It also will require sophisticated software for EW battle management, which the Army is already researching.

THE IRREGULAR WARFARE CHALLENGE

The service's desire to expand its counter-C2 jamming capabilities stems from the growth of irregular warfare in urban areas, aided by the rapid advance of commercial mobile wireless cellular communications technology available to insurgent groups. To meet this irregular warfare challenge, the use of legacy "brute-force" noise jammers that also disrupt friendly and civilian communications is no longer a viable option.

Limiting communications fratricide and maximizing jamming effectiveness in the dense and diverse urban signal environment, Army technologists say, mandate that IEWS use advanced surgical EA techniques that minimize needed output power and transmit time. Those techniques also require that IEWS be able to perform not just EA using jamming transmitters, but that it concurrently utilize the electronic support (ES) capabilities of co-located RF receivers to detect, identify and target a significant number of threat communications devices simultaneously and rapidly in a dynamic operational environment.

IEWS systems on different vehicles will be linked in a secure distributed network using existing Army radios, such as the standard Single Channel Ground and Airborne Radio System (SINCGARS) VHF-FM combat net radio. This will allow the EW systems to share RF situational awareness/threat information gathered by their ES sensors and to execute cooperative jamming missions, rather than having several systems indiscriminately jamming the same threats in an uncoordinated fashion.

OPEN ARCHITECTURE CRUCIAL

As Army technology research official Giorgio Bertoli co-wrote in a 2008 conference paper, "Legacy and modern EW systems in use today cannot execute simultaneous ES and EA missions against a diverse and target-rich battlespace, nor can they coordinate among each other to generate a complete Common Operating Picture of the RF environment. This leads to significant EW capability shortfalls.

"The Army's next-generation EW system must be based on an open software architecture that is flexible enough to allow for the rapid development and integration of new EA/ES techniques against emerging threats. This architecture must be able to minimize and abstract hardware dependencies, allow for rapid development and integration of new

Battle Management Smarter

attack waveforms and techniques, and support concurrent EA/ES mission execution against a diverse target signal set."

Bertoli today is Chief of the Offensive Information Operations Branch of the Intelligence and Information Warfare Directorate (I2WD) at Ft. Monmouth, NJ, and Aberdeen Proving Ground, MD. I2WD is the key Army research lab working on IEWS technologies.

His organization undertook development of that open software architecture now applicable to IEWS under a four-year proof-of-concept technology project called Urban Sabre. It culminated in a successful field demonstration last April at the Yuma Proving Ground, AZ, using a software-programmable-radio-based prototype system.

"The goal of the demonstration," Bertoli told *JED*, "was to get a single vehicle-mounted system to perform multiple EW missions simultaneously, as opposed to having to go after one target at a time. And to do it using an open software architecture that allowed us to add new [threat-specific] EA capabilities easier."

Calling Urban Sabre a first step, he noted, "We were able to demonstrate mitigation of four known threat systems simultaneously in a surgical fashion from the same, very flexible set of generic commercial off-the-shelf hardware."

IRON SYMPHONY

I2WD's follow-on to Urban Sabre is called Iron Symphony. It includes an Urban Sabre continuation effort as well as another technology project called the Advanced Ground EW System (AGES) being conducted by a sister branch of Bertoli's within I2WD.

Iron Symphony is focusing on developing a distributed network version of Urban Sabre.

"We're not going to be able to fit all of our desired platform-protect and counter-C2 capabilities into one nice package, even like we were doing under Urban Sabre, [due to size, weight and power constraints]," Bertoli said. "The only way we're going to achieve what we want is to figure out a way to do EW in a distributed fashion."

As a result, his branch is developing a distributed EW system interface specification with supporting protocols. It would allow cooperation among ES, EA and counter-RCIED platform-protect nodes on the network – enabling them to "talk" to one another and coordinate EW missions – as well as provide connectivity to battle command assets, without adding another radio to each Army combat vehicle.

AGES involves expanding the distributed network capabilities of the Army's current RCIED jammers. An example is providing an intra-convoy communications link among the jammers on different vehicles that would allow them to collaborate more efficiently than just keeping a protective "bubble" around every vehicle as multiple jamming systems redundantly attack the same threat. Threats could be divided automatically among platforms based on their vantage point to a target or current workload, for example, or a single threat could be attacked from multiple platforms if warranted. The ES capabilities of multiple CREW platforms could be leveraged to provide better threat geo-location. The CREW systems could also report ES information to higher headquarters, contributing to the Common Operating Picture of the RF environment.

A key aspect of the Iron Symphony work, Bertoli said, involves developing messaging structures. "What are the messages that need to pass among IEWS and other EW systems, such as [separate] threat geo-location systems? Let's have them register with a central spectrum management node so everyone can know that they are out there and are doing a particular mission right now. And how do different systems, such as IEWS and the Army's Prophet ground-based signals-intelligence vehicle, interact with each other to share information and not interfere with one another?"

An Iron Symphony laboratory demonstration of a distributed EW network is slated to occur in the February time frame. It will show if the base technology can function to a level that is sufficient to support a field demonstration, tentatively targeted for April at the Yuma Proving Ground. "One of the key things we have to demonstrate is that we can get this distributed network to work over SINCGARS radios," he said.

SURGICAL EA TECHNIQUES

The development of advanced surgical EA techniques requiring minimal output power and transmit time is essential to IEWS. "We can't do traditional jamming. It causes way too much interference,

EW Battle Management Gains Traction

Electronic Warfare Battle Management (EWBM) is a warfighting area in its relative infancy that is beginning to receive increased attention across the joint US military services. Just over a decade ago, Northrop Grumman began to develop an EWBM concept to help coordinate and improve jamming between multiple EA-6B Prowlers. Since that time, the concept of EWBM has gained ground not only in the airborne electronic attack (AEA) mission area, but also across a growing portion of the EW community. Today, there are many evolving facets of EWBM that include not only EA but also improved situational awareness via information sharing and optimal positioning of electronic support (ES) systems, whether it is on a ship, a ground vehicle or an aircraft, for example. The aim is to use EW resources more intelligently in the battlespace and, by extension, improve their effectiveness. Another benefit is to provide tactical commanders with a timelier and less ambiguous picture of the electromagnetic battlespace.

Establishing a robust EWBM capability is not simple. Some critical pieces of EWBM, such as the information systems and robust datalinks, can be leveraged from other network-centric warfare programs. But there are some unique aspects of EWBM that must be developed.

One aspect of EWBM entails determining the best use of available radio-frequency jamming assets in a theater of operations, particularly in terms of assigning missions or targets to them. Today, these electronic attack missions are predominantly carried out by manned aircraft.

The missions can be pre-planned – assigned on a daily Air Tasking Order in an air campaign against an integrated air defense system (IADS), for example – or dynamic when involving time-sensitive targets of opportunity, such as enemy mobile surface-to-air missile systems or command-and-control communications devices or networks.

Current support jamming aircraft that make up the DOD's layered Airborne Electronic Attack "System of Systems" are the Navy's new aircraft carrier-based EA-18G Growlers and remaining EA-6B Prowlers, the Marine Corps' EA-6Bs, and the Air Force's EC-130H Compass Call aircraft. They should be joined within a couple years by the Air Force's new expendable unmanned Miniature Air-Launched Decoy-Jammer (MALD-J), which would fly "stand-in" penetration jamming missions close to enemy air defense systems. The Air Force also plans to mount a communications jamming pod on its Reaper unmanned aerial vehicle.

As stated in the Executive Summary of the DOD's current Joint EW Initial Capabilities Document (ICD), "Effective and efficient EWBM in the near-term operational environment will be dependent upon situational awareness, automated decision support aids (to include EW targeting and effectiveness information), and rapid command and control (eventually including direct machine-to-machine interfaces) in order to effectively employ EW in the expected dynamic operational environment."

An indication of the increasing attention being paid to EWBM by the US joint military services was a "Future EWBM Capabilities Industry Week" slated to occur in the Atlanta, GA, area last month. It was sponsored by the Joint Information Operations Warfare Center (JIOWC)'s EW Directorate (formerly the Joint EW Center or JEWC) in San Antonio, TX. It was announced in a Request for Information on "Future EWBM and Electromagnetic BM Capabilities" issued in October by Air Force Aeronautical Systems Division, Wright-Patterson AFB, OH.

The RFI stated, "This is a special notice open to US industry requesting information on technologies available in the next decade to provide new or enhanced current EWBM and EMBM capabilities in order to control the electromagnetic spectrum. As a follow up to the EW Functional Solutions Analysis (FSA), the JIOWC EWD is leading the effort to address capability gaps identified in the approved EW ICD. It is interested in reviewing the state of the art and emerging technologies applicable to all aspects of EWBM/EMBM, to include policy, users/operations and network architecture. The team seeks specific system solutions with an anticipated technology readiness level (TRL) of 7/8 within the next 8-10 years. The intent of the Industry Week is to identify new and game-changing technologies and system upgrades that are not yet incorporated into existing or proposed DOD programs."

Currently, most of the key work in the area of EWBM involves the development of highly sophisticated software algorithms that automate the management of available EW assets and the optimization of EW mission assignments. To that end, Raytheon (Marlborough, MA) has worked on a small $3.5 million three-year EWBM system design contract from the Air Force Research Laboratory at Wright-Patterson AFB since April 2009, and is conducting a series of experiments and demonstrations in AFRL's Virtual Combat Laboratory. Through these experiments, the Air Force says it will be able to improve EW mission coordination by applying EWBM to a variety of scenarios to determine the best use of EW assets.

Despite the EW community's progress to date, EWBM is still in its early days. By the time it matures, it is likely to be such a common concept that future EW operators will ask the "old timers," how did you share target data with nothing but voice communications? – *G. Goodman*


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Bertoli said. "So we have to invest the resources to develop smart ways to go after threat communications devices."

As he explained, "Ideally, we would like to attack a device's software rather than jam its receiver the traditional way. We want to go after its protocol – understand what the protocol is, and then send actual messages to the threat device. It's much more efficient."

He gave a simple analogy. "Think of your cordless phone in your house. Instead of jamming its receiver so you get static – and blocking all the cordless phones in your neighborhood at the same time – I could actually send your specific phone a tiny little message telling it to hang up. It would appear to be a legitimate message, so your phone would unwittingly hang up. It might even respond back to me that it had received my message and had complied. I was able to target your specific phone, let's say, because I knew your telephone number."

SCHEDULING EW "FIRES"

EW battle management is a key part of the Army's IEWS vision. The service intends to treat its counter-C2 EA capabilities as non-kinetic "fires" that would complement or offer an alternative to kinetic fires such as field artillery. Like artillery strikes, jamming missions conducted by networked IEWS vehicles (or unmanned aircraft) could be preplanned (and timed) to disrupt enemy communications during a scheduled combat operation, such as an assault on a village.

"We are working with the Combined Arms Center [Ft. Leavenworth, KS] and Training & Doctrine Command community to help them figure out," Bertoli said, "if we do want to integrate EW into fires, what will that mean? If you send in request for EA support, instead of artillery, how would that trickle down in the system and result in tasking among distributed EW nodes near the objective area? Can I have a mission planning system that shows me, 'If I position five IEWS vehicles here, I'm going to get this sort of coverage.' The overall integration is going to be very interesting."

COL Rod Mentzer, the Project Manager for EW within the Army's Program Executive Office for Intelligence, EW and Sensors, told *JED* that a desired capability for the initial increment of IEWS is "battle management software for an EW officer that would provide him the flexibility to reprogram or 'lift and shift' [jamming] efforts among the networked boxes."

In terms of a vehicle-mounted IEWS operating in a dense irregular warfare RF environment, optimizing the use of its available ES and EA hardware resources to detect, identify and prosecute numerous threat signal devices that may be on the air only briefly is essential. This calls for advanced planning and scheduling software algorithms that can rapidly execute multiple ES and EA functions concurrently (and virtually simultaneously) without the two interfering with each other.

The algorithms would run autonomously but would abide by user-defined policies akin to "rules of engagement," particularly target priorities, while assigning tasks for the system's hardware resources to run at specific times. Many of the scheduled tasks would be generated dynamically by the algorithms as new target signals were identified.

Zeta Associates (Fairfax, VA) developed and validated a set of algorithms that could perform these functions under contract to Bertoli's organization.

Dr. Randall Janka, a Zeta Senior Associate, described in layman's language how the algorithms would work. "Let's say that my ES receivers detect 50 signal devices, and 20 of them are threats that we need to jam. My Planner figures out which EA waveforms we can generate with the 10 processors we have to take out those 20 signals. It turns out that we can only take out 15 of the 20, but five of those 15 are high-value targets, so we will go after those first. My Planner hands off instructions to my Scheduler, which says, 'OK, I need to run this EA waveform on Processor A and then run that one on Processor B, and I have to start and stop them at these times.' So we run that plan, and then ES tells us how we did: we took out four of the five high-value targets, but we missed one. My Planner then says, 'Let's try a different EA technique that might work better against that one target,' and we return to Step 1."

"I'm going after multiple targets at the same time," Bertoli said, "so how do I effectively schedule those EA missions? As targets pop up in the RF environment, which ones do I go after first? Is there a way for me to stack them so I can engage more of them, as opposed to going after the first ones that I detect? And I have to manage my pool of hardware resources. Which one do I use for which signal? We definitely have to use automation software. There's no way that an operator is going to sit there and be able to keep track of all the different signals, especially in a dense urban environment."

Today, every Army ground combat vehicle in Iraq and Afghanistan carries a CREW box to jam RCIED detonation signals. Will the same be true for IEWS? That's too early to tell.

While every Army combat vehicle is likely to carry a CREW-like platform-protect subset of IEWS, Bertoli said, the system physically is not likely to consist of, say, one or more large electronic boxes on every combat vehicle. "That's likely not affordable in the foreseeable future." A full IEWS suite of equipment might be carried on, say, one out of every 5-10 vehicles, he noted, or a vehicle could carry a subset of mission-specific IEWS boxes or modules that could be tasked over the network and would report what they were detecting.

In any event, Bertoli concluded, "IEWS likely is going to be a 'system of systems.' It will be a variety of different networked capabilities placed where needed at different locations."

Photos courtesy US Army and US Department of Defense.


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TECHNOLOGY SURVEY

EW Simulators for Laboratory Testing

By Ollie Holt

This month's technology survey takes a look at EW simulators for supporting integration and lab testing of EW systems covering the RF, UV, IR and laser spectra. Testing and evaluation of EW systems is about as challenging as building an EW system. The task of verifying the specified operation of an EW system requires being able to simulate the operational environment, including threats, friendly emitters and other signals emitted by neutral commercial and government sources. This requires the generation of the signal density and signal dynamics observed by the EW platform. The threat system dynamics include spatial change due to platform movement and changes in the operational modes of the threat systems as the environment changes (missiles get launched and RF signals change modes and/or frequency). Because of the high cost of providing a real operational environment and the large spatial area which this type of range would require, such resources are few and usually unavailable for initial integration and test. These resources are reserved for final acceptance testing and training. Because of the cost and availability of these resources, EW simulators that can simulate one or many threat signals and include both spatial dynamics and signal mode changes are required. These simulators provide a lower cost method of integration and initial system testing.

RF EW simulators vary from simple signal generators that can simulate a single RF pulse or CW signal to a combination of signal generators that under computer control can simulate multiple RF threats moving spatially following a preprogrammed scenario. In the past, most EW simulators were developed for airborne EW scenarios. With the growing IED threat, however, more companies are touting the communications simulation capabilities of their systems. In the UV/IR spectrum, the simulators can simulate the launch of a missile and the fly-out of that missile, including modifying plume spectrum and intensity as the missile moves through a predetermined flight path. A laser threat simulator can vary the signals modulation, PRF and pulse width as it follows a predetermined scenario. As the number of signals and spatial dynamics of each signal become more complex, the cost of these EW simulator systems goes up, and it can go into the tens of millions of dollars.

This survey includes RF, UV, IR and laser simulators. Some companies had some of each type. The results were grouped into simulators of a similar type for ease of comparison.

The first column identifies the company that developed the simulator and the simulator model number. The next column defines the purpose of the simulator. It can be seen that the main purpose of the simulators is to emulate some or all of the identifiable components of a threat signal. That component could be the RF signal pattern, the missile plume or the laser signal pattern. Some of the higher-fidelity systems generate multi-spectral signals to simulate all the various components of a threat system.

The spectrum column identifies the operational spectrum of the simulator. Some are just RF with the RF frequencies ranges defined while others operate in the UV, IR or laser spectra. The operational spectrum defines operational range within the spectrum where the threat signals can be simulated. If the threat to be simulated lies outside the operational range of the simulator it cannot emulate the threat.

The "RF Out" column defines the method of injecting the signal into the EW system to be tested or evaluated. For the RF systems the simplest method is either a direct connection to the antenna ports or with a coupler (also known as an "RF hat") to radiate into the antenna. For RF systems that are also simulating spatial characteristics of the RF signal, each antenna operating at the signal's RF frequency has to be stimulated with the simulated waveform if direct antenna connection or couplers are used. If free space (radiated) RF is used, then the spatial component is created by just the placement of the radiated signal. For UV, IR and laser systems, free space radiation is the method of signal injection. Again the spatial component for UV, IR or laser signals is controlled by the radiator's location and signal amplitude.

The "Number of Signals" column defines the number of different types of signals the simulator could generate. The column specifies the total number of different signals the simulator can be programmed to emulate. It does not tell you how many signals it can create simultaneously. The next column, which is the "Number of Simultaneous Signals," tells you how many signals the simulator can create at a single time. This allows the simulator to create a dense environment consisting of multiple threats. Typically for pulsed RF signal simulations more than one threat can be simulated with a single RF signal generator but with some dropped pulses. Most multi-signal simulations will attempt to simulate all the pulses of a signal but will have to drop some pulses because of pulse-on-pulse conditions. Sometimes the signals can be prioritized, defining which signal can lose pulses and which signal can't.

The intent is that the simulator does not just generate the signals but also simulates the total dynamics of the signal defined by the "Dynamics" column. The "Dynamics" column defines the types of modulation the simulator can apply to the simulated signal to simulate the environmental changes as the signal platform or the receiver platform moves. For RF signals, this not only covers the RF signal parameters that can easily be changed, such as frequency, PRF, pulse width and modulations, but also spatial dynamics for testing an EW system's ability to perform DF and location measurements. For UV and IR simulators, the dynamics are usually temporal and spectral. Changing the temporal and spectral content of the simulated missile plume emulates the fly-out pattern of the missile. For laser signals, its signal dynamics includes the changing PRF, pulse width and modulations of the signal.

The "Programmable" column indicates whether the system is user-programmable or fixed to only generate a specific signal type and not changeable by the user. All the systems listed in the survey can be programmed. Some already come supplied with some pre-programmed threat simulations. All allow the addition of signals or modification to the parameters of the signals provided to support test and evaluation needs.

The next few columns deal with the physical aspects of the simulator – power required to operate, space needed for the simulator, and its weight.

The last column lists comments provided by the suppliers. One interesting factor listed in the comments is the ability to remove the memory containing the threat library for security reasons. Because of the large investment made by some companies in these simulators, it is nice to have removable storage devices that contain the entire data specific to a particular project so that the simulator can be declassified and used by another project on a daily or weekly schedule. The ability to declassify the simulator to make it readily available for the next project or test shift makes it more useful to most users. Hopefully, more of the large simulators will provide removable memory so the task of switching from classified project to classified project becomes easier.

JED's next survey, covering ELINT receivers, will appear in the January issue.


Dual Directional Coupler
180°HYBRID
Model: H7492
Freq: 500-2500 MHz
Pwr: 200 Watts
WERLATONE
NAVY

RF EW SIMULATORS

MODEL	PURPOSE	FREQ./SPECTRUM	RF OUT	# OF SIGNALS	SIMULTANEOUS SIGNALS	SIGNAL DYNAMICS
ELDES s.r.l.; Firenze, Italy; +39-055-720442; www.eldes.it						
E-PRS	Radar simulator	0.5-18 GHz (opt 26-40 GHz)	*	*	Variable	500 MHz frequency agility (1 GHz option)
EW Simulation Technology Ltd; Farnborough, Hampshire, UK; +44 1252 512951; www.ewst.co.uk						
RSS8000/DF	RWR, RF jammer, ELINT	-100 MHz-40 GHz	Direct, antenna coupler or radiated	Up to 4,096 different signals	Up to 32 parallel channels	Spatial, temporal, spectral
RSS8000/P/CP	RWR, RF jammer, ELINT	-100 MHz-40 GHz	Direct, antena coupler or radiated	Up to 4096 different signals	One	Spatial, temporal, spectral
IZT; Erlangen, Germany; +49-9131-4800-100; www.izt-labs.de						
S5000	COMINT/DF testing	20 MHz-3 GHz	Direct cable, antenna coupler	127	127	Variable amplitude, delay, doppler, antenna patterns
COMINT and DF Simulator	COMINT/DF testing	20 MHz-3 GHz, continuous frequency coverage	Direct cable, antenna coupler	3,302	3,302	Variable amplitude, delay, doppler, antenna patterns
KOR Electronics; Cypress, CA; 480-734-6111; www.korelectronics.com						
BaTS	RWR test and simulation	0.5-18 GHz	Direct inject	User defined	10	Yes
WRG	RF signal capture and generation	2.0-18 GHz	Free space	One	One	Yes
Northrop Grumman Electronic Systems - Amherst Systems; Buffalo, NY, USA; +1-800-631-0610; www.northropgrumman.com						
Advanced Multiple Enviroment Simulator (AMES)	RWR, RF jammer	0.01-40 GHz	Direct inject	2,048	2,048	Full 6 degrees of freedom dynamic motion for SUT and all threat signals
Combat Electromagnetic Environment SIMulator (CEESIM)	RWR, RF jammer	0.002-42 GHz	Direct inject	128-8,192	128-8,192 simultaneously	Full 6 degrees of freedom dynamic motion for SUT and all threat signals
Rohde & Schwarz; Munich, Germany; +49-89-4129-11-378; www.rohde-schwarz.com						
GTA-RN5	Testing, training in a defined signal environment	20-400 MHz	*	RF inputs for up to 6 Combat Net Radios plus one ext. jamming input plus one ext.	7-plus external antenna signals	*
Varilog Research, Inc.; Beltsville, MD; +1-301-474-3676; www.varilog.com						
VariGen	PDW, IF or RF simulation for library development, integrated combat test or EW system training	Digital or IF	*	Up to 1,023 active emitters	Up to 8 PDWs per msec; 1-4 time-coincident IF signals	512 platforms with full dynamics, including own- ship

PROGRAMMABLE	POWER (W)	SIZE (HxWxL in/cm)	WEIGHT (lb/kg)	FEATURES
Fully programmable PRF mode and value and pulse width and coding	0 dBm (possible connection with external power amplifier for higher performance)	Variable (typically 19-in. cabinet)	Variable (typically 60-120 kg)	Capability to simulate, according to a user defined scenario, one or more radar transmitting pulses with one or more targets.
Fully user programmable	Up to several kW depending upon configuration	19 in. rack mountable or supplied in rugged transport cases	Up to several 100 kg depending on configuration	Modular parallel structure allows ease of upgrade. Windows-based GUI, 6 DOF modelling, terrain masking, interfaces to control UV, IR and laser simulators in integrated scenarios. DF outputs available – amplitude, phase, DTOA, rotating antenna.
Fully user programmable	500 W	CP unit is 5 U high, 500 mm deep and 600 mm wide. P unit is 12 U high, 500 mm deep and 600 mm wide	Less than 25 kg	Portable system in rugged transport. Fully compatible with RSS8000/DF system software and hardware.
Yes	1,000 W	9 U x 19 in. x 52 cm	40 kg	Up to 14 synchronized antenna outputs for DF validation and operator training. Variable bandwidth from 15 kHz up to 20 MHz for every emitter.
Yes	20,000 W	220 x 900 x 100 cm	3500 kg	Up to 14 synchronized antenna outputs for DF validation and operator training. Variable bandwidth from 15 kHz up to 20 MHz for every emitter.
Yes	4 kW	2 racks 61 in. tall x 36 in. deep x 23 in. wide	750 lbs	Uses all COTS hardware. Six DOF flight dynamics. Amplitude AOA. Receiver antenna pattern definable per each of the four ports. Flexible emitter modelling. Logging with IRIG-B timestamps. Automatic calibration.
Yes	150 W	19-in. rack mount chassis - 2 x 3 U, 1 x 9 U (28 x 19 x 26.26 in. total)	200 lbs	Acquires and stores 14-sec snapshots of 1 GHz RF bandwidth signal space for analysis and playback. Captured, modfied and/or synthic signals can be generated.
User-programmable Full emitter fidelity	Standard AC power for US or international applications.	Standard 19-in. rack(s)	Max 800 lbs per rack bay	1-64 RF channels. >100 AOA ports. Simultaneous multi-SUT stimulation.
User-programmable Full emitter fidelity	Standard AC power for US or international applications	Standard 19-in. rack(s). Portable versions in 3 U or 9 U H chassis	Max 800 lbs per rack bay. 60-120 lbs portable version	Communication signal simulation. Input/playback of recorded signals.
Yes	100-120 V AC/200 V to 240 V AC, 50 Hz to 60 Hz, 170 VA	21.02 x 24.61 x 23.03 in.; 534 x 625 x 585 mm	approx. 143 lbs, 65 kg	Hardware based simulation of wave propagation losses between connected devices. Test of new radio equipment in dedicated, realistic scenarios. Operator training in the fields of ES, EP and EA.
Yes	110 or 220 VAC, < 650 W	5.25 x 19 x 20 in.	28-32 lbs (digital/IF versions)	Windows-hosted software; tailorable remote control. Multi-doc/view GUI interface with drag and drop. Digital/IF versions can incorporate basic or refined SUT-specific antenna/receiver modeling.

UV/IR AND LASER EW SIMULATORS

MODEL	PURPOSE	FREQ./SPECTRUM	RF OUT	# OF SIGNALS	SIMULTANEOUS SIGNALS	SIGNAL DYNAMICS
ESL Defence Ltd; Hamble, Southampton, UK; +44 2380 455110; www.esldefence.co.uk						
Baringa 5.5	Missile plume simulator, UV MWS test and evaluation	240-285 nm	Free space	8 per library	None	Spectral and temporal
IR Baringa	Missile plume simulator, UV MWS test and evaluation	3.8 µm to 4.2 µm, 4.5 µm to 4.8 µm	Free space	8 per library	Red and Blue missile signatures	Spectral and temporal
Hydra SIL	Laser threat simulator, LWR test and evaluation	0.904 µm and 1.550 µm	Free space	8 per library	None	Spectral and temporal
MEON SIL	End-to-end test of DIRCM	*	Free space	8 per library	Single UV and IR missile signatures	Spectral and temporal
MWS Test Bench	MWS system test and evaluation	240-285 nm	Free space	8 per library	Up to 6 UV threats	Spectral and temporal

Survey Key – EW Simulators for Test and Flightline Applications

MODEL

Product name or model number

PURPOSE

What function of the EW or SIGINT System does it test?

- UV = ultraviolet
- MWS = missile warning system
- DIRCM = directed infrared countermeasures
- DF = direction finding
- RWR = radar warning receiver
- PDW = polarization dependent wavelength

SPECTRUM

RF frequency range; EO/IR bands

RF OUT

How are the threat signals delivered into the EW system?

- Directly injected
- RF coupler/hat
- Free space radiation

NUMBER OF SIGNALS

One specific signal or able to simulate many different signals?

- UHF = ultra-high frequency
- VHF = very-high frequency

SIMULTANEOUS SIGNALS

Number of signals the system can produce simultaneously.

SIGNAL DYNAMICS

Both spectral and spatial

PROGRAMMABLE

Can the user program different signals?

- PRF = pulse repeat frequency
- RAID = redundant array of independent disks
- DDR = double data rate
- RAM = random access memory
- AESA = active electronically scanned array
- AWG = array wavelength grating
- LRF = laser range finder
- LDS = line distortion simulation

POWER

Power drain in Watts

SIZE

H x W x L in inches/cm

WEIGHT

Weight in lb/kg

FEATURES

Additional features

- AOA = angle of arrival
- GUI = graphical user interface
- DOF = degrees of freedom
- ES = electronic support
- EP = electronic protect
- EA = electronic attack

PROGRAMMABLE	POWER (W)	SIZE (HxWxL in/cm)	WEIGHT (lb/kg)	FEATURES
Amplitude/temporal missile signatures and remote control	12 VDC @ 2A	5.25 x 4.25 x 13 in., 135 x 115 x 330 mm	8.6 lbs, 3.9 kg	Removable memory for security. Can also be used for flightline operations.
Red and Blue amplitude/temporal missile signatures and remote control	12 VDC @ 2A	5.25 x 4.25 x 13 in., 135 x 115 x 330 mm	9 lbs, 4.1 kg	Removable memory for security. Can also be used for flightline operations.
Threats: LRF, LDS, LBR, wavelength, amplitude, PW and PRF	12 VDC @ 3A	5.25 x 4.25 x 16 in., 135 x 115 x 410 mm	9.9 lbs, 4.5 kg	Removable memory for security. Can also be used for flightline operations. Options include 1.064 & 0.525 μm.
UV/IR amplitude/temporal missile signatures and sequence of UV Tx, IR Tx and IR Detector timing	12VDC @ 5A	7 x 6 x 13.75 in., 180 x 150 x 350 mm	8.8 lbs, 4.0 kg	Removable memory for security. Can be carriage mounted to offer motion. Also measures jam beam code and intensity. Can also be used for flightline operations.
Amplitude/temporal missile signatures, sequence & number of threats	110/220 VAC @ 2.5A	20 x 60 x 120 in., 0.5 x 1.5 x 3 m	220 lbs, 100 kg	Multiple threat simulator; test and evaluation of comple MWS suite.

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
Aeroflex Test Solutions	www.aeroflex.com
Agilent	www.agilent.com
Anritsu	www.us.anritsu.com
Applied IR Sensing (AIS)	www.applied-infrared.com.au
CI Systems (Israel) Ltd.	www.ci-systems.com
Gigatronics	www.gigatronics.com
Kent Optronics	www.kentoptronics.com
Micronetics	www.micronetics.com
Rafael	www.rafael.co.il
Santa Barbara Infrared Inc.	www.sbir.com
Scientific Research Corporation	www.scires.com
Spectra Research	www.spectra-research.com
Tektronix	www.tektronix.com
ViaSat	www.viastat.com

Upcoming Product Surveys

January 2011: ELINT Receivers
March 2011: RWR/ESM Systems
June 2011: Airborne IR Expendables and Dispensers

The deadline for *JED's* January survey questionnaires has past. Please e-mail JEDeditor@naylor.com to request a survey questionnaire for March or June.

2011 EW/SIGINT Resource Guide

Welcome to *JED*'s 2011 EW/SIGINT Resource Guide. This guide is the print snapshot of the AOC's new on-line EW/SIGINT Resource Guide and is designed to list companies and organizations that manufacture products or provide services in the areas of electronic warfare (EW) and signals intelligence (SIGINT).

Visit the AOC EW/SIGINT Resource Guide on-line at

www.ewsigint.net

About this Guide

This guide was assembled by our editorial team, based on our own research and from updated information provided to us by companies using the AOC's new on-line EW/SIGINT Resource Guide, which will launch officially on January 1, 2011. Though we have attempted to produce a comprehensive listing, we expect this guide to continue to grow. If your company does not appear in this year's guide, please see the note below on how to get your company listed in the online guide.

How to Use this Guide

The guide's first section contains a "company listing," in which companies are featured in alphabetical order. The second section includes product and service categories, roughly organized by components/subsystems, systems, software and services. Refer back to the company section for website and location data on listed companies.

Get Listed

Our next print guide will appear in December 2011, however, the online resource guide will be live year-round beginning in January. If you received a login to update your company information, you can use that password information to update your listing year-round. Not sure if you have a login or need to add your company? Visit **www.ewsigint.net** and click on "Get Listed".

COMPANY LISTING

A

AAI Corporation - Test and Training
Hunt Valley, MD, USA
www.aaicorp.com

Abacus EW Consultancy Ltd.
Lincoln, UK
www.abacusewc.com

Adamy Engineering
Sunnyvale, CA, USA

Advanced Compliance Solutions
www.acstestlab.com

Advanced Control Components Inc.
Eatontown, NJ, USA
www.advanced-control.com

Advanced Electronics Company - Military Systems Business Unit
Riyadh, Saudi Arabia
www.aecl.com

Advantech
www.advantech.com

Aeroflex
Plainview, NY, USA
www.aeroflex.com

Aeronix, Inc.
www.aeronix.com

Aethercomm, Inc.
Carlsbad, CA, USA
www.aethercomm.com

Agilent Technologies
Santa Clara, CA, USA
www.agilent.com

Airborne Systems Limited
www.airborne-sys.com

Airborne Tactical Advantage Company - Business Development
Newport News, VA, USA
www.atacusa.com

AIRBUS MILITARY
Blagnac, Cedex, France
www.eads.net

AirScan Inc
www.airscan.com

AKON, Inc.
San Jose, CA, USA
www.akoninc.com

Albrecht Telecommunications
Hunenberg, Switzerland
www.albrecht-telcom.ch

Alion Science and Technology - Defense Operations
McLean, VA, USA
www.alionscience.com

ALKAN
Valenton, France
www.alkan.fr

Allen-Vanguard Corporation
Ottawa, Canada
www.allen-vanguard.com

Alloy Surfaces Co., Inc. (Chemring Group plc)
Chester Township, PA, USA
www.alloysurfaces.com

Altera Corporation
San Jose, CA, USA
www.altera.com

American Microwave Corporation
Frederick, MD, USA
www.americanmicrowavecorp.com

AMESYS
Boulogne, France
WWW.AMESYS.FR

AMEWAS, Inc
California, MD, USA
www.amewas.com

AML COMMUNICATIONS, INC.
Camarillo, CA, USA
WWW.AMLJ.COM

Ampex
www.ampex.com

Amplifier Solutions Corp
Colmar, PA, USA
www.amplifiersolutions.com

AmpliTech
Holbrook, NY, USA
www.amplitechinc.com

AMT Microwave Corp.
Camarillo, CA, USA
www.amt-microwave.com

Analog Devices Inc
Norwood, MA, USA
www.analog.com

Anaren, Inc. - Space & Defense Group
East Syracuse, NY, USA
www.anaren.com

Anatech Electronics
Garfield, NJ, USA
www.anatechelectronics.com

Annapolis Micro Systems, Inc.
Annapolis, MD, USA
www.annapmicro.com

Anritsu
Richardson, TX, USA
www.anritsu.com

Antenna Authority
www.antennaauthorityinc.com

Antenna Products
www.antennaproducts.doc

Antenna Research Associates
Beltsville, MD, USA
www.ara-inc.com

Applied EM Inc.
Hampton, VA, USA
www.appliedem.com

Applied Geo Technologies Inc
Choctaw, MS, USA
www.appliedgeotech.com

Applied IR Sensing (AIS)
www.applied-infrared.com.au

Applied Signal Technology Inc.
Sunnyvale, CA, USA
www.appsig.com

Applied Systems Engineering Inc.
Fort Worth, TX, USA
www.applsys.com

AR Worldwide
www.ar-worldwide.com

ARC Technologies
Amesbury, MA, USA
www.arc-tech.com

Argon ST
Fairfax, VA, USA
www.argonst.com

Aselsan Inc.
Ankara, Turkey
www.aselsan.com.tr

Assemblies Inc.
Andover, MA, USA
www.assembliesinc.net

Association of Old Crows
Alexandria, VA, USA
www.crows.org

Astron Wireless Technologies
www.astronwireless.com

Astronics DME Corporation
Orlando, FL, USA
www.astronics.com

ATDI Ltd
West Sussex, UK
www.atdi.co.uk

ATK Integrated Systems Inc.
Clearwater, FL, USA
www.atk.com

ATK Mission Systems
Woodland Hills, CA, USA
www.atk.com

ATK Space Systems
Brigham City, UT, USA
www.atk.com

Avalon Electronics, Inc.
Bartow, FL, USA
www.avalon-electronics.com

B

BAE Systems
Nashua, NH, USA
www.eis.nabaesystems.com

BAE SYSTEMS Australia
Edinburgh, SA, Australia
www.baesystems.com

BAE Systems Rokar
www.baesystems.com

BARCO
Kortrijk, Belgium
www.barco.com

Barr Associates, Inc.
Westford, MA, USA
www.barrassociates.com

BC Systems
Setauket, NY, USA
www.bcpowersys.com

BEL – Bharat Electronics Ltd
Bangalore, India
www.bel-india.com

BittWare
Concord, NH, USA
www.bittware.com

Boeing Integrated Defense Systems
St. Louis, MO, USA
www.boeing.com

C

C&S Antennas
www.tactmast.com

CACI Technologies Inc
Arlington, VA, USA
www.caci.com

CAP Wireless
Newbury Park, CA, USA
www.capwireless.com

Carinex
www.carinex.hu/english/index.php

Carolina Unmanned Vehicles Inc.
Raleigh, NC, USA
www.carolinaunmanned.com

Cassidian, An EADS Company
Ulm, Germany
www.eads.com

CDO Technologies
www.cdotech.com

CEA Technologies
Fyshwick, ACT, Australia
www.cea.com.au

Ceralta Technologies - Sage Laboratories
Hudson, NH, USA
www.sagelabs.com

CHAS Group
Fort Wayne, IN, USA
www.chasgroup.com

Chemring Countermeasures (Chemring Group plc)
Whitely, Fareham, Hants, UK
www.chemringcm.com

Chemring Energetics Division - Technical Ordnance
Downers Grove, IL, USA
www.scotinc.com

Chengdu SIWI Electronic Co., Ltd
Chengdu, China
www.siwi.com.cn

Chesapeake Technology Intl Corp
California, MD, USA
http://www.chesapeaketechnology.com/

Chordell Systems Ltd.
Oxford, UK, USA
http://www.chordell.com

CI Systems (Israel) Ltd.
www.ci-systems.com

Ciao Wireless, Inc.
Camarillo, CA, USA
www.ciaowireless.com

Clausewitz Technology
Huntsville, AL, USA
www.clausewitztechnology.com

Cobham - Aviation Defence Service (AVdef)
Saint Gilles, France
www.avdef.fr

Cobham - FR Aviation
Christchurch, Dorset, UK
www.cobham.com

Cobham Antenna Systems - Marlow - Chelton Ltd.
Marlow, Buchinghamshire, UK
www.cobham.com

Cobham Defense Systems
Herndon, VA, USA
www.cobham.com

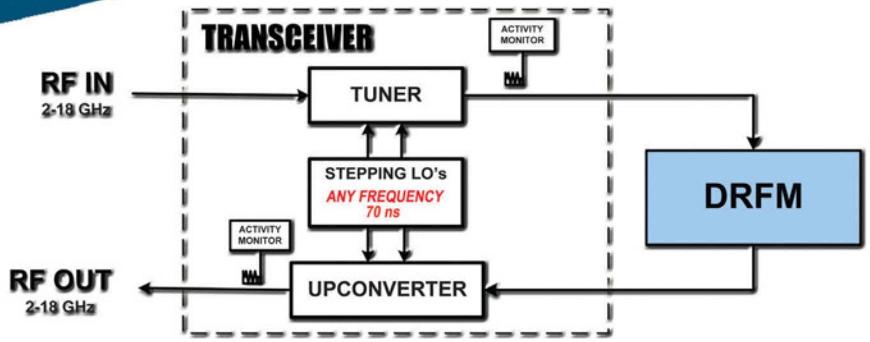
Coleman Microwave Company
Edinburg, VA, USA
www.colemanmw.com

Communications & Power Industries, Inc (CPI)
Palo Alto, CA, USA
www.cpii.com

Communications Audit UK Limited
Cheltenham, UK
http://www.commsaudit.com

Communications Supply and Support Ltd
Epping, Essex, UK

Comtech PST
Melville, NY, USA
www.comtechpst.com



AKON has developed a complementary line of matching receiver/tuners, fast stepping LO synthesizers, and transmit up converters for use in modern highly integrated EW/ECM systems. These subsystems are designed so that the customer can supply his own DRFM and receiver/signal processor subsystems, leveraging the customer's internal digital processor, software and DSP capability, and allowing the simple purchase of the required microwave components to complete the ECM system.

Visit us at www.akoninc.com for detailed technical specifications and other information.

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DEDICATED TO EXCELLENCE

COMPANY LISTING

Concurrent Technologies
Johnstown, PA, USA
www.ctc.com

Crane Aerospace & Electronics - Crane Co.
Redmond, WA, USA
www.craneae.com

CREE
www.cree.com

CSC Score Division
www.cscnorco.com

CSIR - DPSS
Pretoria, South Africa
www.csir.co.za

CTT, Inc.
Sunnyvale, CA, USA
www.cttinc.com

Cubic Defense Systems
San Diego, CA, USA
www.cubic.com

Cuming Microwave Corporation
Avon, MA, USA
www.cumingmw.com

Curtiss-Wright Controls Electronic Systems
Fairborn, OH, USA
www.cwcelectronicsystems.com

Curtiss-Wright Controls Electronic Systems
Santa Clarita, Canada
http://www.cwcelectronicsystems.com

Curtiss-Wright Controls Embedded Computing
Leesburg, VA, USA
www.cwcembedded.com

D

DAICO Industries
www.daico.com

DARE Electronics, Inc
Troy, OH, USA
www.dareelectronics.com

dB Control
Freemont, CA, USA
www.dBControl.com

Defence Research and Development Canada
Ottawa, ON, Canada
www.ottawa.drdc-rddc.gc.ca

Defense Research Associates, Inc.
Beavercreek, OH, USA
http://www.dra-inc.net

Delta Microwave
Oxnard, CA, USA
www.deltamicrowave.com

DePriest Associates, Inc.
www.depriest-associates.com

Diehl BGT Defence GmbH & Co. KG
Überlingen, Germany
www.diehl-bgt-defence.de

Dielectric Labs
Cazenovia, NY, USA
www.dilabs.com

Digital Receiver Technology
Germantown, MD, USA
www.drti.com

Directive Systems
Lebanon, ME, USA
www.directivesystems.com

Dow-Key Microwave
Ventura, CA, USA
www.dowkey.com

DRS Defense Solutions - DRS Signal Solutions
Gaithersburg, MD, USA
www.drs-ds.com

DRS Defense Solutions - ICAS (Buffalo, NY)
Buffalo, NY, USA
www.drs.com

DRS Defense Solutions - ICAS (Merrimack, NH)
Merrimack, NH, USA
www.drs.com

DRS Defense Solutions - Signal Recording
Columbia, MD, USA
www.drs.com

DSPCon, Inc.
Bridgewater, NJ, USA
www.dspcon.com

D-TA Systems
Annapolis, MD, USA
www.d-ta.com

Ducommun Technologies
Carson, CA, USA
www.ducommun.com

Dynamic Analytics & Test, Inc.
Arlington, MA, USA
www.dat-inc.com

DynaWave Inc
Haverhill, MA, USA
www.dynawave.com

Dynetics Inc.
Huntsville, AL, USA
www.dynetics.com

E

e2v
Chelmsford, Essex, UK
www.e2v.com

EADS - North America
Arlington, VA, USA
www.eadsnorthamerica.com

Eclipse Electronic Systems, Inc.
Richardson, TX, USA
www.sigint.com

EFJohnson Technologies
Irving, TX, USA
www.efjohnsontechnologies.com

Elbit Systems
Haifa, Israel
www.elbitsystems.com

Elcom Technologies
Rockleigh, NJ, USA
www.elcom-tech.com

ELDES srl - Radar Division
Scandicci, Firenze, Italy
www.eldes.it

Electro-Metrics Corp.
Johnstown, NY, USA
www.electro-metrics.com

ElectroOptic Industries Ltd.
Rohovot, Israel
www.el-op.com

Elettronica SpA
Rome, Italy
www.elt-roma.com

Elisra
Bene Beraq, Israel
www.elisra.com

ELTA Systems Ltd
Ashdod, Israel
www.iai-elta.co.il

EM Research
Reno, NV, USA
www.emresearch.com

Empower RF Systems
Inglewood, CA, USA
www.EmpowerRF.com

EMS Technologies, Inc. - Defense and Space
Norcross, GA, USA
www.emsdss.com

Endwave Corp.
San Jose, CA, USA
www.endwave.com

Eneroth EWSC
Linghem, Sweden

eonic BV
Delft, Netherlands
www.eonic.com

ESL Defence Limited (AAI Corp. subsidiary)
Southampton, Hampshire, UK
www.esldefence.co.uk

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www.esterline.com

ET Industries
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www.etiworld.com

Etienne Lacroix
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www.etienne-lacroix.com

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www.etm-inc.com

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www.ets-lindgren.com

European Antennas
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www.european-antennas.co.uk

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www.ewst.co.uk

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www.ewsys.com

EWA - Electronic Warfare Associates
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www.ewa-gsi.com

F

FEI-Zyfer
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First RF Corp
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www.fi rstrf.com

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www.flann.com

FLEXCO Microwave
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www.fl excomw.com

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www.foster-miller.com

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www.fractenna.com

FS Antennentechnik GmbH
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www.fsant.de

G

GE Intelligent Platforms
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www.ge-ip.com

General Dynamics - Information Systems & Technology
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www.gtri.gatech.edu

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www.goodrich.com/sis

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GTEK, LLC.

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www.hubersuhner.com

I

I.F. Engineering Corp
www.ifengineering.com

IBD Deisenroth Engineering
www.ibd-deisenroth-engineering.de

IFI - Instruments for Industry Inc.
Ronkonkoma, NY, USA
www.ifi.com

IMI - Israel Military Industries
Ramat Hasharon, Israel
www.imi-israel.com

INDRA
Alcobendas, Madrid, Spain
www.indracompany.com

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Erlangen, Germany
http://www.izt-labs.de

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www.isigtech.com

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IOMAX
www.iomax.net

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http://cs.itt.com/c4products.html

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dwww.jels-tech.com

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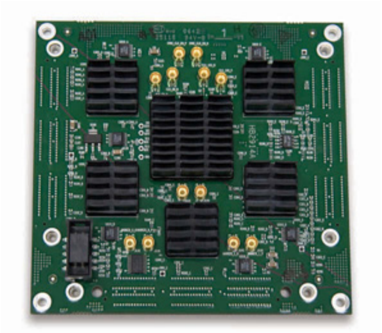

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www.nec-mwt.com

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Nextreme Thermal Solutions
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Northrup Grumman - Aerospace Systems, Electronic Systems, Information Systems
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www.novadefence.com.au

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www.novatech-instr.com

Nuvotronics LLC
Radford, VA, USA
www.nuvotronics.com

O

Ocean Microwave Corp.
Beijing, China
www.oceanmicrowave.com

OEwaves
Pasadena, CA, USA
www.oewaves.com

OPHIR RF
Los Angeles, CA, USA
www.ophirrf.com

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www.orbit-cs.com

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P

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www.spraycool.com

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www.pascall.co.uk

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Tampere, Finland
www.patria.fi

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antenna.pctel.com

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Planar Monolithics
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Pole/Zero Corporation
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www.pdt-usa.com

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http://qrctech.com

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www.quarterwave.com

QuinStar Technology, Inc.
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www.quinstar.com

R

Radio Reconnaissance Technologies
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Radio Research Instrument Co. Inc.
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www.radiores.com

Rafael - Systems Division
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Red Rapids
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www.rflogic.net

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www.rfcore.com

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www.rh-labs.com

Rheinmetall Defence - Protection Systems division
Unterlüss, Germany
www.rheinmetall-defence.com

Rising Edge Technologies
Herndon, VA, USA
www.risingedge.com

Rockwell Collins
Cedar Rapids, IA, USA
www.rockwellcollins.com/ewsigint

Rodale Electronics Inc
Hauppage, NY, USA
www.rodaleelectronics.com

Rodelco Electronics Corp.
Ronkonkoma, NY, USA
www.rodelco-usa.com

Rohde & Schwarz GmbH Ko KG
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www.rohde-schwarz.com

Roke Manor Research Ltd (Chemring plc)
Hampshire, UK
http://www.roke.co.uk/electronicwarfare

Rotating Precision Mechanisms, Inc.
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www.rpm-psi.com

RT Logic, Inc.
Englewood, CO, USA
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RUAG - Aerospace
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Rubisoft
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S

Saab - Electronic Defence Systems
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TIL Defense Systems
Ptakh Kitva, Israel
www.til.co.il

Times Microwave Systems
Wallingford, CT, USA
www.timesmicrowave.com

TINEX AS
Haslum, Norway
www.tinex.no

TJR Electronics
Rockledge, FL, USA
www.tjrelectronicsinc.com

TMC Design Corporation
www.tmcdesign.com

TMD Technologies LTD
Hayes, UK
www.tmd.co.uk

Top Aces
Point Claire, Quebec, Canada
www.topaces.ca

Total Aircraft Services, Inc. - An IKHANA Group Company
Van Nuys, CA, USA
www.tasaircraft.com

Toyon Research Corporation
Goleta, CA, USA
www.toyon.com

TRAK Microwave
Tampa, FL, USA
www.trak.com

Tri Star Engineering, Inc.
www.star3.com

TriaSys Technologies Corp.
Chelmsford, MA, USA
www.triasys.us

TriQuint Semiconductor, Inc.
Hillsboro, OR, USA
www.triquint.com

Triton Services Inc. - Electron Technology Division
Easton, PA, USA
www.tritonetd.com

Trival Antene D.O.O.
Kamnik, Slovenia
www.trival-antennas-masts.com

TRU Corporation
Peabody, MA, USA
www.trucorporation.com

U

UB Corp.
Tampa, FL, USA
www.ubcorp.com

Ultra Electronics - Avalon Systems
Maswon Lakes, SA, Australia
www.avalon.com.au

Ultra Electronics Telemus
Ottawa, ON, Canada
www.ultra-telemus.com

United Monolithic Semiconductors
www.ums-gaas.com

US Dynamics Corporation
Amityville, NY, USA
http://usdynamicscorp.com

V

Varilog Research, Inc
Beltsville, MD, USA
www.varilog.com

Verint
verint.com

ViaSat, Inc. - RF Simulation Group
Carlsbad, CA, USA
www.viasat.com/government-communications/rf-signal-stimulation

Vicor Corporation
Andover, MA, USA
vicorpower.com

Virtualabs srl
Rome, Italy
www.virtualabs.it

W

Wallop Defence Systems Ltd.
Middle Wallop, Hampshire, UK
www.wallopdefence.co.uk

Wang Electro-Opto Corp.
Marietta, GA, USA
www.weo.com

Wavepoint Research, Inc.
Newburgh, IN, USA
www.wavepointresearch.com

Werlatone, Inc.
Brewster, NY, USA
www.werlatone.com

Wide Band Systems Inc
Rockaway, NJ, USA
www.pps-ag.ch

Wideband Systems Inc.
Silver Spring, MC, USA
www.wideband-sys.com

Wyle Laboratories, Inc. - Aerospace Group
Lexington, MD, USA
www.wylelabs.com

X

X-COM Systems, LLC
Reston, VA, USA
www.xcomsystems.com

Z

Microsystems, Inc.
San Diego, CA, USA
www.zmicro.com

CATEGORY INDEX

2011 EW/SIGINT Resource Guide

Product/Service Listing

RF MICROWAVE COMPONENTS & SUBSYSTEMS

Antennas/Arrays

AMT Microwave Corp.
Applied EM Inc.
CEA Technologies
Chengdu SIWI Electronic Co., Ltd
Cobham Defense Systems
Communications & Power Industries, Inc (CPI)
Defence Research and Development Canada
DRS Defense Solutions - ICAS (Merrimack, NH)
ET Industries
ETS-Lindgren
European Antennas
First RF Corp
Fractal Antenna Systems
FS Antennentechnik GmbH
HUBER+SUHNER AG
IFI - Instruments for Industry Inc.
ITT - CS- Antenna Products & Technologies
ITT Communications Systems
JEM Engineering
L-3 Communications - ESSCO
L-3 Communications - Linkabit
L-3 Communications - Randtron Antenna Systems
Link Microtek
Medav Gmbh
Micronetixx, P.A.
Microsemi Corporation
Microwave Engineering Corp.
Ocean Microwave Corp.
Orbit Communication Systems, Inc.
PCTEL Inc. - Antenna Products
Pharad, LLC
PLATH GmbH
Poynting Antennas (Pty) Ltd.
Q-par Angus Ltd
QuinStar Technology, Inc.
Radio Reconnaissance Technologies
Rantelon
Raven Research
Rohde & Schwarz GmbH Ko KG
Rubisoft
Saab - Electronic Defence Systems
Seqtor ApS
SKY Computers Inc.
Southwest Research Institute
TCI International, Inc.
TECOM Industries, Inc.
Trival Antene D.O.O.
UB Corp.
Wang Electro-Opto Corp.

Antenna Mounts/ Support Structures

ITT - CS- Antenna Products & Technologies
L-3 Communications - Randtron Antenna Systems
Q-par Angus Ltd
Rotating Precision Mechanisms, Inc
SKY Computers Inc.
TECOM Industries, Inc.
Total Aircraft Services, Inc. - An IKHANA Group Company

Antenna Radomes

CEA Technologies
Cobham Defense Systems
HUBER+SUHNER AG
ITT - CS- Antenna Products & Technologies
L-3 Communications - ESSCO
L-3 Communications - Randtron Antenna Systems
Orbit Communication Systems, Inc.
Q-par Angus Ltd
SKY Computers Inc.
TECOM Industries, Inc.
Total Aircraft Services, Inc. - An IKHANA Group Company

Active RF Components

Advanced Control Components Inc.
Anaren, Inc. - Space & Defense Group
CAP Wireless
CEA Technologies
Ceralta Technologies - Sage Laboratories
Cobham Defense Systems
Crane Aerospace & Electronics - Crane Co.
Delta Microwave
EM Research
ET Industries
Hittite Microwave
I.F. Engineering Corp
Innovationszentrum fuer Telekommunikationstechnik GmbH (IZT)
Jabil Defense and Aerospace Services
Jersey Microwave
KOR Electronics
L-3 Communications - Electron Device Division
L-3 Communications - Narda Microwave-East
LNX Corporation
Mica Microwave - a division of Micronetics, Inc.
Micro Lambda Wireless, Inc.
Microsemi Corporation
MITEQ Inc. - Microwave Components
Pole/Zero Corporation
Protium Technologies, Inc
Rodelco Electronics Corp.
TEK Microsystems, Inc.
Tektronix
Teledyne Cougar
Times Microwave Systems
TRAK Microwave
US Dynamics Corporation

Analog-to-Digital Converters

Analog Devices Inc
CEA Technologies
Curtiss-Wright Controls Embedded Computing
GE Intelligent Platforms
Intersil
iVeia, LLC
KOR Electronics
Mercury Computer Systems
Microwave Concepts (Micro- Con) - a division of Micronetics, Inc.
National Semiconductor
Pentek
Protium Technologies, Inc
Red Rapids
SpectrumControl, Inc. - Spectrum Microwave, Inc.
TEK Microsystems, Inc.
Tektronix
X-COM Systems, LLC

Digital-to-Analog Converters

Analog Devices Inc
Crane Aerospace & Electronics - Crane Co.
Curtiss-Wright Controls Embedded Computing
GE Intelligent Platforms
iVeia, LLC
KOR Electronics
Microwave Concepts (Micro- Con) - a division of Micronetics, Inc.
Pentek
Protium Technologies, Inc
Red Rapids
SpectrumControl, Inc. - Spectrum Microwave, Inc.
TEK Microsystems, Inc.
Tektronix
X-COM Systems, LLC

Semiconductor Integrated Circuits

Crane Aerospace & Electronics - Crane Co.
e2v
Hittite Microwave
Tektronix

Digital Signal Processors

Altera Corporation
Analog Devices Inc
BittWare
Curtiss-Wright Controls Embedded Computing
Eclipse Electronic Systems, Inc.
GE Intelligent Platforms
iVeia, LLC
Pentek
Protium Technologies, Inc
RF Engines Ltd
Signatec
SKY Computers Inc.
Synectics Defence Systems
TEK Microsystems, Inc.

ASICs

e2v
Tektronix

FPGAs

Altera Corporation
BittWare
GE Intelligent Platforms
iVeia, LLC
KOR Electronics
Nallatech, Inc.
Red Rapids
Signatec
TEK Microsystems, Inc.

Frequency Converters

AKON, Inc.
Anaren, Inc. - Space & Defense Group
Crane Aerospace & Electronics - Crane Co.
Delta Microwave
Elcom Technologies
EM Research
Herley-CTI, Inc
I.F. Engineering Corp
Jersey Microwave
K&L Microwave, Inc.
KMIC Technology, Inc.
L-3 Communications - Narda Microwave-East
LNX Corporation
Micronetics, Inc
Microwave Concepts (Micro- Con) - a division of Micronetics, Inc.
MITEQ Inc. - Microwave Components
Planar Electronics Technology
Red Rapids
TRAK Microwave

Frequency Synthesizers

AAI Corporation - Test and Training
Aeroflex
AKON, Inc.
Analog Devices Inc
Anritsu
Elcom Technologies
EM Research
Herley General Microwave Israel
Herley-CTI, Inc
ITT Microwave Systems
L-3 Communications - Narda Microwave-East
LNX Corporation
Micro Lambda Wireless, Inc.
MITEQ Inc. - Microwave Components
Novatech Instruments
Phase Matrix
Planar Electronics Technology
RFCore Co, Ltd.
Rodelco Electronics Corp.
Sivers IMA AB
Spinnaker Microwave
Teledyne Technologies - Microwave
TRAK Microwave
Wide Band Systems Inc

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

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

HERLEY-CTI

Series DS Direct Synthesizer

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

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

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

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

HERLEY Industries, Inc.

Proven Microwave Performance

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FAX: 973-887-6245 • www.herley.com • sales@herley-cti.com

Product/Service Listing

Oscillators

Analog Devices Inc
Crane Aerospace & Electronics - Crane Co.
EM Research
Giga-tronics Incorporated
Herley Farmingdale
Herley General Microwave Israel
Herley-CTI, Inc
Hittite Microwave
Jersey Microwave
Micro Lambda Wireless, Inc.
Micronetics, Inc. - VCO Division
Microsemi Corporation
Pascall Electronics Limited
Phase Matrix
QuinStar Technology, Inc.
RF Micro Devices
Sivers IMA AB
SpectrumControl, Inc. - Spectrum Microwave, Inc.
TRAK Microwave

Low Noise Amplifiers

Aethercomm, Inc.
AML COMMUNICATIONS, INC.
Amplifier Solutions Corp
AmpliTech
CAP Wireless
Ciao Wireless, Inc.
CTT, Inc.
Delta Microwave
Endwave Corp.
Giga-tronics Incorporated
Herotek, Inc
Hittite Microwave
Jersey Microwave
K&L Microwave, Inc.
Keragis
KMIC Technology, Inc.
L-3 Communications - Narda Microwave-West
Microsemi Corporation
Microwave Communications Laboratories
Microwave Concepts (Micro- Con) - a division of Micronetics, Inc.
Pascall Electronics Limited
Planar Electronics Technology
Planar Monolithics
Pole/Zero Corporation
QuinStar Technology, Inc.
RF Micro Devices
Rodelco Electronics Corp.
SpectrumControl, Inc. - Spectrum Microwave, Inc.
Teledyne Cougar
Teledyne KW Microwave
Teledyne Technologies - Microwave
TRAK Microwave
TriQuint Semiconductor, Inc.
US Dynamics Corporation

Passive RF Components

Aeroflex
American Microwave Corporation
Analog Devices Inc
Anritsu
Ceralta Technologies - Sage Laboratories
Coleman Microwave Company
Delta Microwave
Dielectric Labs
Dow-Key Microwave
Ducommun Technologies
Endwave Corp.
ET Industries
Herley Farmingdale
Herley New England
Herotek, Inc
Hittite Microwave
Honeywell Aerospace
HUBER+SUHNER AG
I.F. Engineering Corp
Jabil Defense and Aerospace Services
K&L Microwave, Inc.
L-3 Communications - Narda Microwave-East
L-3 Communications - Narda Microwave-West
Link Microtek
LNX Corporation
Lorch Microwave
MECA Electronics
MESL Microwave
Mica Microwave - a division of Micronetics, Inc.
Micronetics, Inc. - Noise and Test Division
MicroPhase Corp
Microsemi Corporation
Microwave Communications Laboratories
Microwave Engineering Corp.
Nuvotronics LLC
PA&E
Pascall Electronics Limited
Picosecond Pulse Labs
Planar Monolithics
Q Microwave, Inc
QuinStar Technology, Inc.
Rantelon
Raven Research
Renaissance Electronics Corporation
RF Micro Devices
RH Laboratories
Rodelco Electronics Corp.
SpectrumControl, Inc. - Spectrum Microwave, Inc.
Superconductor Technologies Inc.
Teledyne Cougar
Teledyne KW Microwave
Teledyne Relays
Teledyne Technologies - Microwave

Converters and Mixers

Anaren, Inc. - Space & Defense Group
Anritsu
CAP Wireless
Ceralta Technologies - Sage Laboratories
EM Research
Hittite Microwave
I.F. Engineering Corp
Jersey Microwave
KMIC Technology, Inc.
Mica Microwave - a division of Micronetics, Inc.
Micronetics, Inc
Microsemi Corporation
MITEQ Inc. - Microwave Components
Protium Technologies, Inc
QuinStar Technology, Inc.
RH Laboratories
Rodelco Electronics Corp.
Teledyne Cougar

Couplers

Anaren, Inc. - Space & Defense Group
Ceralta Technologies - Sage Laboratories
Cobham Defense Systems
Delta Microwave
DynaWave Inc
ET Industries
HUBER+SUHNER AG
I.F. Engineering Corp
K&L Microwave, Inc.
Krytar Inc.
MECA Electronics
MESL Microwave
Microwave Communications Laboratories
Microwave Engineering Corp.
MITEQ Inc. - Microwave Components
Planar Monolithics
Precision Connector
Raven Research
RF Industries
RF Micro Devices
Southwest Microwave
Werlatone, Inc.

Fiber-Optic Cable

HUBER+SUHNER AG

Fiber-Optic Connectors

HUBER+SUHNER AG
PA&E

Filters and Diplexers

AKON, Inc.
Anatech Electronics
Ceralta Technologies - Sage Laboratories
Cobham Defense Systems
Coleman Microwave Company
Delta Microwave
Endwave Corp.
ET Industries
HUBER+SUHNER AG
KMIC Technology, Inc.
L-3 Communications - Narda Microwave-West
Link Microtek
Lorch Microwave
MECA Electronics
MESL Microwave
Micro Lambda Wireless, Inc.
Micronetixx, P.A.
MicroPhase Corp
Microwave Communications Laboratories
Microwave Engineering Corp.
Picosecond Pulse Labs
Pole/Zero Corporation
Q Microwave, Inc

Power Dividers/Combiners

Anatech Electronics
ET Industries
I.F. Engineering Corp
K&L Microwave, Inc.
L-3 Communications - Narda Microwave-East
L-3 Communications - Narda Microwave-West
MECA Electronics
Micronetixx, P.A.
Microwave Communications Laboratories
Microwave Concepts (Micro- Con) - a division of Micronetics, Inc.
Microwave Engineering Corp.
Planar Monolithics
QuinStar Technology, Inc.
Raven Research
Renaissance Electronics Corporation
Rodelco Electronics Corp.
Superconductor Technologies Inc.
Teledyne Cougar
Teledyne KW Microwave
Teledyne Technologies - Microwave
Werlatone, Inc.

RF Absorptive Materials/ Shielding

ARC Technologies
Cuming Microwave Corporation
ETS-Lindgren

RF Cables / Cable Assemblies

Anatech Electronics
Assemblies Inc.
FLEXCO Microwave
HUBER+SUHNER AG
IW Microwave
MECA Electronics
MegaPhase
Micro-Coax, Inc
RF Industries
RF Logic
Teledyne Reynolds
Teledyne Storm Products
THERMAX
Times Microwave Systems
TRU Corporation

Thermal Management Solutions

PA&E
Parker Aerospace - Isothermal Systems Research, Inc.
Thermacore

Waveguides

Anatech Electronics
Cobham Defense Systems
Dow-Key Microwave
K&L Microwave, Inc.
Keragis
Link Microtek
MESL Microwave
Micronetixx, P.A.
Microwave Communications Laboratories
Microwave Engineering Corp.
PA&E
Q Microwave, Inc
Q-par Angus Ltd

Digital Frequency Discriminators

AKON, Inc.
Anaren, Inc. - Space & Defense Group
CEA Technologies
Ceralta Technologies - Sage Laboratories
CSIR - DPSS
LNX Corporation
MITEQ Inc. - Microwave Components
Protium Technologies, Inc
Teledyne Technologies - Defence Limited
Wide Band Systems Inc

Product/Service Listing

Digital RF Memories

Anaren, Inc. - Space & Defense Group
CSIR - DPSS
Herley Micro Systems
KOR Electronics
LNX Corporation
MC Countermeasures Inc
Saab - Electronic Defence Systems
Systems & Processes Engineering Corp
TEK Microsystems, Inc.
X-COM Systems, LLC

Integrated Microwave Assemblies

AKON, Inc.
AML COMMUNICATIONS, INC.
Cobham Defense Systems
Comtech PST
Dow-Key Microwave
Herley Farmingdale
Herley General Microwave Israel
Herley New England
ITT Microwave Systems
Jabil Defense and Aerospace Services
L-3 Communications - Electron Device Division
L-3 Communications - Narda Microwave-East
LaBarge, Inc
Lorch Microwave
Micronetics, Inc
MicroPhase Corp
Microsemi Corporation
Planar Monolithics
Quarterwave Corp.
RFCore Co, Ltd.
Rodelco Electronics Corp.
SpectrumControl, Inc. - Spectrum Microwave, Inc.
Technograph Microcircuits Ltd
Tektronix
Tektronix Component Solutions
Teledyne Cougar
Teledyne Electronic Manufacturing Services
Teledyne Technologies - Microelectronics
Teledyne Technologies - Microwave
US Dynamics Corporation

RF Receivers

Agilent Technologies
AMESYS
Applied Signal Technology Inc.
Argon ST
Cobham Defense Systems
Communications & Power Industries, Inc (CPI)
Communications Audit UK Limited
Cubic Defense Systems
Digital Receiver Technology
DRS Defense Solutions - DRS Signal Solutions
D-TA Systems
Eclipse Electronic Systems, Inc.
Elcom Technologies
GE Intelligent Platforms
Innovationszentrum fuer Telekommunikationstechnik GmbH (IZT)
Jersey Microwave
L-3 Communications - Linkabit
Medav Gmbh
Mercury Computer Systems
Microwave Concepts (Micro- Con) - a division of Micronetics, Inc.
Mid-Atlantic RF Systems
OEwaves
PLATH GmbH
Plextek Ltd
Radio Reconnaissance Technologies
Raven Research
Red Rapids
RF Engines Ltd
Rockwell Collins
Rohde & Schwarz GmbH Ko KG
Roke Manor Research Ltd (Chemring plc)
RT Logic, Inc
Spectrum Signal Processing
Tampa Microwave
TCI International, Inc.
Teledyne Technologies - Defence Limited
Wide Band Systems Inc
X-COM Systems, LLC

RF Tuners

AKON, Inc.
Cobham Defense Systems
Communications Audit UK Limited
DRS Defense Solutions - DRS Signal Solutions
Elcom Technologies
FS Antennentechnik GmbH
Innovationszentrum fuer Telekommunikationstechnik GmbH IZT
Medav Gmbh
Mid-Atlantic RF Systems
PLATH GmbH
Red Rapids
Rockwell Collins
Rohde & Schwarz GmbH Ko KG
Roke Manor Research Ltd (Chemring plc)
Teledyne Technologies - Defence Limited

Signal Conditioners

GE Intelligent Platforms
Pole/Zero Corporation
Rantelon
Teledyne Technologies - Defence Limited

Displays

BARCO
L-3 Communications - Display Systems
L-3 Communications - Electronic Systems
Precision Display Technologies
Z Microsystems, Inc.

Power Amplifiers

Aethercomm, Inc.
AML COMMUNICATIONS, INC.
Applied Systems Engineering Inc.
BC Systems
CAP Wireless
Cobham Defense Systems
Comtech PST
Crane Aerospace & Electronics - Crane Co.
CTT, Inc.
dB Control
e2v
Empower RF Systems
ETM Electromatic Inc.
Herley Power Amplifier Systems
IFI - Instruments for Industry Inc.
Keragis
KMIC Technology, Inc.
L-3 Communications - Applied Technologies
L-3 Communications - Electron Device Division
L-3 Communications - Electron Technologies, Inc.
L-3 Communications - Narda Microwave-West
Micronetics, Inc
Microsemi Corporation
Mid-Atlantic RF Systems
MILMEGA
NEC Microwave Tube, Ltd.
OPHIR RF
Planar Monolithics
Pole/Zero Corporation
Quarterwave Corp.
Rantelon
RFCore Co, Ltd.
Rodelco Electronics Corp.
Stealth Microwave, Inc
Teledyne Technologies - Microwave
Thales Electron Devices
TMD Technologies LTD
TriQuint Semiconductor, Inc.

TWTs

Applied Systems Engineering Inc.
Communications & Power Industries, Inc (CPI)
Crane Aerospace & Electronics - Crane Co.
dB Control
e2v
L-3 Communications - Electron Device Division
L-3 Communications - Electron Technologies, Inc.
NEC Microwave Tube, Ltd.
Stealth Microwave, Inc
Teledyne MEC
Thales Electron Devices
TMD Technologies LTD
Triton Services Inc. - Electron Technology Division

TWT Assemblies

Applied Systems Engineering Inc.
Communications & Power Industries, Inc (CPI)
dB Control
e2v
ETM Electromatic Inc.
IFI - Instruments for Industry Inc.
L-3 Communications - Electron Technologies, Inc.
NEC Microwave Tube, Ltd.
Quarterwave Corp.
Teledyne MEC
Thales Electron Devices
TMD Technologies LTD
Triton Services Inc. - Electron Technology Division

MPM Modules

Communications & Power Industries, Inc (CPI)
dB Control
L-3 Communications - Electron Device Division
L-3 Communications - Electron Technologies, Inc.
NEC Microwave Tube, Ltd.
Stealth Microwave, Inc
Thales Electron Devices
TMD Technologies LTD
Triton Services Inc. - Electron Technology Division

Power Supplies

BC Systems
Communications & Power Industries, Inc (CPI)
Vicor Corporation

Data Recorders

Ampex
Annapolis Micro Systems, Inc.
Avalon Electronics, Inc.
Curtiss-Wright Controls Electronic Systems
DRS Defense Solutions - Signal Recording
DSPCon, Inc.
eonic BV
GE Intelligent Platforms
Goodrich Sensors and Integrated Systems - Digital Data Systems
Innovationszentrum fuer Telekommunikationstechnik GmbH (IZT)
L-3 Communications - Communication Systems-East
L-3 Communications - Electrodynamics
L-3 Communications - Targa Systems
Rising Edge Technologies
Scientific Research Corporation - Communications, Networks and Electronics Division
Shogi Communications Ltd.
Signami-DCS - EW/Range
Signatec
Sypris Data Systems
Wideband Systems Inc.
X-COM Systems, LLC

Signal Analysis Systems

Annapolis Micro Systems, Inc.
Innovationszentrum fuer Telekommunikationstechnik GmbH (IZT)
Innovative Signals Technology (ISigTech)
Rantelon
Rohde & Schwarz GmbH Ko KG
SKY Computers Inc.
Southwest Research Institute
X-COM Systems, LLC

TEST EQUIPMENT

Oscilloscopes

Agilent Technologies
Giga-tronics Incorporated
Rohde & Schwarz GmbH Ko KG
Signatec
Tektronix Inc.

Signal Generators

Aeroflex
Agilent Technologies
Anritsu
Giga-tronics Incorporated
Hittite Microwave
Innovationszentrum fuer Telekommunikationstechnik GmbH (IZT)
ITT Test and Support Systems
Micronetics, Inc. - Noise and Test Division
Novatech Instruments
Phase Matrix
Rohde & Schwarz GmbH Ko KG
Signatec
Tektronix Inc.
TINEX AS
Varilog Research, Inc


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UBRAFE
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Product/Service Listing

Spectrum Analyzers
Agilent Technologies
Anritsu
DSPCon, Inc.
Giga-tronics Incorporated
Rohde & Schwarz GmbH Ko KG
Signatec
Tektronix Inc.

Power Meters
Aeroflex
Agilent Technologies
Anritsu
Giga-tronics Incorporated
Micronetics, Inc. - Noise and Test Division

Network Analyzers
Agilent Technologies
Anritsu
Giga-tronics Incorporated
Rohde & Schwarz GmbH Ko KG
Tektronix

Automatic Test Equipment
AAI Corporation - Test and Training
Aeroflex
Agilent Technologies
Astronics DME Corporation
Giga-tronics Incorporated
ITT Test and Support Systems
Mass Consultants Limited
MES S.p.A.
Rodale Electronics Inc
RUAG - Aerospace
ViaSat, Inc. - RF Simulation Group

EO/IR COMPONENTS & SUB SYSTEMS

IR Detectors
L-3 Communications - Infrared Products
Teledyne Scientific and Imaging

Optical Filters
Barr Associates, Inc.

Fine-Track Sensors
Defense Research Associates, Inc.
ElectroOptic Industries Ltd.
General Dynamics - Information Systems & Technology

Lasers (IR Countermeasures)
ElectroOptic Industries Ltd.
Lockheed Martin - Aculight
SELEX Galileo
Teledyne Technologies - Microelectronics

IRCM Transmitter Assemblies
ElectroOptic Industries Ltd.
SELEX Galileo

EW/SIGINT SYSTEMS

Radar Warning Receivers
BAE Systems
BAE SYSTEMS Australia
BEL – Bharat Electronics Ltd
Cassidian, An EADS Company
Elettronica SpA
Elisra
ELTA Systems Ltd
INDRA
ITT Electronic Systems - Integrated Electronic Warfare Systems
MiKES Microwave Electronics Systems Inc.
Northrop Grumman Corporation - Electronic Systems
Rafael - Systems Division
Raytheon - Space and Airborne Systems
Saab - Electronic Defence Systems
SELEX Galileo
Tata Power Strategic Electronics Division
Teledyne Technologies - Defence Limited
Thales Systèmes Aéroportés

ESM Systems
Aeronix, Inc.
Applied Signal Technology Inc.
Argon ST
BAE Systems
BAE SYSTEMS Australia
BEL – Bharat Electronics Ltd
Cassidian, An EADS Company
Defence Research and Development Canada
Elettronica SpA
Elisra
General Dynamics - Information Systems & Technology
INDRA
ITT Electronic Systems - Integrated Electronic Warfare Systems
ITT Electronic Systems - Reconnaissance and Surveillance Systems
Lockheed Martin - IS&GS - Gaithersburg
Lockheed Martin - MS2 - Owego
MiKES Microwave Electronics Systems Inc.
Northrop Grumman Corporation - Aerospace Systems
Northrop Grumman Corporation - Electronic Systems
Rafael - Systems Division
Raytheon - Space and Airborne Systems
Raytheon - Space and Airborne Systems
Saab - Electronic Defence Systems
SELEX Galileo
Sierra Nevada Corporation
Southwest Research Institute
Synectics Defence Systems
Tata Power Strategic Electronics Division
Teledyne Technologies - Defence Limited
Thales Systèmes Aéroportés
TINEX AS
Ultra Electronics - Avalon Systems
Ultra Electronics Telemus

Radar Jammers
ATK Missile Products
BAE Systems
BEL – Bharat Electronics Ltd
Elettronica SpA
Elisra
ELTA Systems Ltd
INDRA
ITT Electronic Systems - Integrated Electronic Warfare Systems
ITT Electronic Systems - Reconnaissance and Surveillance Systems
MiKES Microwave Electronics Systems Inc.
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Maneuvering Air Launched Decoys
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Terma A/S - Airborne Systems

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Sagem Defense Securite
SELEX Sistemi Integrati
Terma A/S - Airborne Systems
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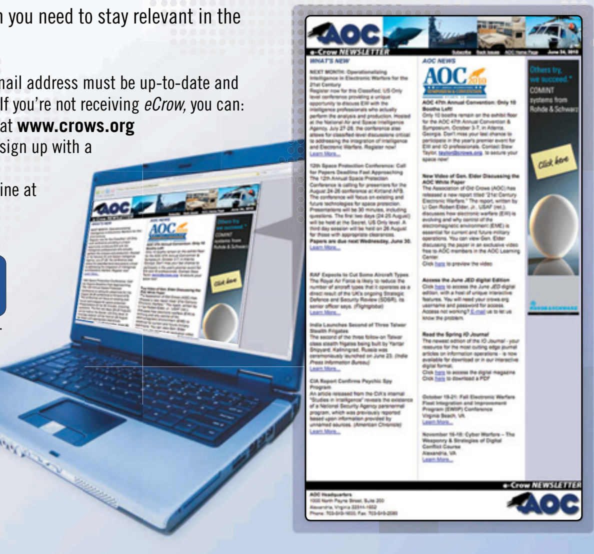

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EW Against Modern Radars – Part 13

Random Frequency or PRI, Burn-through Modes and Home-on-Jam

By Dave Adamy

In this final column for our series on modern radar, we consider a few radar features that make jamming more difficult and one that makes it dangerous.

Frequency Diversity

A radar can have multiple operating frequencies as shown in **Figure 1**. Note that a radar needs an efficient antenna and a well-behaved power amplifier, so the range of frequencies used can be expected to be less than 10 percent. As explained in the November 1997 "EW 101" column, a parabolic antenna can have 55 percent efficiency if it operates over less than 10 percent frequency range, but that a wider frequency range antenna will have much lower efficiency. For example, a 2-18 GHz EW antenna can be expected to have about 30 percent efficiency.

The simplest case of frequency diversity is a set of selectable frequencies, with the radar operating at the selected frequency for an extended time. As long as a receiver associated with a jammer can measure the operating frequency, the jammer can be set to the frequency in use and can optimize its jamming bandwidth against that signal. This applies to spot jamming with narrowband noise, as well as to deceptive jamming techniques.

A more challenging use of frequency diversity is assignment of one frequency per sweep of the radar antenna. For example, if the radar antenna has a helical scan (one circular azimuth sweep at each of several elevation angles) the radar might change frequencies after each circular sweep. This gives the radar the advantage of a single frequency during its coherent processing interval. When a jammer has a digital radio frequency memory (DRFM), it will be able to measure the frequency (and other parameters) of the first pulse it sees and make accurate copies of all subsequent pulses during the time the radar beam is covering the target on which the jammer is located. (Note that we will be discussing DRFMs in detail in a later "EW 101" column series.)

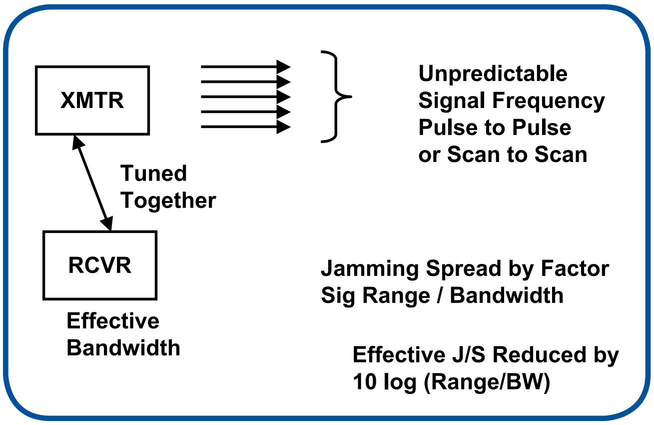

Figure 1: Frequency diversity requires a jammer to cover multiple frequencies or an increased frequency range.

The most challenging case of frequency diversity is pulse-to-pulse frequency hopping. In this case, each pulse is transmitted at a pseudo-randomly selected frequency. Because the jammer cannot anticipate the frequency of future pulses, it is impossible to optimally jam the radar. Also note that this type of radar can be expected to avoid frequencies at which jamming is detected, so jamming a few of the frequencies is unlikely to improve the jamming performance. If there are only a few frequencies, it may be practical to set a jammer to each frequency, but more typically, it is necessary to jam the whole frequency-hopping range. For example, if the radar operates over a 10 percent frequency range at about 6 GHz and has a 3 MHz receiver bandwidth:

- The jammer must cover 600 MHz of frequency range.
- The radar only sees the 3 MHz of the jamming signal in its bandwidth
- Thus, the jamming effectiveness is only 0.05 percent
- This reduces the effective J/S (compared to matched jamming) by 23 dB

PRF Jitter

If a radar has a pseudo-randomly selected pulse repetition interval, as shown in **Figure 2**, it is not possible to anticipate the arrival time of radar pulses. Thus it is not possible to use RGPI jamming (see the January 2010 "EW 101" column). If cover pulses are used to deny the radar range information, they must be extended to cover the full range of possible pulse positions. This requires the jammer to have a longer duty cycle in its cover pulse stream, which reduces the jamming efficiency.

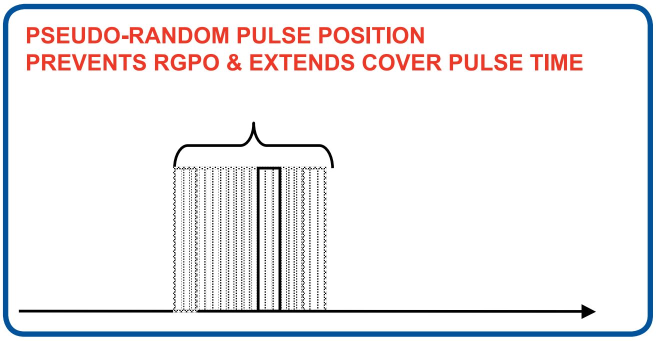

Figure 2: Random PRI requires a jammer to cover the full-time excursion of pulse times.

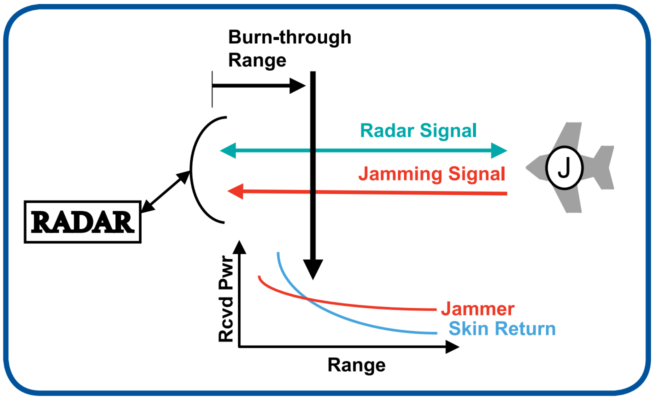

Figure 3: A radar's burn-through range is the range at which it can re-acquire a target in the presence of jamming.

Burn-Through Modes

As discussed in the December 2009 "EW 101" column, the jamming-to-noise ratio for self-protection jamming is a function of range because the radar signal loses power by the square of the range on the way to the target and again on the way back from the target – while the jamming signal only travels from the target location to the radar. As shown in **Figure 3**: as the target (on which the jammer is mounted) approaches the radar, the jamming signal in the radar receiver increases by the square of the reducing range, while the skin return increases by the fourth power of the reducing range. The range at which the J/S is reduced sufficiently for the radar to reacquire the target is called the burn-through range. Note that the figure shows this range to occur when the jammer and skin return signal are equal. This is a little misleading, because the minimum J/S to protect the target depends on the jamming technique applied and the design of the radar.

Also covered in the December 2009 column is the case of stand-off jamming. The difference is that the jammer is assumed not to move as the target approaches the radar. The range to the *target* at which the (assumed stationary) stand-off jammer can no longer provide protection is the burn-through range.

The radar range equation, defining the range at which a radar can acquire a target, is given in Stimson's excellent and very readable book, *Introduction to Airborne Radar*. The equation is used in several different forms, but all have a time term in the numerator for the time the radar illuminates the target. This is because the radar range depends on the received energy of the skin return signal. The signal energy to noise energy must reach a required level (typically taken as 13 dB) for detection to occur.

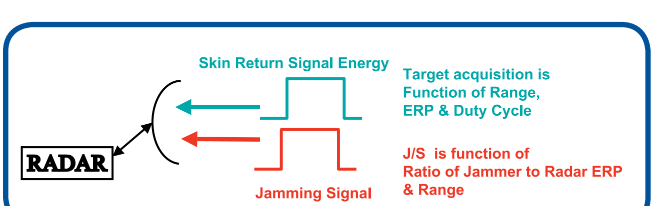

Figure 4: Burn-through modes extend the burn-through range by increasing either the transmitted power or the duty cycle of the signal.

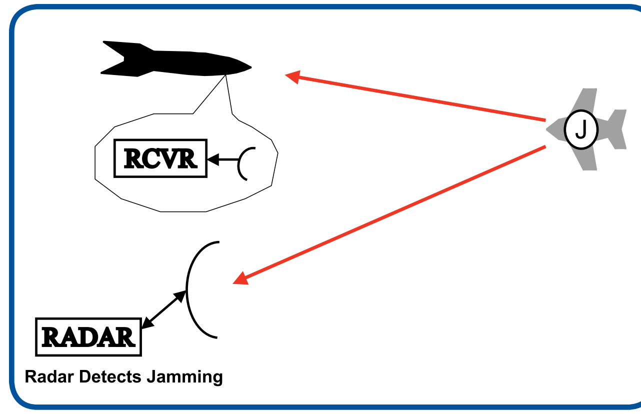

Figure 5: Home-on-jam modes require a passive guidance capability in the missile, which allows it to home onto the source of jamming energy.

Figure 4 shows the skin return and jamming signals arriving at the jammed radar. The figure makes the point that the radar is looking for energy while the jammer supplies jamming power. The radar can increase its acquisition range by increasing its effective radiated power or by increasing the duty cycle of its pulse train. Many radars use emission control, outputting only enough radiated power to achieve a good quality return signal-to-noise ratio. If jamming is detected, the radar can increase its output power to the maximum level. Because the J/S is a function of the ratio of the jammer to radar effective radiated power, any increase in radar power reduces the J/S and thus increases the range over which the radar can overcome the jamming.

Because the radar's acquisition range is directly proportional to the time that the target is illuminated, any increase in the radar's duty cycle will increase the acquisition range, hence allowing the radar to acquire (or reacquire) the target at a greater range.

Home-on-Jam

Many modern missile systems have home-on-jam modes, also called "track on jam" modes. As shown in **Figure 5**, this requires that the missile be able to receive the jamming signal and determine its direction of arrival. If the radar detects jamming, it can then go into a home-on-jam mode, causing the missile to steer itself toward the jammer. This feature makes it very dangerous to use self-protection jamming for terminal protection. Because this mode can also be used against a stand-off jammer, it can threaten this high-value/low-inventory asset if the missile has sufficient range to reach the stand-off jamming location. Note that by lofting the missile, it may be practical to achieve more range in the home-on-jam mode.

What's Next

During the next two months, we will discuss the differences between ES systems and SIGINT systems, both of which are designed to receive hostile signals. Then, we will start a new series covering some significant (technical) issues related to net-centric warfare. This will include digital command and data links, spectrum management and related issues. For your comments and suggestions, Dave Adamy can be reached at dave@lynxpub.com.

AOC

association news

VIEWS FROM THE AOC CONVENTION

The AOC's 47th Annual International Symposium and Convention brought more than 1,500 people to Atlanta for four days of education, exhibition and networking. In addition to top-level speakers, including keynote addresses by Maj Gen. Thomas K. Andersen, Director of Requirements, ACC; Lt Gen Ted Bowlds, Commander, Air Force Electronic Systems Center; and Brigadier General Giovanni Fantuzzi, Chief, Aerospace Planning Division, Italian Air Force, among many others.

Miss any of this year's sessions? Visit the AOC Live Learning Center at http://aoc.sclivelearningcenter.com to view this year's presentations, audio and video. And mark your calendar now for next year's Convention, November 13-16, 2011, in Washington, DC.


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