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ASSOCIATION OF OLD CROWS

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JEWD

The Journal of Electronic Defense

US Army EMBM Development & Acquisition

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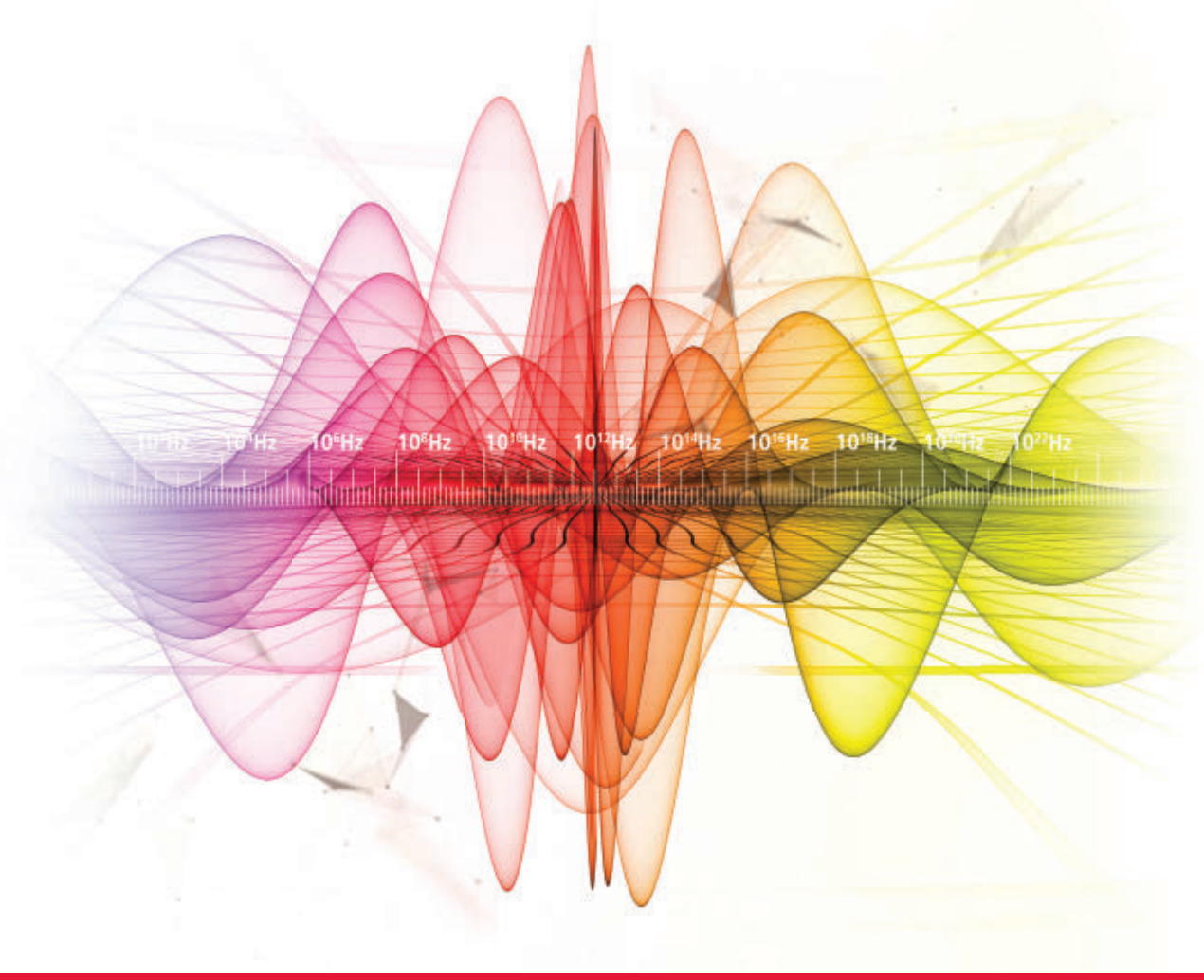

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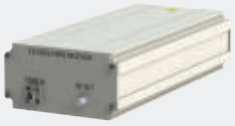

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The first Next Generation Jammer Mid-Band Engineering Development Model pod arrived at Naval Air Station Patuxent River after a trek across America in late July. Members of the combined Airborne Electronic Attack Systems Program Office (PMA-234), Air Test and Evaluation Squadron (VX) 23 and industry partner test teams navigate the newly arrived pod to its temporary home at the VX-23 squadron. The pod began various verification and test procedures in preparation for the second pod delivery in the early fall. U.S. NAVY

News

Features

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LOOKING EAST

Back in March 1994, when I first walked through the door at *JED,* many parts of the world were experiencing a transitional period in global affairs. NATO was drawing down its Cold War forces across Europe and North America. This was painful, but it was nothing compared to the political and military collapse experienced by many Warsaw Pact nations. During this time, it was interesting to see how parts of Eastern Europe were beginning to transform. Countries, such as Estonia, Latvia, Lithuania, Belarus and Ukraine had emerged from the collapse of the Soviet Union. Some of these countries aligned themselves with Russia, while others were more committed to Europe.

From the rubble of the Warsaw Pact, Poland was a nation that saw its future in Europe rather than Russia. In the late 1980s, it began the process of joining the European Economic Community, and it became a full member of the European Union in 2004. In 1999, after several years of rapid military transformation, Poland formally joined NATO.

Last month, Poland's modernization reached another milestone, when it signaled its intent to buy the F-35 from the US. Under its Harpia program, the Polish Air Force plans to acquire an initial batch of 32 F-35A aircraft for approximately $6.5 billion. The new F-35s, which will allow Poland to begin replacing its Su-22 and Mig-29 aircraft, represent a major boost in Poland's air power, as well as its EW capabilities.

For any country, buying a fifth-generation fighter such as the F-35 is a massive challenge. The aircraft's radar, EW and EO/IR targeting sensors require the user to maintain and manage a sophisticated database. In addition, the F-35 must seamlessly fit within a larger C4ISR-enabled sensor-to-shooter architecture in order to realize its true capabilities. When you consider how Poland's military was structured 30 years ago, it is a remarkable achievement for the country to be buying the F-35 today.

Poland represents just one example of Eastern Europe's military transformation and modernization since the end of the Cold War. Other NATO countries in the region, such as Estonia, the Czech Republic, Hungary, Croatia and Romania, will continue to aggressively modernize their military forces to offset Russia's military resurgence. Ukraine, which is trying to extricate itself from Russia's sphere of influence, is also modernizing its forces while at the same time it fights against Russian-backed separatists in its eastern Donbass region.

There is no single event that has signaled a dramatic shift in Eastern Europe's military modernization. This trend began in the late 1980s and early 1990s with political change, and has now reached a new phase, as countries in the region must respond to Russian behavior. What has changed, however, is the evolving sophistication of Eastern Europe's military forces. Twenty-five years of modernizing to NATO standards has created regional military forces that are able to buy more advanced EW and SIGINT systems. Poland's F-35 program is just one example of this. More examples are likely to follow in the coming years. – *J. Knowles*

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OCTOBER

5th Annual Cyber Electromagnetic Activities (CEMA) Conference
October 8-10
Aberdeen Proving Ground, MD
www.crows.org

AUSA Annual Meeting
October 14-16
Washington, DC
www.ausa.org

Seoul ADEX 2019
October 15-18
Seoul, ROK
www.seouladex.com

56th Annual AOC International Symposium and Convention
October 28-30
Washington, DC
www.crows.org

NOVEMBER

Electronic Warfare South Africa (EWSA2019)
November 4-6
Pretoria, South Africa
www.aardvarkaoc.co.za

MILCOM 2018
November 12-14
Norfolk, VA
www.milcom.org

Directed Energy Day
November 13
Alexandria, VA
www.directedenergy.dsigroup.org

Dubai Airshow 2019
November 17-21
Dubai, UAE
www.dubaiairshow.aero

AAAA Aircrft Survivability Equipment Symposium
November 18-19
Huntsville, AL
www.quad-a.org

DSEI Japan
November 18-20
Tokyo, Japan
www.dsei-japan.com

Defence & Security 2019
November 18-21
Bangkok, Thailand
www.pandci.com

Directed Energy Systems Symposium
November 18-22
San Diego, CA
www.deps.org

DECEMBER

Expodefensa 2019
December 2-4
Bogota, Colombia
www.expodefensa.com.co

JANUARY

Surface Navy Association 32nd Annual National Symposium
January 14-16
Arlington, VA
www.navysna.org

Directed Energy Test and Evaluation Conference
January 27-30
Albuquerque, NM
www.deps.org

FEBRUARY

AOC Electronic Warfare Asia
February 4-5
Singapore
www.crows.org

Defexpo 2018
February 5-8
Lucknow, Uttar Pradesh, India
defexpoindia.in

6th International Conference on EW – EWCI 2018
February 18-20
Bangalore, India
www.aoc-india.org

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October 8-17
4 sessions, 1300-1600 EDT
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Radar Principles
October 14-18
Swindon, UK
www.cranfield.ac.uk

Software-Defined Radio Development with GNU Radio: Theory and Application
October 16-19
Atlanta, GA
www.pe.gatech.edu

NATO Joint Electronic Warfare Course
October 21-25
Oberammergau, Germany
www.natoschool.nato.int

Understanding the US Combat Missions and Aviators
October 23-25
Winter Garden, FL
www.pe.gatech.edu

AOC Live Course: Fundamental Principles of Electronic Warfare
October 26-27
0800-1700 EDT
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AOC Live Course: Machine Learning for EW
October 26-27
0900-1700 EDT
www.crows.org

NATO Electronic Warfare Operational Planning Course
October 28 – November 1
Oberammergau, Germany
www.natoschool.nato.int

AOC Live Course: Advanced Principles of Electronic Warfare
October 31 – November 1
0800-1700 EDT
www.crows.org

AOC Live Course: Electronic Countermeasures – Theory and Design
October 31 – November 1
0900-1700 EDT
www.crows.org

NOVEMBER

AOC Virtual Series Webinar: 3 Pillars of EW – Part I - Electronic Attack
November 7
1400-1500 EST
www.crows.org

Basic RF Electronic Warfare Concepts
November 12-14
Atlanta, GA
www.pe.gatech.edu

AOC Virtual Series Webinar: 3 Pillars of EW – Part II - Electronic Support
November 14
1400-1500 EST
www.crows.org

AOC Virtual Series Webinar: 3 Pillars of EW – Part III - Electronic Protect
November 21
1400-1500 EST
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FEBRUARY

Radar Electronic Warfare
February 3-7
Swindon, UK
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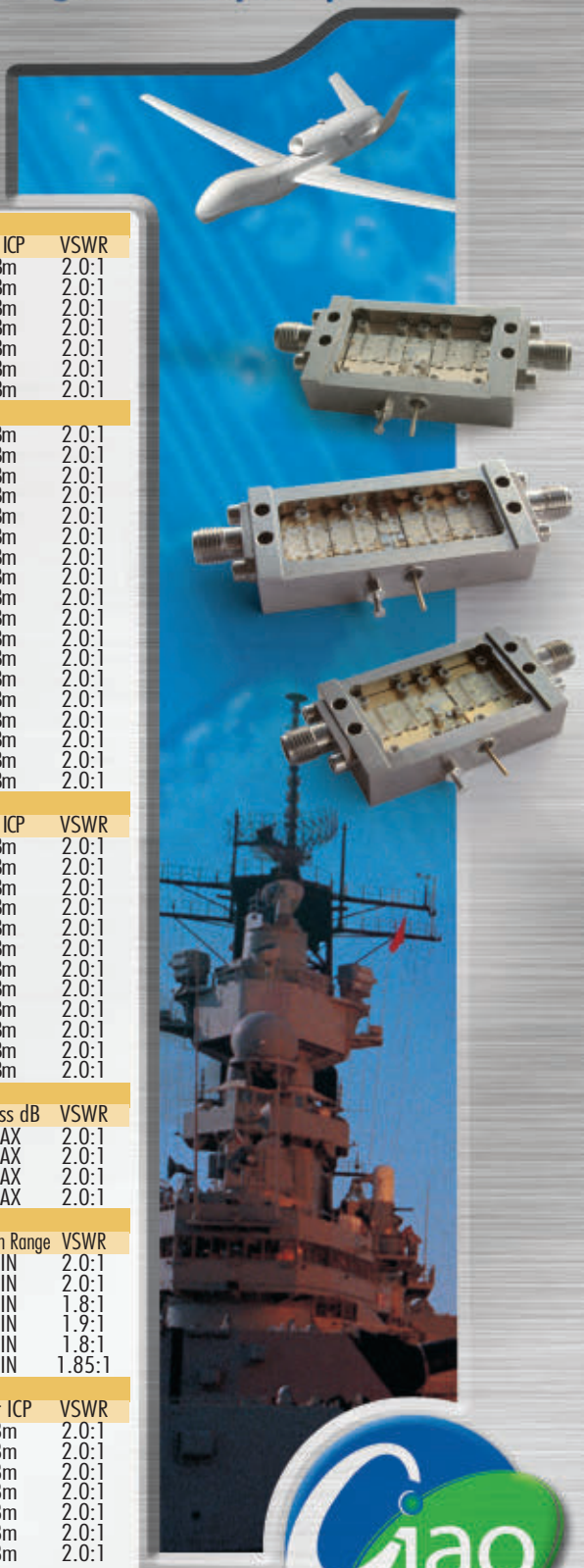

OCTAVE BAND LOW NOISE AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA01-2110	0.5-1.0	28	1.0 MAX, 0.7 TYP	+10 MIN	+20 dBm	2.0:1
CA12-2110	1.0-2.0	30	1.0 MAX, 0.7 TYP	+10 MIN	+20 dBm	2.0:1
CA24-2111	2.0-4.0	29	1.1 MAX, 0.95 TYP	+10 MIN	+20 dBm	2.0:1
CA48-2111	4.0-8.0	29	1.3 MAX, 1.0 TYP	+10 MIN	+20 dBm	2.0:1
CA812-3111	8.0-12.0	27	1.6 MAX, 1.4 TYP	+10 MIN	+20 dBm	2.0:1
CA1218-4111	12.0-18.0	25	1.9 MAX, 1.7 TYP	+10 MIN	+20 dBm	2.0:1
CA1826-2110	18.0-26.5	32	3.0 MAX, 2.5 TYP	+10 MIN	+20 dBm	2.0:1

NARROW BAND LOW NOISE AND MEDIUM POWER AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA01-2111	0.4 - 0.5	28	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA01-2113	0.8 - 1.0	28	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA12-3117	1.2 - 1.6	25	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA23-3111	2.2 - 2.4	30	0.6 MAX, 0.45 TYP	+10 MIN	+20 dBm	2.0:1
CA23-3116	2.7 - 2.9	29	0.7 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA34-2110	3.7 - 4.2	28	1.0 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA56-3110	5.4 - 5.9	40	1.0 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA78-4110	7.25 - 7.75	32	1.2 MAX, 1.0 TYP	+10 MIN	+20 dBm	2.0:1
CA910-3110	9.0 - 10.6	25	1.4 MAX, 1.2 TYP	+10 MIN	+20 dBm	2.0:1
CA1315-3110	13.75 - 15.4	25	1.6 MAX, 1.4 TYP	+10 MIN	+20 dBm	2.0:1
CA12-3114	1.35 - 1.85	30	4.0 MAX, 3.0 TYP	+33 MIN	+41 dBm	2.0:1
CA34-6116	3.1 - 3.5	40	4.5 MAX, 3.5 TYP	+35 MIN	+43 dBm	2.0:1
CA56-5114	5.9 - 6.4	30	5.0 MAX, 4.0 TYP	+30 MIN	+40 dBm	2.0:1
CA812-6115	8.0 - 12.0	30	4.5 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA812-6116	8.0 - 12.0	30	5.0 MAX, 4.0 TYP	+33 MIN	+41 dBm	2.0:1
CA1213-7110	12.2 - 13.25	28	6.0 MAX, 5.5 TYP	+33 MIN	+42 dBm	2.0:1
CA1415-7110	14.0 - 15.0	30	5.0 MAX, 4.0 TYP	+30 MIN	+40 dBm	2.0:1
CA1722-4110	17.0 - 22.0	25	3.5 MAX, 2.8 TYP	+21 MIN	+31 dBm	2.0:1

ULTRA-BROADBAND & MULTI-OCTAVE BAND AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA0102-3111	0.1-2.0	28	1.6 Max, 1.2 TYP	+10 MIN	+20 dBm	2.0:1
CA0106-3111	0.1-6.0	28	1.9 Max, 1.5 TYP	+10 MIN	+20 dBm	2.0:1
CA0108-3110	0.1-8.0	26	2.2 Max, 1.8 TYP	+10 MIN	+20 dBm	2.0:1
CA0108-4112	0.1-8.0	32	3.0 MAX, 1.8 TYP	+22 MIN	+32 dBm	2.0:1
CA02-3112	0.5-2.0	36	4.5 MAX, 2.5 TYP	+30 MIN	+40 dBm	2.0:1
CA26-3110	2.0-6.0	26	2.0 MAX, 1.5 TYP	+10 MIN	+20 dBm	2.0:1
CA26-4114	2.0-6.0	22	5.0 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA618-4112	6.0-18.0	25	5.0 MAX, 3.5 TYP	+23 MIN	+33 dBm	2.0:1
CA618-6114	6.0-18.0	35	5.0 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA218-4116	2.0-18.0	30	3.5 MAX, 2.8 TYP	+10 MIN	+20 dBm	2.0:1
CA218-4110	2.0-18.0	30	5.0 MAX, 3.5 TYP	+20 MIN	+30 dBm	2.0:1
CA218-4112	2.0-18.0	29	5.0 MAX, 3.5 TYP	+24 MIN	+34 dBm	2.0:1

LIMITING AMPLIFIERS

Model No.	Freq (GHz)	Input Dynamic Range	Output Power Range Psat	Power Flatness dB	VSWR
CLA24-4001	2.0 - 4.0	-28 to +10 dBm	+7 to +11 dBm	+/- 1.5 MAX	2.0:1
CLA26-8001	2.0 - 6.0	-50 to +20 dBm	+14 to +18 dBm	+/- 1.5 MAX	2.0:1
CLA712-5001	7.0 - 12.4	-21 to +10 dBm	+14 to +19 dBm	+/- 1.5 MAX	2.0:1
CLA618-1201	6.0 - 18.0	-50 to +20 dBm	+14 to +19 dBm	+/- 1.5 MAX	2.0:1

AMPLIFIERS WITH INTEGRATED GAIN ATTENUATION

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	Gain Attenuation Range	VSWR
CA001-2511A	0.025-0.150	21	5.0 MAX, 3.5 TYP	+12 MIN	30 dB MIN	2.0:1
CA05-3110A	0.5-5.5	23	2.5 MAX, 1.5 TYP	+18 MIN	20 dB MIN	2.0:1
CA56-3110A	5.85-6.425	28	2.5 MAX, 1.5 TYP	+16 MIN	22 dB MIN	1.8:1
CA612-4110A	6.0-12.0	24	2.5 MAX, 1.5 TYP	+12 MIN	15 dB MIN	1.9:1
CA1315-4110A	13.75-15.4	25	2.2 MAX, 1.6 TYP	+16 MIN	20 dB MIN	1.8:1
CA1518-4110A	15.0-18.0	30	3.0 MAX, 2.0 TYP	+18 MIN	20 dB MIN	1.85:1

LOW FREQUENCY AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure dB	Power-out @ P1-dB	3rd Order ICP	VSWR
CA001-2110	0.01-0.10	18	4.0 MAX, 2.2 TYP	+10 MIN	+20 dBm	2.0:1
CA001-2211	0.04-0.15	24	3.5 MAX, 2.2 TYP	+13 MIN	+23 dBm	2.0:1
CA001-2215	0.04-0.15	23	4.0 MAX, 2.2 TYP	+23 MIN	+33 dBm	2.0:1
CA001-3113	0.01-1.0	28	4.0 MAX, 2.8 TYP	+17 MIN	+27 dBm	2.0:1
CA002-3114	0.01-2.0	27	4.0 MAX, 2.8 TYP	+20 MIN	+30 dBm	2.0:1
CA003-3116	0.01-3.0	18	4.0 MAX, 2.8 TYP	+25 MIN	+35 dBm	2.0:1
CA004-3112	0.01-4.0	32	4.0 MAX, 2.8 TYP	+15 MIN	+25 dBm	2.0:1

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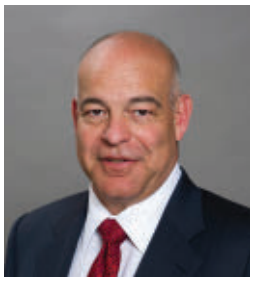

INFORMATION WARFARE

Last month, I attended the AOC's 2019 Pacific Information Operations Symposium, where the focus was on "Countering Coercion and the role of Information Operations." This was a great event put on by our Diamond Head Chapter and J-39 US Indo-Pacific Command. One of the most informative briefs, presented by the Army, was an overview of the initial findings and recommendations of their Information Warfare Design Planning Team that was created to influence the Army's development of capabilities for multi-domain operations. The team focused on the construct of Information Warfare, which was defined in working terms as: "The employment of military capabilities to generate deliberate effects in the cognitive, physical and informational dimensions of the information environment (IE) to achieve military objectives versus an adversary."

The analysis and findings presented by the team were also reflected in many of the briefings throughout the conference that addressed multiple internal, neural, and adversarial challenges that impact our ability to operate in the Information Environment (IE). These challenges included: 1) information as a decisive capability in warfare not culturally recognized or leveraged; 2) decision-making that is too slow to fight and win an information war; 3) risk aversion in the IE (political/legal sensitivities); 4) current information-related capabilities (IRCs) and processes that exist in stovepipes; 5) our focus on large-scale ground combat over competition; and 6) authorities that are not permissive and held at too high a level.

Western democracies are currently at a disadvantage in conducting Information Warfare. We are competing against adversaries that utilize techniques to create conditions that use disinformation and misinformation to achieve a wide range of objectives from the tactical maneuver level to the strategic information level. Adversaries additionally have an advantage because of their social control of their populations, authoritarian governments, and fully permissive authorities.

To address these acknowledged disadvantages, the Army team identified future Information Warfare characteristics integrated into a "whole of government approach" that is "globally engaged, regionally aligned and strategically nested" with a focus on multi-domain and cognitive dimension/behavior outcomes. We will need streamlined processes that enhance decision-making to advance us from a reactive to a proactive/anticipatory stance.

These actions will enable us to defend, counter, and mitigate adversary disinformation activities at a relevant speed in today's information environment. To accomplish these objectives, there will need to be a realignment of DOTMLPF-P, as well as a cultural change in our organizations that elevates Information Warfare to a major component of our warfighting strategies that can be applied with persistence to influence/create positive outcomes.

If we successfully address these challenges, we can achieve an end state that will deliver capabilities that are integrated or synchronized throughout development, creating efficiency, accelerating processes, and ensuring completeness for proactive and reactive responses in the IE. This endeavor will not be a short-term effort. It will require long-term awareness, commitment, investment, and focus. Information Warfare is critical to achieving victory and is a major contributor in all phases of warfare. – *Muddy Watters*

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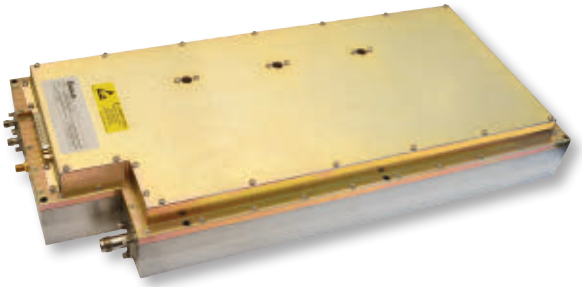

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the monitor news

EDTF 2019 REPORT CALLS FOR EMS AS JOINT WARFIGHTING DOMAIN

The Air University's Lemay Center for Doctrine Development and Education has published a report from the Electromagnetic Defense Task Force (EDTF) summarizing the conclusions reached at its second EDTF Summit (EDTF 2.0) held 29 April – 1 May of this year. Overarching above all others, the Task Force report makes "the strongest and most robust recommendation that EMS be declared a joint war-fighting domain."

As stated in the report, "Unlike other domains that connect but can be segregated, or that terminate at definitive boundaries such as a shoreline between land and the sea or at the skyline between air and land, the EMS crosscuts all domains. In other words, degradation to an EMS environment can degrade operations in and permeate all other environments at the same time…This exceptional domain cannot be isolated, is the most connected, and undergirds the very survival of electronics-dependent civilizations…Once fully leveraged, this domain will enable total communications and information control in the twenty-first century. Such may lead to a state where the dominant feature of future warfare becomes electromagnetic warfare (EW)."

The initial EDTF was formed in 2018 as a "triage response to an enterprise-wide knowledge deficiency about the criticality of issues confronting the US and its allies as every aspect of modern society becomes increasingly reliant on the electromagnetic spectrum (EMS)." The Task Force brought together over 360 senior representatives (fellows) from multiple federal agencies, the military, industry, and academia, and included almost 5,000 hours of war-gaming and tabletop exercises (TTX).

In its 2018 report, the EDTF posited four key findings: "EMP and geomagnetic disturbance (GMD) are significant and continuing threats to the military and civil society with risks including, but not limited to, nuclear power station resilience, military installation resilience, and exercise realism and training (education); Emerging 5G technologies and the design of regional and continental networks can present strategic threats; Directed energy (DE) and high-powered microwave systems can pose threats to human biology and hardware dependent on electronics and; EMS management is struggling to maintain pace with rapid technical evolutions within the spectrum." The report included a series of national-, regional-, and local-level recommendations on how to increase the resilience of key military and civil critical infrastructure.

For the 2019 summit (EDTF 2.0), more than 220 fellows participated in TTXs organized into four tracks: electromagnetic spectrum operations (EMSO); high-powered electronics and microwaves (HPEM)/DE/spectrum management; EMP and GMD; and quantum and 5G technologies. In total, 17 teams formed, including two special teams to address nuclear power station vulnerabilities and analyze commercial reports and data generated by the electric power industry.

Focusing heavily on the potential impact of electromagnetic pulse (EMP) and geomagnetic disturbance (GMD) events, four primary questions were to be addressed: Based on the EMS scenario, and assessing post-event Joint Force (military) capabilities, what assets/functions remain viable?; Based on what remains viable (preserved), what Joint Force strategies/regeneration options can be realistically put forward to national leaders for recovery and/or military response?; What are our strategic blind spots in regard to each track in a severe EMS-degraded environment, and how should we place near-term bets to counter/frustrate enemy efforts? and; What happens when we lose positioning, navigation, and timing (PNT)?

The lengthy and comprehensive report examines each of these areas in great detail, defining the dangers, particular areas of vulnerability and their likely impact and implications on all aspects of our military capabilities and society as a whole, as well as proposing possible approaches to mitigating their effects. One of its strongest recommendations is that "USNORTHCOM develop concepts of operations and contingency plans for major EMS impacts (including EMP, GMD, and space-based PNT/GPS degradation) to the lower contiguous 48 states."

One area receiving particular attention is the emergence of 5G communications technology. Pointing out that, "to achieve 5G coverage over an area the size of the United States will require tens of millions of 5G sites as opposed to several million 4G sites," and that "the sheer number of 5G sites needed to achieve broad coverage makes any 5G network difficult to protect from EMS interruption," the report warns that, "Ultimately, if the 5G network deployed in the United States is not designed and constructed to be inherently resilient to EMS threats, and the electric power assets sustaining this network are not resilient to EMS threats, our Nation will face an even more profound vulnerability than the status quo…If the US continues to pursue the creation of 5G networks, planners should give full consideration to the fact that they will be providing a less resilient telecommunications system. Use of this knowledge can afford planners the ability to build in resilience and mitigate vulnerabilities, up front."

EDTF 3.0 is expected to be held in the National Capital Region in late 2019 or early 2020. – *J. Haystead*

US ARMY SEEKS "MULTIMODE, MULTIMISSION, MULTIFUNCTION" AESA ANTENNA

The US Army's Intelligence and Information Warfare Directorate (I2WD) (Aberdeen Proving Ground, MD) has issued a Request for Information (RFI) for an active electronically scanned array (AESA) antenna technology that can perform multiple roles from radar and communications to electronic warfare (EW) and signals intelligence (SIGINT), which today are typically performed by separate electronic systems.

The Directorate is seeking information about modular and scalable AESA antennas that are at Technology Readiness Level 4 (TRL 4) or higher "with a defined path to TRL 6 within two to three years," according to the RFI. "These AESA antennas would be capable of providing multi-mode, multi-mission, multi-function support to include, but not limited to, Dismount/Ground Moving Target Indicator (DMTI/GMTI), Synthetic Aperture Radar (SAR), Signals Intelligence (SIGINT), Electronic Warfare (EW) and vehicle protection systems. The antenna design should focus on low Size, Weight, and Power – Cooling (SWaP-C) technologies and provide the ability to support Intelligence, Surveillance and Reconnaissance/Reconnaissance, Surveillance, and Target Acquisition (ISR/RSTA) missions to address Warning Intelligence and/or Targeting."

The RFI further describes the traits it is seeking:

1) "Modular: An antenna design that encompasses a well-defined architecture for access and control by a 3rd party system supporting radio frequency (RF) convergence across radar/communication/electronic warfare systems.
2) Scalable: refers to the ability to dynamically increase/decrease the antenna aperture size, e.g. by using a panel architecture, with zero/minimal radar backend changes.
3) Multi-mode: Sensor system that is capable of supporting multiple missions (e.g. SAR, DMTI/GMTI) at different times, but not multiple simultaneous missions.
4) Multi-mission: Sensor system that is capable of supporting multiple missions (e.g. SAR, DMTI/GMTI) simultaneously.
5) Multi-function: Sensor system that is capable of supporting multiple RF functions (e.g. radar, electronic warfare, communications, signal intelligence). Functions may or may not be executed simultaneously.
6) Warning Intelligence: Those intelligence activities intended to detect and report time-sensitive intelligence information on foreign developments that forewarn of hostile actions or intention against United States entities, partners, or interests.
7) Targeting:
   - Intelligence Targeting: Intelligence that portrays and locates the components of a target or target complex and indicates its vulnerability and relative importance.
   - Military Operation Targeting: Process of selecting and prioritizing targets and matching the appropriate response to them, consider-

ing operational requirements and capabilities."

Responses to the RFI are due by October 6. The contracting point of contact is John G. Sdanowich, (443) 861-4639, e-mail john.g.sdanowich.civ@mail.mil. – *JED Staff*

US ARMY LAYS OUT PLANS FOR CYBER QUEST 2020

The US Army has announced plans to hold its fifth annual Cyber Quest prototyping experiment next summer. The Army outlined its plans in a Broad Agency Announcement released in August. As with previous Cyber Quest events, Cyber Quest 2020 will help the Army's CEMA Community "to assess emerging (cyber, EW, intelligence and networking) solutions/technologies against associated Army capability requirements, inform capability development efforts, inform rapid acquisition requirements, as well as validate candidate technology solutions for future participation in other Army/Joint exercises and experiments (i.e., Cyber Blitz, Army Live Prototype Assessments (ALPA), Joint Warfighting Assessments (JWA), etc.)," according to the BAA. Cyber Quest 2020 is planned for May 25 through June 20.

At the 2020 event, Government, industry and academic organizations will demonstrate cyberspace operations, signal intelligence and/or EW solutions addressing a wide variety of experiment objectives. DOD participation at the event will include the Cyber Battle Lab, Intelligence Battle Lab, Army Cyber Command (ARCYBER), Cyber Protection Brigade (CPB), TCM Cyber, TCM EW, TCM Tactical Radio, TCM Networks and Services, Requirements and Integration Division (RID), Capabilities and Analysis Division (CAD), and the Army acquisition community Cross Functional Teams (CFTs).

Each objective is aligned with the Training and Doctrine Command (TRADOC) Capability Manager (TCM) responsible for developing that capability requirement. Among TCM Cyber objectives are the Cyberspace Situational Understanding (SU) experiments aimed at demonstrating technologies that will enhance the commander's Cyber SU during multi-domain operations and tools capable of assessing overall mission risk and cyberdefensive posture. Offensive cyber operations experiments include identifying capabilities that can deny, degrade, disrupt, destroy and manipulate secure networks, devices and applications through RF-enabled delivery methods. Defensive cyber operations experiments will look to identify capabilities that allow the dynamic reshaping of cyberspace based on mission and threat to include obfuscation, deception and evasion.

TCM Networks and Services (N&S) will pursue network-related experiments including identifying emerging radio technologies that can provide Army maneuver units a high-capacity, line-of-sight (LOS), terrestrial backhaul network. Together with TCM Tactical Radios, TCM N&S will also conduct Lower Tactical Network experiments, including identifying Low Earth Orbit (LEO) and Medium Earth Orbit (MEO) satellite capabilities that can support Army multi-domain operations data transport requirements.

TCM EW will be conducting EW Support (ES) experiments including identifying emerging technologies that can provide Army formations enhanced sensing of the electromagnetic environment (EME) at extended ranges. EW Protection (EP) experiments will identify technologies that can provide Army commanders the ability to sense and visualize their own use of the electromagnetic spectrum (EMS), as well as the ability to baseline the EMS in their area and identify interference attempts by Red Forces. TCM EW will also be conducting EMS deception experiments involving technologies that can provide Army units freedom of movement within a saturated EME by utilizing spectrum obscuration, and identifying capabilities that will deceive the enemy of the movements of the Army unit within the saturated EME.

In addition, TCM EW and TCM N&S will work together on information warfare support experiments to identify emerging RF technologies that can provide Army BCT and below a high-capacity LOS terrestrial backhaul network that can support TLS (Terrestrial Layer System) and Logistics network (LOGNET) requirements.

Intelligence experiment objectives are aimed at "identifying capabilities that can provide the Army a Dynamic Intelligence Synchronization Matrix (DISM) to provide immediate automated visualization of the linkage between decision points (DP), priority intelligence requirements (PIR), indicators, specific information requirements, collection tasks, and the platform/sensor tasked. It provides the commander the flexibility and choice to view the status of ongoing intelligence collection in terms of time, space, forces/units, functions, domains, and effects." – *J. Haystead*

IN BRIEF

Naval Air Systems Command (NAVAIR) is soliciting proposals for the NGJ-LB Capability Block 1 (CB1) phase of the Next Generation Jammer Low Band (NGJ-LB) program. The contract includes design, development, building, integration, test and maintenance of a complete low-band capability solution. This includes two Captive Mass Model Aeromechanical Pods, four Jettison Mass Model Pods, two Mission System Prototype Test Pods, eight Operational Prototype Pods, two Technique Development Stations and 10 Pod Simulators. The NGJ-LB program will replace some of the ALQ-99 Tactical Jamming System (TJS) pods currently in use on the EA-18G Growler. The point of contact is: Sarah Littleton. Phone: (301) 757-5522; email, sarah.littleton@navy.mil.

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Lockheed Martin has awarded a Block 4 modernization contract to **BAE Systems** (Nashua, NH) to upgrade the EW capabilities of the F-35 Lightning II fighter aircraft. The contract includes the modernization of BAE's AN/ASQ-239 Electronic Warfare/Countermeasures (EW/CM) system. BAE has been the EW suite contractor for the F-35 throughout the Blocks 1, 2 and 3 phases. The Block 4 program will be a multi-year, multi-contract, continuous-capability development and delivery (C2D2) effort that will include 11 new capabilities to

enhance the EW systems in multiple F-35 variants.

Northrop Grumman Corporation (Rolling Meadows, IL) has received a contract award for up to $482 million from the US Army for production and support of the Common Infrared Countermeasures (CIRCM) system. The initial task order provides $82.8 million in funding for expanded CIRCM production and logistics support as the program advances to full rate production, allowing for integration of CIRCM in additional aircraft and missions.

The US Army Corps of Engineers has issued a $1.2 million task order to **Environet Inc.** (Davenport, IA) for the design and construction of the Electronic Attack Test Range at the Naval Surface Warfare Center – Crane (Crane, IN).

Northrop Grumman Amherst Systems (Buffalo, NY) has been awarded an $870,000 contract from the Naval Surface Warfare Center – Crane (Crane, IN) to deliver a Pulseman Portable Combat Electromagnetic Environment Simulator (CEESIM) mmW. The CEESIM will be used to perform end-to-end system testing of the AN/SLQ-57 and the AN/SLD-4 ESM systems on the US Navy's Littoral Combat Ships for the validation of threat libraries and electronic attack data files. There is an option for maintenance and repair for up to three years.

The **Defense Advanced Research Projects Agency's (DARPA's)** Information Innovation Office (I2O) has issued a Request for Information (RFI) to help identify companies that can support classified cyberspace operations and information operations (COIO) research and development (R&D) to combat current and emerging cyber threats. Interested sources must include personnel currently holding security clearances or who are eligible to receive clearances, though responses to this RFI may be classified or unclassified. Submissions must be received by September 30, 2020. Inquiries and submissions should be emailed to: DARPA-SN-19-77@darpa.mil.

The Air Force Research Laboratory (AFRL) (Wright-Patterson AFB, OH) has awarded separate contracts to **Northrop Grumman Systems Corporation** (Falls Church, VA), **RAM Photonics LLC** (San Diego, CA) and **Photonic Systems Inc.** (Billerica, MA) for the development of prototype photonic-electronic systems for the Radio-Frequency Intercept by Photonic-Assisted Threat Identification, Disaggregation, and Extraction (RIP-TIDE) project. This program is intended to demonstrate prototype photonic-electronic systems that provide advanced capabilities beyond those of current all-electronic solutions, including "the capture of signals over an ultra-wide frequency range with a large instantaneous bandwidth; the realization of large 'effective' bandwidth solutions; the rapid analysis of wide-frequency signals; solutions which exploit photon-

ics to realize low-latency capabilities; the ability to both stare, self-cue, and analyze/process." The contract award dollar amounts include: Northrop Grumman Systems Corporation, $1.4 million; RAM Photonics LLC, $1.6 million; Photonic Systems Inc., $1.2 million.

DARPA has awarded a $470,000 contract to **II-VI Optical Systems, Inc.** for the research and development of Fiber-Array Based Energy Relay (FABER) for High-Altitude High Energy Laser (HEL) Weapon Platforms.

Northrop Grumman Innovation Systems (Northridge, CA) has received a Sole Source Cost Plus Fixed Fee contract for $1 million from Naval Air Systems Command (NAVAIR). The company will integrated the Rockwell Collins NavStrike-M Global Positioning System (GPS) receiver into the AGM-88E Advanced Anti-Radiation Guided Missile (AARGM). Work will be completed at Northrop Grumman, Defense Electronic Systems in Northridge, CA. Contracting point of contact is: Garrett Wayne Sprinkle. Phone: (301) 342-2126; email, garrett.sprinkle@navy.mil.

The **Naval Research Lab (NRL)** (Washington, DC) has issued a Request for Information (RFI) for implementing a demonstration of power-beaming technologies. Power beaming involves sending microwave, millimeter wave or laser energy over long distances after which it can be converted into electrical power and used by weapons platforms. The RFI states, "The technology itself takes several forms, including: (1) laser transmission at a range of possible wavelengths to receivers consisting of bandgap-tuned photovoltaics, thermophotovoltaics, or heat engines, (2) millimeter-wave transmission using solid state or gyrotron sources to rectennas or heat engines, and (3) microwave transmission at a range of possible frequencies from vacuum or solid state electronics to rectenna receivers. Supporting technology, including high altitude vehicles, aerostats, inexpensive adaptive optics, and others have also made significant recent gains. For defense purposes, a number of application areas are of immediate interest: swarming, teamed, and individual autonomous air, ground, and sea vehicles, off board countermeasures, unattended ground and sea sensors, explosive ordnance disposal, and camp/convoy/port/fleet security. These cover a range of mission areas, including providing communications, intelligence, surveillance, target acquisition, and reconnaissance. They are applicable in numerous military contexts, such as forward operating bases, combat outposts, landing parties, fleet operations, and distributed sensor networks." NRL is seeking inputs for demonstrating a power beaming capability that is safe for users and bystanders, and that delivers on an ongoing basis at least 1 kW of power at a distance of at least 1 km. The contracting point of contact is Anastasia Lenfest, e-mail Anastasia.Lenfest@nrl.navy.mil.

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ISRAELI MOD SELECTS ACTIVE PROTECTION SYSTEM FOR EITAN AFV

The Israeli Ministry of Defense (IMOD) has selected Elbit Systems to supply its Iron Fist Light Decoupled active protection system (APS) for the Israeli Defense Forces' new Eitan eight-wheeled Armored Fighting Vehicle (AFV) and the D-9 bulldozer.

Designed to provide 360-degree protection coverage for close-range scenarios in both open terrain and urban environments, the Iron Fist Light Decoupled APS uses independent optical sensors, tracking radar, launchers, and countermeasure munitions to defeat threats at a safe distance from the defended AFV. The system's hard-kill concept is based on intercepting the threat by launching a small warhead and initiating it at a safe distance from the protected platform, at a precisely calculated moment, and defeating or destructing the threat through a shock-wave effect.

The Iron Fist Decoupled system was selected by the IMOD following competition against Rafael's Trophy APS. A contract award is subject to completion of negotiations. – R. Scott

PRAETORIAN DASS ENHANCEMENT STUDY UNDER CONTRACT

The EuroDASS industry consortium has been contracted to explore potential upgrades for the Praetorian Defensive Aids Subsystem (DASS) equipping the four-nation Eurofighter Typhoon combat aircraft.

Lasting 18 months, the Praetorian Long Term Evolution (LTE) study activity will characterize the future threat environment, and identify technologies and techniques intended to enhance the survivability of Typhoon out to 2050 in the face of evolving threats. Developed by the EuroDASS consortium – comprising Leonardo (Luton, UK), Elettronica (Rome, Italy), Indra (Madrid, Spain) and Hensoldt (Ulm, Germany) – the Praetorian DASS includes electronic support measures, an active missile approach warner, electronic countermeasures, towed decoys, and initiation of chaff/flares.

Under a contract awarded by BAE Systems (on behalf of Eurofighter GmbH), the EuroDASS consortium will examine the evolution of the existing Praetorian DASS system, including managing parts obsolescence challenges, as well as new technology options to address likely future threats.

Among the options being considered are a more flexible software-driven architecture, allowing for the introduction of new capabilities in a more agile and low-cost manner. Improvements to the exploitation and fusion of onboard sensors will also be investigated, and work will additionally consider both onboard and offboard countermeasures.

A broad set of options will be explored and presented to NETMA (the four-nation prime customer and management body representing Germany, Italy, Spain and the UK) at an interim review. It is anticipated that NETMA will then select a number of options for further investigation during the remaining part of the study.

The Praetorian LTE is intended to lay the foundation for sustaining and enhancing the Typhoon DASS through to the aircraft's planned end-of-life. The contract is running in parallel with a number of other Eurofighter Typhoon LTE studies aimed at identifying technology enhancements in areas of mission system architecture, human-machine interface, power and cooling, and engine performance. – *R. Scott*

MAIR INFRARED SYSTEM BEGINS FLIGHT TESTING

Leonardo (Nerviano, Italy) has successfully completed a first flight test of its new Multiple Aperture Infra-Red (MAIR) system.

Designed to provide both helicopters and fixed-wing aircraft with full, spherical, infrared-sensor functionality – including missile warning, hostile fire indication, day/night imaging and target tracking – MAIR works by using a series of distributed IR sensors to provide all-round coverage.

A first flight test was undertaken on board a helicopter operating from La Spezia on the northwest coast of Italy. During the test, which took the aircraft north along the coast past Genoa, the MAIR system operated as expected and demonstrated its ability to gather and process information from multiple infrared cameras simultaneously. Further flight testing will now take place to verify the MAIR system's full suite of modes.

As well as providing improved situational awareness, MAIR can boost survivability by automatically cueing protective measures such as directed infrared countermeasures. – *R. Scott*

IN BRIEF

- Elbit Systems has been selected to supply the electronic warfare (EW) suite for the Força Aérea Portuguesa's (Portuguese Air Force's) five new Embraer KC-390 multi-mission aircraft, which are due to begin arriving in early 2023. The suite will comprise radar and laser warning systems, an infrared missile warning system, a countermeasures dispensing system, directed infrared countermeasures, and a radar jamming system.
- The government of Taiwan has requested the purchase of 66 F-16C/D Block 70 aircraft from the US via the Foreign Military Sales program. The potential deal includes 75 AN/ALQ-211A(V)4 Airborne Integrated Defensive Electronic Warfare Suites (AIDEWS) from L3Harris; 75 ALE-47 countermeasures dispensers; an unspecified quantity of chaff and flare cartridges; and 120 ALE-50 towed RF decoys from Raytheon.

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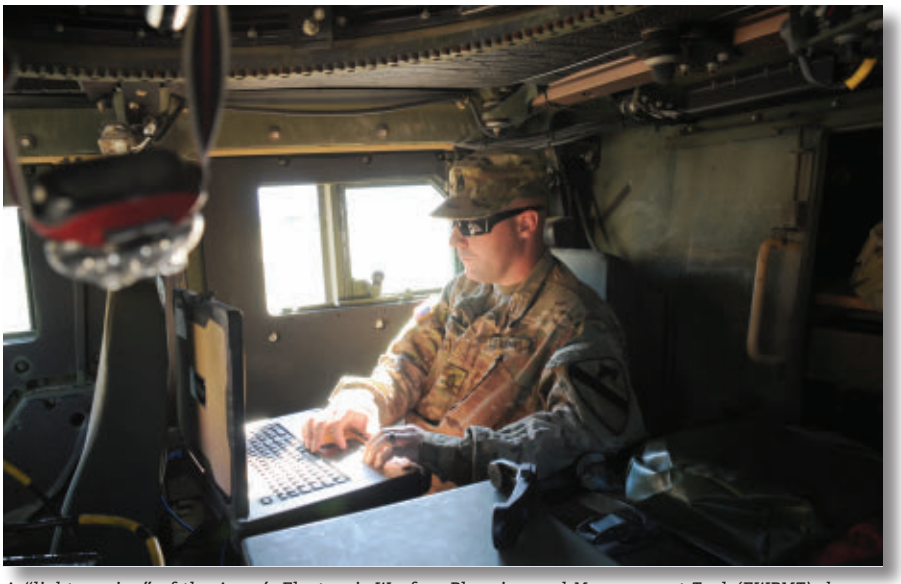
Aberdeen Proving Gr EMBM Development

By John Haystead



PHOTOS COURTESY OF US ARMY

A "light version" of the Army's Electronic Warfare Planning and Management Tool (EWPMT), known as "Raven Claw," was fielded as part of USAEUR and CEMA Operational Needs Statements (ONSs).

The Program Executive Office (PEO) Intelligence Electronic Warfare & Surveillance (IEW&S) and the Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance and Reconnaissance (C5ISR) Center are the core sources of the US Army's EW and SIGINT capabilities. Both organizations are located at Aberdeen Proving Ground, MD.

PEO IEW&S is the Army's lead organization for developing, acquiring and fielding a broad range of advanced electronics technology and systems for its ground and airborne forces, as well as its space-based capabilities in support of their IEW&S mission responsibilities. In addition to its headquarters at APG, it also includes facilities at Fort Belvoir, VA; Redstone Arsenal, AL, and Los Angeles AFB, CA.

The PEO is composed of six Project Manager (PM) elements: Aircraft Survivability Equipment; Distributed Common Ground System – Army; DOD Biometrics; Electronic Warfare & Cyber (EW&C); Position, Navigation & Timing; and Terrestrial Sensors. In addition, there are two Project Director (PD) offices: Tactical Exploitation of National Capabilities (TENCAP) and Sensors Aerial Intelligence.

Following the transition to Army Futures Command in February 2019, RDECOM changed its name to the Combat Capabilities Development Command (CCDC). Formerly known as CERDEC, the C5ISR Center is now one of eight science and technology "domains" within the CCDC, serving as the Army's information technologies and integrated systems center, conducting R&D programs in command, power and integration; intelligence and information warfare; night vision and electronic sensors; and space and terrestrial communications. The C5ISR Center incorporates the Intelligence and Information Warfare Directorate (I2WD), which is the Army's primary center for EW and SIGINT science and technology R&D.

The work of both PEO IEW&S and the C5ISR Center must necessarily support, and be synchronized with, the Army Futures Command (AFC) (Austin, TX) and its eight Cross Functional Teams (CFTs): Long-Range Precision Fires (LRPF); Next Generation Combat Vehicle (NGCV); Future Vertical Lift (FVL); Army Network; Assured Precision Navigation & Timing (PNT); Air & Missile Defense (AMD); Soldier Lethality (SL); and Synthetic Training Environment (STE).

Speaking at a recent media day sponsored by both PEO IEW&S and the C5ISR Center, BG Robert Collins, Program Executive Officer IEW&S, said, "In terms of modernization, we spend a lot of time making sure we're both ready today, and posturing ourselves to modernize for the future. We do a significant amount of coordination with, and through, AFC here with our CFTs." As examples, he cited their work "mapping" to the Network CFT, as well as the PNT CFT (particularly emphasizing the importance of timing), and on IR sensors associated with the NGCV CFT. "So, a lot of the work we do is with Futures Command and helping with the requirements process, so that as things come into the acquisition community we're prepared to deliver."

Directly associated with this, General Collins adds that "a lot of our focus in working with Futures Command is also on making sure we stay relevant to the National Defense Strategy (NDS), and as we focus on multi-domain operations and the NDS, we're trying to implement a new approach to acquisition – with tailored acquisition approaches, iterative in the sense that you don't ever really achieve an end-state where you've met every single requirement. You iterate those using other types of instruments such as Other Transaction Authorities (OTAs), and try-before-you-by approaches to allow for the incorporation of soldier feedback. I look at it as a balance of threat-based acquisition, informed by soldier-feedback, with continued involvement with industry, targeting things that are achievable and that can deliver value for the taxpayer."

ound Home to Army and Acquisition

Specific to EW and SIGINT, or more broadly, Electromagnetic Battle Management (EMBM) requirements, General Collins observes that, "Certainly within the NDS, we recognize that there are constantly evolving competition and penetration factors involved. For example, in terms of operations, it's no longer a linear, yes-or-no proposition when it comes to penetration. It's not just physical observation, but from an advanced sensor perspective, there can also be virtual electromagnetic penetration, and we're putting a lot more emphasis on that. We recognize that the EMS is a very precious resource, as well as very finite, and we're trying to figure out new ways to get better-use cases out of the spectrum, be more agile, and to better deconflict our objectives. Today, the EWO mission is more critical than ever. The future battlefield is not just kinetic, but is increasingly becoming non-kinetic, and their value on this battlefield is more important than ever."

Speaking to the question of the lack of a dedicated CFT for EMBM, General Collins points to the Intelligence, Surveillance and Reconnaissance (ISR) Task Force. Formed in 2018 within the office of the G-2, the ISR Task Force is aimed at optimizing the Army's ISR capabilities for multi-domain operations and to exploit complimentary capabilities across the joint force and intelligence community. Collins notes that "the ISR Task Force includes significant participation from our Intel Center of Excellence and the Cyber Center of Excellence, and it has been the guiding team that we're working through, providing the synergy that helps shape the CONOPs driving our requirements and making sure that we have a fully-integrated strategy."

Still, General Collins agrees that, "it's true that EW has been something where we need to continue to sharpen our tools." But, he points out that the Army is "making investments in force structure and starting to make some investments in materiel to make sure that we get back some of those capabilities in the non-kinetic and EW environment. The ISR Task Force has been the lead on that effort."

EWPMT

The IEW&S's Electronic Warfare Planning and Management Tool (EWPMT) sits squarely at the center of the Army's rejuvenated emphasis on ISR capabilities and multidomain operations (MDO). Managed by Project Manager for Electronic Warfare & Cyber (PM EW&C) within PEO IEW&S, the EWPMT is intended to be a commander's primary tool to integrate multi-domain operations into the military decision making process, providing for complete visualization of the Electromagnetic Spectrum (EMS) including the RF signatures of both threat and own forces, "in order to conduct offensive and defensive Electronic Attack (EA), EW targeting, and enable maneuver by synchronizing EW and spectrum management operations across intelligence, operations, and signals to successfully execute a multi-domain battle," according to the Army program description.

As described by Lieutenant Colonel Jason Marshall, PEO IEW&S Product Manager, Electronic Warfare Integration, "EWPMT utilizes an open system architecture and, when fielded in near future, it will be a part of the Command Post Computing Environment (CPCE) server stack, plugging into the mission command suite and interacting with the Army's Command Post of the Future (CPOF) and the Data Distribution

Incorporating the EWPMT in the military decision making process was another key point for many of the personnel who travelled to the Aberdeen area for a User Verification Event (UVE). CPT Sacarra Pusey, an EWO from Fort Polk, LA, observed that, "My NCOs were able to talk to [the engineer] and get updates, 'can we have the right click capability, can we have the alerts hidden, can we talk through the chat,' and as we went through the steps in the processes, a lot of the kinks were taken care of."

System (DDS) to display and fuse data, as well as with the Advanced Field Artillery Tactical Data System (AFATDS) for targeting. It is being tailored to use the current network, and will hopefully drive some of the requirements for the future network."

EWPMT is currently in development with an operational needs statement (ONS). As described by LTC Marshall, "We took the tool from the point that it was in its developmental cycle, added some additional capability and, although not a full-up fielding, deployed it with certain designated units to facilitate multidomain operations. When we did this, we added the capability to plug into current Quick Reaction Capability (QRC) sensors and provide EMS visualization to users in the field." Although the EWPMT currently requires a "very robust computer," LTC Marshall says they're working with the prime contractor, Raytheon, to enable the system to be ported to different hardware platforms using configuration installation wizards based on different functional requirements.

The ongoing EWPMT development program is broken up into increments spanning several years and incorporating Capability Drops (CDs) every 18-24 months. Says LTC Marshall, "Breaking up the development allows us to incrementally field new software capabilities into the system. At this point, we're fielding software on an annual basis, and are looking to accelerate that rate."

According to Army-provided briefing materials, CDs 1 and 2 of Increment 1 "provided the foundational elements of EW planning, EW targeting, spectrum management, and enhanced modeling and simulation (M&S)." The program is currently on CD 3 of Increment 1, which together with CD 4, are intended to "provide threat-pacing capabilities for Disconnected, Intermittent, and Latent (DIL) environments; Remote Control & Management (RCM) of EW assets; Enhanced Situational Awareness; EW Effectiveness; and Enhanced EW Targeting. In addition, the CDs are aimed at providing foundational elements for Cyber Situational Understanding support to the Army's Cyber-Electromagnetic Activities (CEMA) teams."

The EWPMT program development utilizes User Verification Events (UVEs), where users located around the world come to APG and are presented with tactical vignettes focused on different aspects of the tool, such as planning and targeting, mission execution, etc. Says LTC Marshall, "Because we're software intensive, we get a new software 'sprint' from our developer (Raytheon) every three months that we can directly roll into the subsequent software sprint. So, we're developing it around the user while it's still in the development stage." So far, the PM has made over 200 modifications based on this feedback alone.

Another unique aspect of the program is something called an "IT Box" requirement. As outlined by LTC Marshall, the requirement is specific to software-intensive programs and basically sets minimum boundaries of cost, schedule and key performance parameters. "Given that we stay within these prescribed boundaries, we can reprioritize requirements based on user feed-

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Specialists with the Expeditionary Cyber Support Detachment, 782nd Military Intelligence Battalion (Cyber), provide cyberspace operations support to a training rotation for the 3rd Brigade Combat Team, 1st Cavalry Division at the NTC. The Army's planned 915th Cyber Warfare Support Battalion (CWSB) will be composed of a number of Expeditionary Cyber Teams (ECTs) and tailored to provide support to CEMA units at corps and below level.

back and the current threat. So, when we get new software into the hands of the user, whether here at CONUS or at deployed units, and as these users are developing their current Tactics, Techniques and Procedures (TTPs) and doctrine, we're agile enough to be able to trade requirements both to best pace the threat as well as accommodate how the users will implement EWPMT into the military decision-making process." According to Marshall, "The most recent requirement has been direct connection into surrogate and future program-of-record sensors."

Although EWPMT is not a part of the AFC's CFT construct, Marshall points out that they do interface with both the Army Network and the Assured Position Navigation and Timing (PNT) CFTs. In July, the PM participated in the PNT Assessment Exercise (PNTAX) held at White Sands Missile Range, NM, where Marshall says they integrated successfully with four different sensors to help the program office visualize some of their requirements.

The EWPMT has also played an important role in Army's annual Cyber Quest and Cyber Blitz exercises. Marshall said, "We use venues such as those to integrate with different sensors and different artificial intelligence capabilities that are at, or near, technical maturity in order to display the capabilities to different users." At the time of the media event, the PM had already begun integration efforts for Cyber Blitz 19 (held in September), for which Marshall says they planned 17 different integration events ranging from VROD/VMAX to two different AI efforts, to TEWS, to DDS and CPOF, among others. Although Marshall added that they're looking to support similar types of events in future "to the best of our ability," he noted that "we do have to prioritize, as we're not a big program office and have two different ONSs we're supporting, doing multiple user events and really starting to ramp-up the fielding."

According to CW2 Will Flanagan, Senior EW Targeting Officer, Operations Group, Fort Irwin, CA, "At the National Training Center, the Army is also getting ready to evaluate the integration work of the EWPMT system with the Tactical EW System (TEWS), which will be part of the Terrestrial Layer System (TLS). This will be a big test to see how well it actually performs all of the things we expect it to do."

The EWPMT is a PM EW&C program, and according to COL Kevin Finch, EW &C Project Manager, CD 3 is already undergoing field testing as part of ONS efforts, and users in Europe will now be

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receiving EWPMT CD 3, which will start fielding in FY20.

In July 2018, Raytheon was awarded a $49 million contract for EWPMT CD 4 development, and contractor support for the maintenance and fielding of CD3 through CD4. At the time of the award, the estimated completion date was September 2022. Colonel Finch says they're now also working on the requirements for Increment 2, as well as waiting on a decision from DOD as to the role that the EWPMT will play in the Joint Electromagnetic Battle Management (EMBM) tool requirement established in the National Defense Strategy (NDS). Says Finch, "EWPMT is not necessarily expected to completely meet the Joint requirement, but to form the basis for that, which would be about 80% of what the Joint Force is looking for." An announcement is expected sometime within the next three months.

VROD/VMAX

As alluded to earlier, the Army has also been working with the C5ISR Center to rapidly field a number of new EW sensor and electronic attack (EA) capabilities through Quick Reaction Capability (QRC) efforts. Principle among these are the Virtual Radio Observation and Direction (VROD) electronic surveillance system, together with its full-up capability version that includes the Modular Adaptive Transmit mode (VMAX), adding an EA capability to the system.

Ken Gilliard, C5ISR Center's Team Leader, Rapid System Application Team, Rapid Applications Branch, Exploitation Analysis and Response Division, Intelligence and Information Warfare Directorate (I2WD), describes VMAX as a "lightweight (25-30 lb), man-portable system able to find, monitor, locate and jam RF communication and datalink emitters in real time in support of tactical operations, including potentially counter-UAS use." VMAX also represents the Army's "first ever man-packable offensive ES/EA capability with DF and precision geolocation capabilities."

The system began fielding in 2016, and Gilliard says "thus far, we've built over 200 VMAX nodes, with several hundred more of the VROD nodes deployed around the globe in use by US, Allied and Special Forces." The system can also be used at fixed-site locations, has been vehicle mounted, and has also been flown on various air platforms, providing longer range EA capabilities. Gilliard says they are also currently working on prototypes of the VROD system integrated on unmanned vehicles. "These would be UAS's smaller than what the MFEW-Air Large effort is looking at."

EW personnel can operate the VMAX system in a standalone configuration using an Android tablet, and it is also capable of being networked with an EWPMT-enabled system where it can be controlled remotely by an EWO from a Tactical Operations Center (TOC). The system software and hardware is 100% government-owned, developed by I2WD and its in-house contractors. It is also field reconfigurable based on the intended mission, with new software updates pushed regularly to the field.

Though not a Program of Record (POR), Gilliard notes that it is, however, informing future PORs such as TLS and others. "We're also working with several

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CFTs to provide the prototype capability as part of their demonstrators to inform their efforts. These include Soldier Lethality, Next-Gen Combat Vehicle, Network C3&I, as well Assured PNT." VMAX was one of four sensors integrated into the PNT Assessment Exercise, feeding into the EWPMT and providing location information on sources of GPS interference. It has also been used to support other training and assessment events, such as Cyber Blitz and Cyber Quest. Gilliard says they're currently looking at redesigns that will improve the system's capabilities, such as extending frequency coverage, wider bandwidth, incorporating faster processors, etc.

COL Kevin Finch, Project Manager for Electronic Warfare & Cyber, talks about how his office's Tactical Electronic Warfare System (TEWS) team worked with members of the 2nd Brigade, 2nd Stryker Brigade Combat Team, 2nd Infantry Division, as part of training and testing during the Joint Warfighting Assessment 2019 at Yakima Training Center, WA.

PM EW&C

Although all of the PM and PD shops within PEO IEW&S are of interest to the EW/SIGINT community, PM EW&C is naturally the central focus. PM EW&C is the nexus for all of the Army's EMBM capability rebuilding efforts.

PM EW&C's Colonel Finch says he has four major priorities for his operation. The first is to "build new programs." In this "bucket" Finch places the Terrestrial Layer System (TLS) and the cyber-focused Joint Common Access Platform to support the 915th Cyberspace Warfare Support Battalion (CWSB). The 915th CWSB is described as "the Army's first scalable organic expeditionary battalion to meet current and projected tactical Cyberspace Electromagnetic Activities (CEMA) requirements." Army Cyber Command (ARCYBER) expects it to reach full operational capability by the end of FY 2025, with twelve Expeditionary Cyber Teams (ECTs).

TLS is a program of record managed by PM EW&C to develop a tactical EW, SIGINT and cyber attack capability, with the initial prototype development phase being funded under an Other

Transaction Authority (OTA) contracting vehicle with the C5 Consortium. The program will begin to receive funding in FY20 and has already developed an Initial Capabilities Document (ICD) and received a Materiel Development Decision (MDD).

Colonel Finch says one of the unique things about TLS is its connection with both the Intel Center of Excellence and the Cyber Center of Excellence, and the fact that it will be the first integrated EW and cyber platform. "This is why there are three TCMs (TRADOC Capability Managers) involved and collaborating on the requirements – TCM-EW, TCM Terrestrial and Identity, and TCM Cyber. All three TCMs recognize what an important capability this is, serving multi-domain operations." TLS EMD prototypes are planned for completion in 2021, and Colonel Finch says, "They will be in the hands of soldiers before the end of FY21, with our first unit equipped planned for the fourth quarter of FY22."

EXECUTING EXISTING PROGRAMS

Colonel Finch's second priority is to "execute our current programs including EWPMT, MFEW-Air Large, and Prophet Modernization." The Prophet Modernization program is aimed at both maintaining the Prophet system's current SIGINT and EW capability until TLS is fielded, as well as to provide it with improved capabilities in the interim through the incorporation of enhanced signal processing. Says Colonel Finch, "This is key because, when the Prophet systems were first realized, they were made to address more of the Counter Insurgency (COIN) fight. With the new NDS and the focus on near-peer threats, however, we went back holistically to see where we could upgrade the system for that mission."

The upgrade incorporates some of the components that are currently within the TEWS QRC. In addition, Finch points out that, in collaboration with I2WD, they did additional work through the Tactical SIGINT (TSIG) effort with a new software framework known as Photon. "We incorporated Photon in TEWS and took it to the next level with I2WD to demonstrate the capability in TSIG. Now we're taking that capability and putting it into the Prophet Enhanced Signal Processing (Prophet-ESP) to help get after the near-peer threat. Having the Photon interface allows us to integrate new capabilities, such as multiple Software Defined Radios (SDRs), in short order. We were able to integrate six different SDRs within a matter of a month." Funding for Prophet Modernization was provided in the FY20 budget, but Finch says "work is already well underway."

In January, Lockheed Martin was awarded a rapid prototyping project through an OTA valued at $18 million to design, develop and test a cyber/EW podded system for the "Air Large" component of the US Army's Multi-Function Electronic Warfare (MFEW) program. Carried on an MQ-1C Gray Eagle unmanned aircraft, the system will provide brigade commanders with an organic electronic support and electronic attack capability, as well as cyber attack.

The MFEW-Air Large is based on an Independent Research and Development (IRAD) pod from Lockheed Martin called

The Army's Tactical EW System (TEWS) was integrated on Stryker vehicles of the 2nd Stryker Brigade Combat Team, 2nd Infantry Division, as part of the Joint Warfighting Assessment (JWA) 2019 at Yakima Training Center, WA.

"Silent Crow." Colonel Finch observes that the Silent Crow pod was flown during this year's Cyber Blitz exercise, and "we're using the information from that to advance the program." As part of its ONS work, Finch also points to an initial capability called COBRA, which is another pod-based system flown on the Gray Eagle that they have also learned from. "We learn from engaging with the user community, so when it comes to developing and fielding new capabilities, while an initial capability doesn't have all the functionality that the POR system will have, it allows for the development of TTPs and informing of the DOTMLPF for the final product."

Under the first phase of the contract, Lockheed will deliver one prototype system for demonstration aboard a surrogate aircraft, followed by four systems for integration on the Gray Eagle in the second phase. Phase 2 is planned for the first quarter of fiscal year 2020.

TEWS, TEWL, TO TLS

Colonel Finch's third priority is to "deliver capabilities now." These are the Army's USAEUR and CEMA ONS efforts. Finch describes these efforts as "critical because these are the programs that are now informing the QRC TEWS and TEWL development efforts and ultimately the TLS." TEWS is the EW platform currently on STRYKER vehicles and TEWL is an ES-only capability currently carried on Flyer 72 Ground Mobility Vehicles (GMVs) being provided to infantry units. Says Finch, "These are the items that we currently have that are really informing and connecting the dots for the TLS."

In the first phase of the USAEUR ONS, the PM fielded a vehicle-mounted EW capability called "Sabre Fury" and also a "light version" of the EWPMT tool known as "Raven Claw" primarily for that theater. Finch says they're now "coming back to provide a Phase 2, which will be

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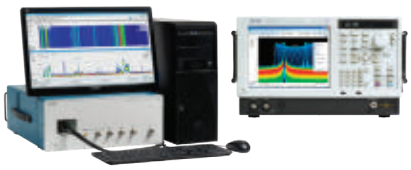

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the TEWS and TEWL capability." TEWS will be going to the Stryker vehicles of the Army's 2nd Cavalry Regiment based in Vilsek, Germany, and the 173rd Airborne Brigade Combat Team in Vicenza, Italy, will get the TEWL capability. Although the USAEUR ONS and CEMA ONS are intended for different locations and at different threats based on the NDS, both involve Raven Claw and TEWS.

Colonel Finch says that over this past summer, the Army conducted what he calls a "campaign of learning." The decision was made to divert equipment that was originally scheduled to go direct to Europe and to give it to 2nd Stryker Brigade Combat Team, 2nd Infantry Division, Joint Base Lewis-McChord, WA, where it was used for a development of experimentation and prototyping (DEMP) event to inform the TLS requirement. The BCT utilized the equipment at three separate exercises – the Joint Warfighting Assessment (JWA) 2019 at Yakima Training Center, WA; a deployment at Camp LeJeune, NC; and at the time of this writing, was completing a National Training Center (NTC) rotation. Says Finch, "Through these exercises, we were able to put the systems into different scenarios to learn DOTMLPF and to get soldier feedback. We learned a lot about how the systems are going to be employed, as well as limitations on the systems and platforms." Throughout the process, Finch says they've been working hand-in-hand with the TRADOC Capability Managers (TCMs), including TCM EW at Fort Gordon, GA, and TCM Terrestrial and Identity at Ft. Huachuca, AZ. "All the feedback and lessons-learned from these exercises are all being folded into the TLS requirement," says Finch.

SUPPORT OF EXISTING EQUIPMENT AND CAPABILITIES

Closely related to "deliver capabilities now," another priority for EW&C is to maintain and improve the Army's current inventory of EW and SIGINT gear. Says Colonel Finch, "We are in no way moving away from providing our full support of existing systems and requirements."

For example, Finch says, "The Counter RCIED EW (CREW)/Duke systems are still as relevant today as when we first fielded them. They're being used in theater, and we're continually working to make sure all of our systems are synched with the targets and continue to pace the threat."

Another example is the Thor III man-packable system. To address the changing threat, PM EW&C awarded a contract to Sierra Nevada (Sparks, NV) to replace and upgrade the Thor III with its "Modi" modular man-packable system. Modi units will be transitioning to the Central Command (CENTCOM) area of responsibility (AOR) over the next year. Says Colonel Finch, "We already have about 30 systems, and are on our way to about 400 for the CENTCOM AOR. While the NDS emphasizes the near-peer threat, and we're definitely addressing this through our ONS programs for the USAEUR and CEMA, we also cannot lose sight of the fact that we still have troops engaged every day in COIN operations, and we're ensuring that we are still addressing that threat as well."

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KEYNOTE SPEAKERS

The Honorable Don Bacon
United States House of Representatives NE-02 (invited)

The Honorable Alan R. Shaffer
Deputy Under Secretary of Defense for Acquisition and Sustainment

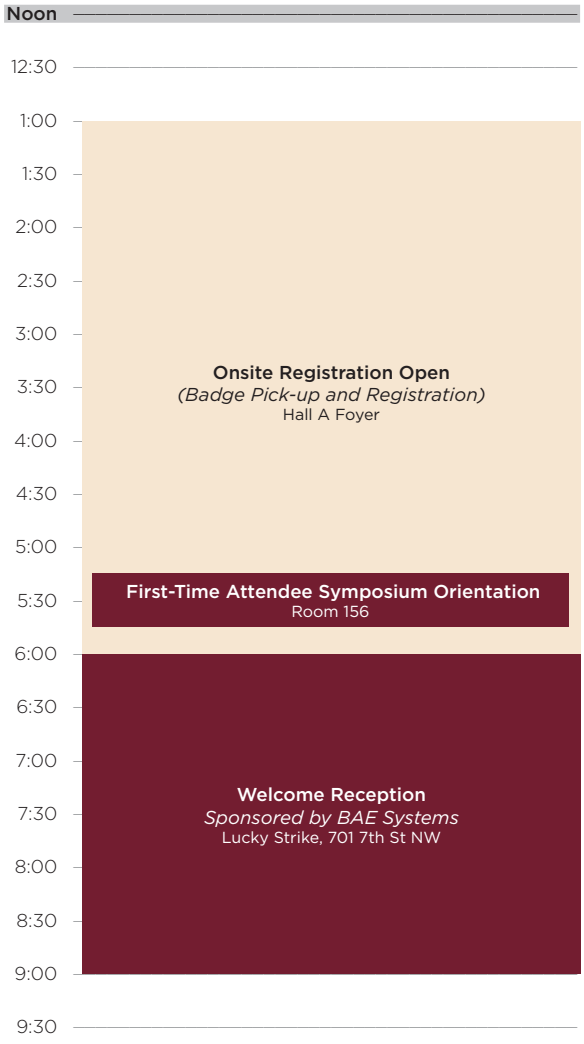
Dr. Tim Grayson
Director, Strategic Technology Office (STO), DARPA

Mr. James A. Faist, SES
Director, Adv. Capability, OUSD Research & Engineering

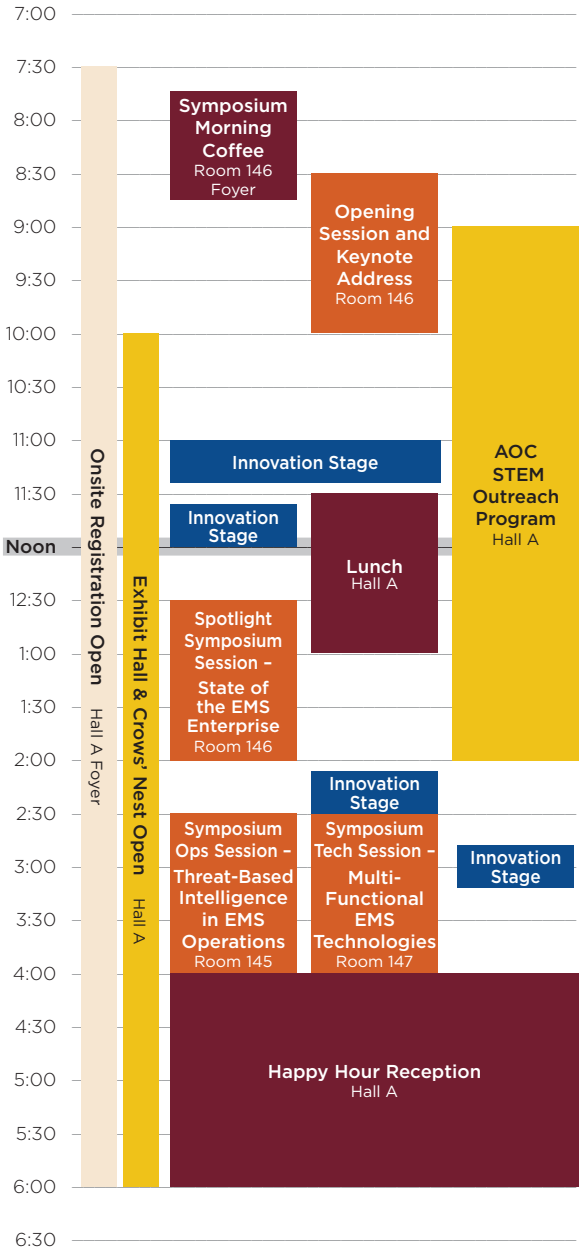
SCHEDULE AT-A-GLANCE

As of September 9, 2019. Subject to change.
All events occur at Walter E. Washington Convention Center unless otherwise noted.

SUNDAY, OCTOBER 27

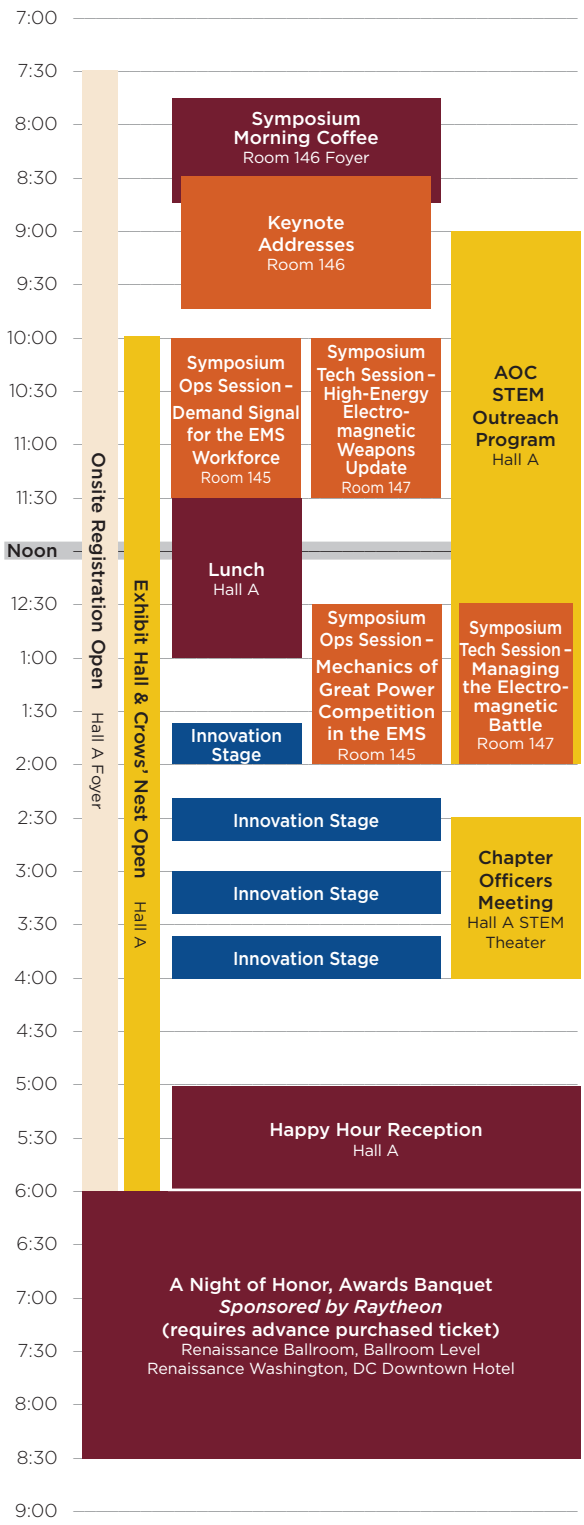


MONDAY, OCTOBER 28

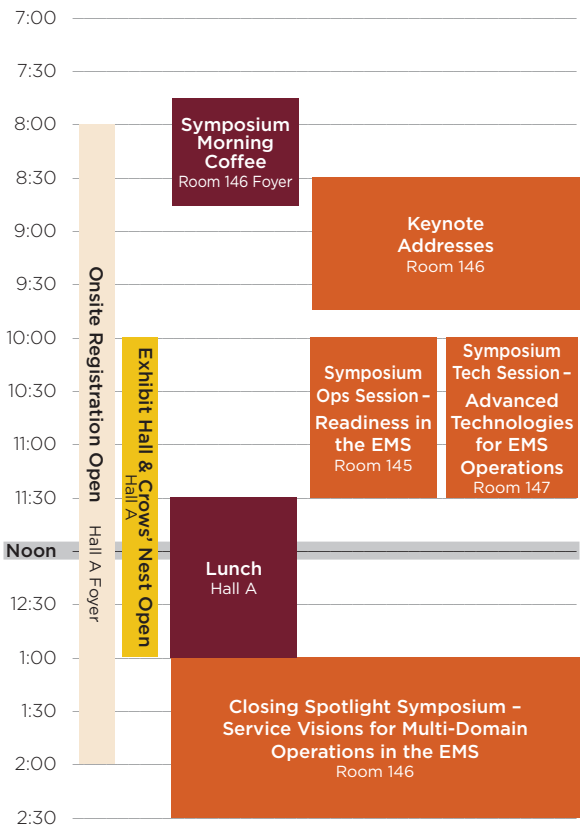


All Innovation Stage Presentations take place in Hall A

TUESDAY, OCTOBER 29



WEDNESDAY, OCTOBER 30



All Innovation Stage Presentations take place in Hall A

Professional Development Courses

(requires advance purchased ticket, available at the registration desk)

Saturday, October 26 – Sunday, October 27
8:00 AM – 5:00 PM

Fundamental Principles of Electronic Warfare
Presented by: Dave Adamy
Renaissance Washington, DC Downtown Hotel, Rm TBD

Machine Learning for EW
Presented by: Kyle Davidson
Renaissance Washington, DC Downtown Hotel, Rm TBD

Thursday, October 31 – Friday, November 1
8:00 AM – 5:00 PM

Advanced Principles of Electronic Warfare
Presented by: Dave Adamy
Renaissance Washington, DC Downtown Hotel, Rm TBD

Electronic Countermeasures—Theory and Design
Presented by: Kyle Davidson
Renaissance Washington, DC Downtown Hotel, Rm TBD

EVENT PRICING AND REGISTRATION INFORMATION

	~~By 7/31~~	8/1-10/4	10/5-On-Site
All Access Industry (Member)	~~$695~~	$795	$895
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Exhibiting companies may purchase their additional ticket in the booth personnel registration portal or via email – cs1@blueskyz.com.

Schedule as of September 16, 2019, subject to change.

Monday, October 28

11:00 - 11:45 AM: **CDR Dick Froderman**, OPNAV N2N6F

12:00 - 12:45 PM: **Lt Col Mike DiMaria**, Chief, EW Strategic Planning, AFLCMC/WNY

1:00 - 1:45 PM: **Mr. Matt Bryant**, Chief Engineer, AFLCMC/WNY

2:00 - 3:30 PM: **COL Kevin Finch, COL Jennifer McAfee, COL Mark Dotson, COL John Transue, COL Francesca Ziemba, Mr. Kenneth Strayer**, PEO IEWS Project Manager/TCMS EW & Cyber

Tuesday, October 29

10:00 - 10:45 AM: **Mr. Roy Fox**, **SES**, US Army Intelligence Center of Excellence

11:00 - 11:45 AM: **COL Kevin Chaney**, Project Manager, PEO IEWS Aircraft Survivability Equipment

12:00 - 12:45 PM: **Paul G. Zablocky**, **Ph.D.**, Program Manager, DARPA STO

1:00 - 1:45 PM: **Capt Jason Denney**, Program Manager, PMA-265

2:00 - 2:45 PM: **Mr. Jon Graves**, AFLCMC/XZ

4:00 - 4:45 PM: **Col Dave W. Burton**, Program Manager Intelligence Systems, Marine Corps Systems Command

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Monday - October 28
presented by: ROHDE&SCHWARZ Make ideas real

To win in the EMS domain requires agility and responsiveness. The dynamic threat environment calls for seamless communication between warfighters and commanders, and the flexibility of a defense force to rapidly insert new technologies and capabilities. Partnerships with defense industry are essential to achieving this goal of developing advanced and integrated capabilities from concepts to fielded systems. With an acclaimed set of international speakers, Monday's sessions brought to you by Rohde & Schwarz will bring together the elements of operations, industry, and how to bridge the linkage for a rapidly changing EW threat environment.

Tuesday - October 29
presented by: KEYSIGHT TECHNOLOGIES

A major gap divides complex EW, radar, and communications systems in the lab from their real-world performance. Verifying capabilities under realistic conditions in the EMS and other domains is of critical importance. Experts at Tuesday's sessions brought to you by Keysight Technologies will delve into coexistence challenges between radar, 5G, and existing communications systems. Additional topics include cognitive EW and the latest cybersecurity techniques for the EMS enterprise.

VISIT 56.CROWS.ORG FOR MORE INFORMATION ON THE 2019 INNOVATION STAGE SCHEDULE AS IT DEVELOPS.

AOC CAREER FAIR

The Association of Old Crows is proud to announce the 2019 AOC Career Fair, held in conjunction with the 56th Annual AOC International Symposium & Convention. The industry's top employers will be showcasing their **current openings** to the largest concentration of **qualified candidates** in the Electromagnetic Warfare community! The Career Fair takes place all 3 days in the Exhibit Hall during official show hours.

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As of September 16, 2019. Subject to change.

MONDAY, OCTOBER 28

8:30 – 10:00 AM
Opening Session, Welcome & Keynote Address

SPEAKERS:

The Honorable Alan R. Shaffer, Deputy Under Secretary of Defense for Acquisition and Sustainment (A&S)

Mr. Stephen "Muddy" Watters, AOC President

Mr. Ray Brousseau, VP & Deputy GM, Electronic Systems Sector, BAE Systems

12:30 – 2:00 PM
Spotlight Session - State of the EMS Enterprise

Against the backdrop of the EMS Operations Cross Functional Team (EMSO CFT) initiated in April, this discussion will provide observations on the status of key components of the emerging EMS Enterprise. How can OSD and Joint-level support to EMS Enterprise Governance enable the EMSO CFT to advance mission focus, materiel acquisition, and manpower capacity issues?

SESSION CHAIR:

Brigadier General Lance Landrum, USAF, Dep Dir, JS Reqmts & Capability Development

SESSION PRESENTERS:

Mr. Chris O'Donnell, SES, DASD, Platform and Weapon Portfolio Management OUSD (A&S)

Mr. Fred Drummond, SES, DASD, Force Education & Tng, OUSD (P&R)

Brigadier General James R. Stevenson Jr., USAF, USSTRATCOM J3E (Joint EMSO Office)

2:30 - 4:00 PM
Ops Symposium Session – Threat-Based Intelligence in EMS Operations

Threat perspectives from the Intelligence Community underpin the EMS Superiority narrative of gaining initiative to create opportunity. This discussion will explore long range emerging threats to the US and its allies; examine the key EM operating concepts of regional powers; and identify institutional challenges to supporting decisive fires and maneuver across the EMS Domain.

SESSION CHAIR:

Captain Mark Alexander, USN, Deputy Director of Integrated Fires, N2N6F3

SESSION PRESENTERS:

Dr. Joseph Kirschbaum, Director, Defense Capabilities and Management Team, U.S. Government Accountability Office

Commander Catherine Deppa, J2E Strategist, USCYBERCOM

Mr. Mike Dahm, Johns Hopkins University Applied Physics Laboratory

2:30 - 4:00 PM
Tech Symposium Session – Multi-Functional EMS Technologies

Requirements for multifunction systems are driven by new operational concepts developed in response to emerging threat capabilities. Multifunction technology has applications across all types of weapons platforms from the very large (such as surface combatants) to the very small (inexpensive, expendable drones and non-kinetic munitions operating in swarms). Yet the challenges we face are not limited to size, weight and power. How will multifunction systems exploit open architectures and machine learning? In the near term, who will develop multifunction systems and how will the Services buy them?

SESSION CHAIR:

Mr. Stephen "Muddy" Watters, AOC President

SESSION PRESENTERS:

Mr. Dean A. Ebert, P.E., Vice President, Central Region Engineering and Sciences, Northrop Grumman Mission Systems

Ms. Laura Cawthron, Assistant Program Manager for the Strategic Electronic Warfare Portfolio, Johns Hopkins University Applied Physics Laboratory

Mr. Anthony Nigara, Vice President, Strategy & Business Development Space & Airborne Systems, L3Harris

TUESDAY, OCTOBER 29

8:30 - 9:45 AM
Keynote Addresses

SPEAKERS:

Mr. James A. Faist, SES, Director, Advanced Capability, OUSD Research & Engineering

Dr. Tim Grayson, Director, Strategic Technology Office (STO), DARPA

10:00 - 11:30 AM
Ops Symposium Session - Demand Signal for the EMS Workforce

As we move away from solving episodic fires problems toward capitalizing on new maneuver opportunities across the EMS, this evolved thinking sheds light on the need to ensure skilled manpower is produced to staff platforms, command staffs, and the new organizational constructs whose need is becoming obvious as a result of this thinking. As the EW Officer/Operator population shrinks in some Services, is there an EMS manpower crisis on the horizon? What skills are we developing within the EMS workforce? This session will look at these issues and more.

SESSION CHAIR:

Mr. Tom Taylor, GS15, EMS Policy & International Engagement, DoD CIO

SESSION PRESENTERS:

Captain Brian "Hinks" Hinkley, USN (Ret), Vice President for EMS Strategic Operations, AECOM

Commander Shelly Frank, USN, Military Faculty at Joint Forces Staff College, National Defense University

Ms. Angela Lane, Deputy Chief, Joint Electromagnetic Spectrum Information Analysis and Fusion, Joint Electronic Warfare Center

10:00 - 11:30 AM
Tech Symposium Session - High-Energy Electromagnetic Weapons Update

Current doctrine and future technology applications for electromagnetic attack will increasingly feature LASER, high-power microwave (HPM), and electromagnetic pulse (EMP) weapons and protective measures. This discussion will give insights to Joint and Service level developments for this emergent technology group.

SESSION CHAIR:

Mr. Mark W. Neice, Executive Director, Directed Energy Professional Society (DEPS)

SESSION PRESENTERS:

Dr. Kelly D. Hammett, SES, Director, Directed Energy Directorate, Air Force Research Laboratory

Dr. Frank E. Peterkin, SES, Distinguished Scientist/Engineer for Directed Energy Naval Surface Warfare Center, Office of Naval Research (ONR)

Dr. Lawrence Grimes, Director, HEL Joint Transition Office

12:30 - 2:00 PM
Ops Symposium Session – Mechanics of Great Power Competition in the EMS

In conflict and contingency operations worldwide, mastery of friendly and adversary participation in the Electromagnetic Spectrum silently yet absolutely underwrites the effectiveness of all theater plans, military capabilities, and culminating options across the range of military operations. This session will touch on concepts for achieving mastery, current trends in EMS warfighting capability, and campaign level modeling.

SESSION CHAIR:

Mr. Bryan Clark, Senior Fellow, CSBA

SESSION PRESENTERS:

Lieutenant Colonel David Mueller, USMC, OSD EMS Operations Cross Functional Team (EMSO CFT)

Captain Ken "Kilo" Parks, USN (Ret), Former Commanding Officer Fleet Information Warfare Command (FICW), Principal Business Development, L3Harris Corp

Mr. Bill Urrego, MITRE

12:30 - 2:00 PM
Tech Symposium Session – Managing the Electromagnetic Battle

Is it possible for our hierarchical, Second Offset fighting force to re-imagine itself enough to create asymmetry at operational scale? This panel will discuss initiatives and methods for underpinning EMS Superiority across or force via deliberate operational control of maneuver, signatures, fires, sensing and participation in the EMS Domain.

SESSION CHAIR:

Dr. John A. Stine, Head of Operations Research, MITRE

SESSION PRESENTERS:

Mr. Alan Rosner, GS15, DISA/DSO

Mr. Christopher McConnell, Civ, Staff Synchronization Officer (SSO): Electronic Warfare, Force Development Intelligence (FDI), DCS G-8, Pentagon

Mr. Jose Perez, Maj, USMC (Ret), EW Analyst, EW Requirements Division, Joint EW Center, USSTRATCOM

6:00 - 8:30 PM
A Night of Honor, Annual Awards Banquet

Celebrate with us on Tuesday from 6:00 – 8:30 PM for our Night of Honor, AOC's Annual Awards Banquet. Each year AOC bestows prestigious awards to individuals and military units who have accomplished outstanding performance in furthering the aims of the Association of Old Crows in support of the United States and Allied Nations in Electromagnetic Spectrum Operations (EMSO) and information-related military activities. While honoring these individuals and units, you will be treated to delicious food, wine, an award presentation and a riveting keynote address.

Note: This event requires a purchased ticket.

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WEDNESDAY, OCTOBER 30

8:30 - 9:45 AM
Keynote Addresses and Congressional Panel

SPEAKERS:

The Honorable James Langevin, U.S. House of Representatives (RI-02); Chairman, Intelligence and Emerging Threats and Capabilities Subcommittee, House Armed Services Committee (invited)

The Honorable Don Bacon, U.S. House of Representatives (NE-02); House Armed Services Committee; House Homeland Security Committee (invited)

PANEL DISCUSSION:

Congressional Perspectives on EW/EMSO in the FY 2020 Defense Budget

Panelists: Coming Soon!

10:00 - 11:30 AM
Ops Symposium Session – Readiness in the EMS

For modern forces, operations in the EMS can no longer be regarded as an array of disparate actions or a consequence of military activities. One aspect of fixing this problem is to define and assess EMSO readiness for the warfighter. This session will discuss how professionals are developing methods, tools, and tracking schema designed for deliberately enhancing and maintaining readiness of the EMS force.

SESSION CHAIR:

Colonel Eric Shafa, USAF, Air Force Chair, Eisenhower School, NDU

SESSION PRESENTERS:

Lieutenant Colonel Matthew E. Poole, USMC, Chief, Electronic Warfare Requirements Division, Joint Electronic Warfare Center

Lieutenant Colonel Gary "Mongo" Lyke, USA, Operations Branch Chief, Joint Electromagnetic Preparedness for Advanced Combat (JEPAC), Nellis AFB

Colonel Craig "Magnum" Harm, USAF (Ret), Association of Old Crows Board of Directors

10:00 - 11:30 AM
Tech Symposium Session – Advanced Technologies for EMS Operations

As EMSO shifts the traditional warfighting discussion from threat-constrained to opportunity-based thinking, new advanced technologies will combine with new operational concepts to serve as the foundation for this disruptive approach. This discussion will touch on dynamic force composition, artificial intelligence, and emergent computing technologies (et al) as they apply to EMS capability superiority.

SESSION CHAIR:

Dr. William Conley, Chief Technology Officer, Mercury

SESSION PRESENTERS:

Colonel William "Dollar" Young, USAF, Special Assistant to the Commander
USAF Warfare Center

Dr. David Stupples, Support to the UK NoD GCHQ, Professor of Electronic and Radio Systems, City University London

Dr. Dan Green, PM for Electronic Warfare, Office of Naval Research

1:00 - 2:30 PM

Spotlight Session – Service Visions for Multi-Domain Operations in the EMS

Service Department program managers are preparing, sustaining, and evolving their capability solutions for making the maximum contribution to Joint Warfighting. This panel will examine senior Service level perspectives, plans, concepts and challenges to populating a robust and decisive EMS capability enterprise.

SESSION CHAIR:

Lieutenant General Robert Elder, USAF (Ret), AOC Senior Advisory Board

SESSION PRESENTERS:

Rear Admiral Steven Parode, USN, OPNAV N2/N6F Warfighting Integration

Brigadier General David Gaedecke, USAF, Director, EMS Superiority, Deputy Chief of Staff for Strategy, Integration & Requirements, HQAF

Brigadier General Robert Collins, USA, Program Executive Officer (PEO) for Intelligence, Electronic Warfare and Sensors (IEW&S)

Photos from the 55th Annual International Symposium & Convention

PHOTOS BY DAVID KEITH

AOC PROFESSIONAL DEVELOPMENT COURSES

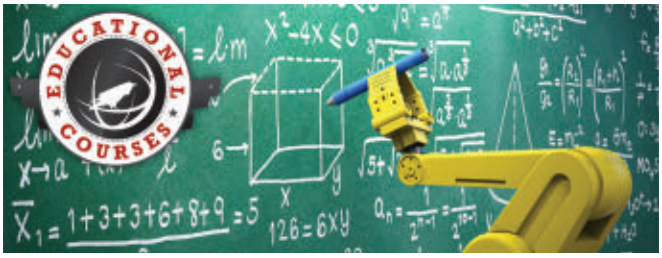
Every year, the Association of Old Crows holds professional development courses immediately following the Annual Symposium & Convention. This year, the AOC will be holding four very valuable courses for two days before this year's event and two days following it. Access to these courses is NOT included in the price of symposium registration and is a separate fee. Learn more about the courses below.

October 26-27, 2019

Fundamental Principles of Electronic Warfare

Presented by: Dave Adamy

This is a two day overview of Electronic Warfare (EW) with little math above Algebra. It assumes no prior knowledge of the field, but will allow you to understanding the underlying principles of EW and make some important performance calculations. Examples are: The range at which an enemy radar can be intercepted, the jamming to signal (J/S) ratio that can be achieved with a particular jammer against a particular radar or hostile communication threat as a function of a particular engagement.



Machine Learning for EW

Presented by: Kyle Davidson

This course introduces students to the fundamentals of machine learning and its application to modern EW and cyber solutions. Commencing with an overview of machine learning, and its recent evolution into deep learning, the course focuses on providing an education in how these algorithms work and training on how to apply them in an EW context. The course contains four major topics: introduction to machine learning, classification using neural networks, training machine learning systems for EW, and developing solutions using machine learning for EW.

October 31-November 1, 2019

Advanced Principles of Electronic Warfare

Presented by: Dave Adamy

This is a follow-on overview course to the EW Fundamentals course presented at the beginning of the AOC convention. It builds on the earlier discussion, extending coverage to new generation radar and communication threats and countermeasures against them.

Electronic Countermeasures – Theory and Design

Presented by: Kyle Davidson

The goal of this course is to educate the participants in the field of Electronic Countermeasures (ECM) and Electronic Attacks (EA). This includes the complete countermeasures development cycle, from analyzing threat systems to developing jammer techniques, and finally confirming their effectiveness.

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THE PERCEPTION PROBLEM

By John Knowles

A couple of years ago, I was part of a group that was providing EW briefings to some Military Legislative Aides (MLAs) on Capitol Hill. It was a Friday morning, when the House members were back home in their districts for the weekend and their MLAs were free to meet in one of the committee hearing rooms. In the hallway outside the briefing room, we had placed some recent EW reports and articles – including one about maneuver in the EM Domain – on a table so that staffers could grab some extra information.

fter the briefing, as we were filing out of the hearing room and into the hallway outside, we crossed paths with another group – mostly Air Force officers – which was waiting to go into the hearing room for their meeting, which was about training for cyberspace operations. I noticed a couple of the younger officers looking at the EW literature we had placed on the table. As I walked past them, I overheard one ask the other, quite honestly and a bit disdainfully, "Maneuver in the EMS? How do you *maneuver* in the EMS?" It was a telling moment that captured how many military professionals – especially those in the cyber community – perceive the EM Domain. For them, the EM Domain is simply a utility that primarily exists for transporting electronically generated data packets. Some might even argue that the EM Domain is merely a part of the Information Environment, because cyber systems use the EM Domain to move information.

The problem is that this perception about the EM Domain is simply wrong. The EM Domain in a strategic maneuver space that is characterized by radiant analog energy – not data or information in digital form. It is worth spending some time digging into this myth, because it reveals why so many defense leaders are reluctant to recognize the EM Domain as a major warfighting domain.

THE TECHNOLOGY LENS

From its early days in World War II, and right through to the present day, electronic warfare (EW) has been named for a specific group of electronic systems that we use to receive and send signals through the EM Domain. Beginning in World War II, as radar and radio became more important to warfare, the ability to deny the enemy access to the EM Domain, and simultaneously protect friendly access to the EM Domain, became more important. In those early days, however, military leaders did not see these operations as a form of maneuver in a unique space defined by physics. Instead, they perceived it primarily as a technology competition, and so it became known as electronic warfare – named for the electronic systems (radar, radio and EW) that they were using. This is akin to renaming air warfare as fighter warfare or bomber warfare or renaming naval warfare as destroyer warfare or cruiser warfare. In this mode of thinking, the technology defines the domain.

From World War II until today, EW has been primarily associated with a "black box" or a pod under the wing of an aircraft. In short, EW sounds like it is merely a "tool" for sensing and jamming other electronic black boxes, such as radars, radios, or GPS receivers. If we talk about EW personnel, we immediately conjure up an image of an EW operator – someone in the rear seat of a Growler or in the back seat of a HMMWV – who is using one kind of black box (an EW system) to defeat an adversary's black box (a radar, a radio, etc.). In short, many people perceive EW primarily through a technology lens, mainly because EW is named for electronics technology. The EM Domain, by association, is seen primarily through a technology lens, as well.

This perception immediately changes if we rename *electronic* warfare and instead begin referring to *electromagnetic* warfare (EMW). The term, "electromagnetic," re-orients everyone's perception because it evokes the physical space (i.e., the EM Domain) through which the operator is maneuvering rather than the technology he or she is employing. Subtle but profound. It also aligns EMW with air warfare, land warfare, etc.

THE "C" WORD

So, why does this matter? What is so wrong about viewing the EM Domain through a technology lens? Well, for one thing, when we view the EM Domain through a technology lens, we fail to recognize and appreciate the many ways that we use it. We shrink its scope by thinking about the EM Domain mainly in terms of the electromagnetic technologies that we use to maneuver through it. Yes, we use radars, radios, and GPS systems to maneuver in the EM Domain. But, long before these electromagnetic systems were created, humans used their eyes as their primary electromagnetic sensor to facilitate just about everything we do, including hunting and fighting. And through our skin, we sense the sun's electromagnetic energy. In an effort to exploit this physiological trait, we have developed and fielded microwave systems, such as the Active De-

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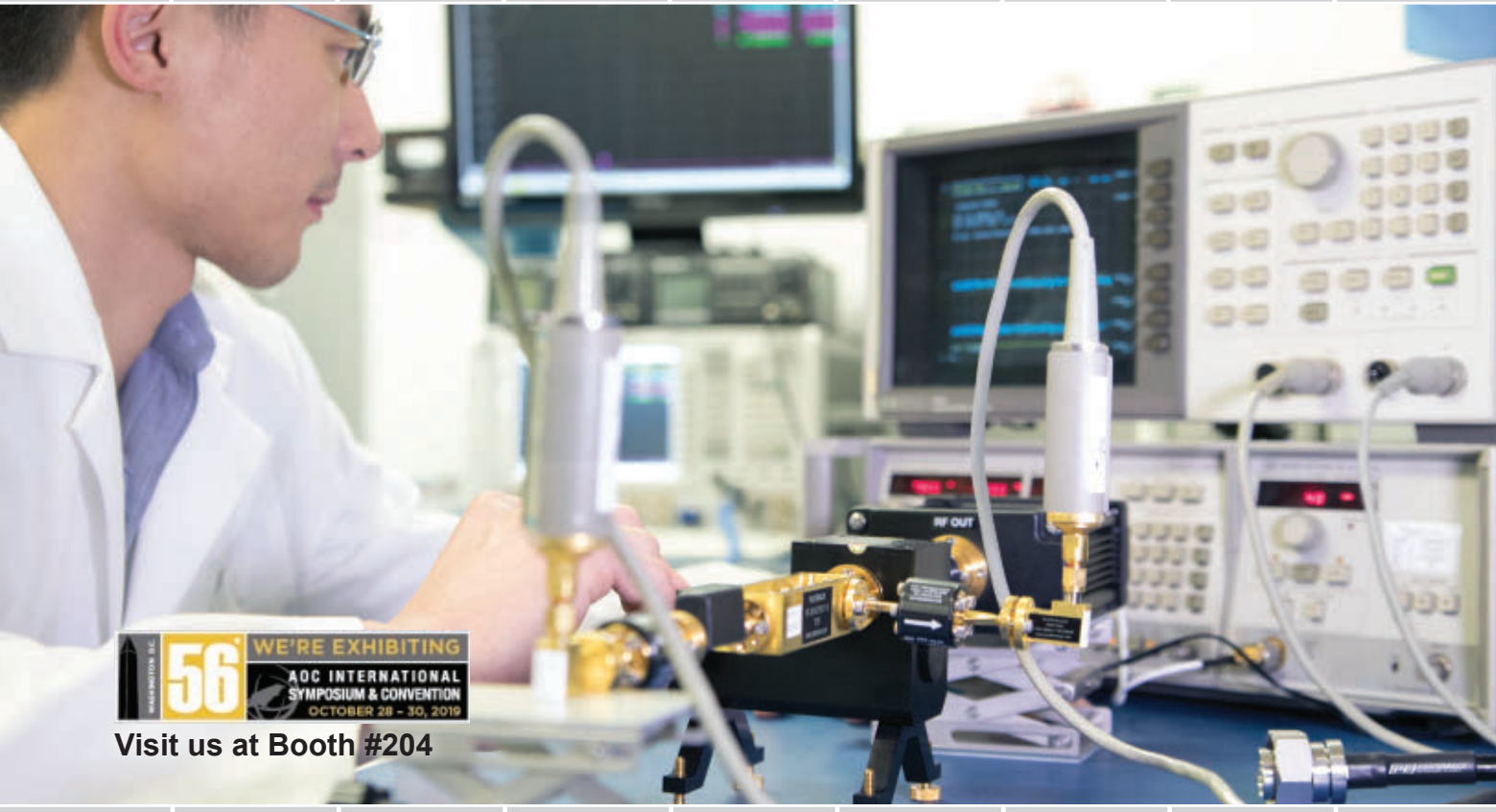

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nial System, which generates a 95-GHz signal that creates a burning sensation on your skin. The point is that there is no implicit relationship between the EM Domain and electromagnetic technologies. The EM Domain is certainly not a man-made maneuver space that is defined by electronic technologies.

When we stumble into the erroneous concept of a technologically-defined EM Domain, we feed the mistaken idea that the EM Domain and the Cyberspace Domain are not only "two sides of the same coin" but that they are somehow "converging." Let's take a moment to unpack this idea.

"Convergence" is an extremely loaded and misused term. In general, "convergence" means two things becoming one. There is certainly technological convergence between cyber systems and electromagnetic systems, as evidenced by radars, EO/IR sensors and EW systems sharing, fusing and correlating sensor data over an information network. But, as we have stated, the EM Domain is not defined by technology, so this technological convergence is not driving domain convergence. Two physically distinct domains cannot converge. If technological convergence could, in fact, drive domain convergence, then aircraft carriers (planes flying from ships) would have driven convergence between the Air Domain and Naval Domain many decades ago.

There is also a convergence of effects, in the sense that different tools operating in different domains can achieve similar effects on the same target. For example, a radar in an air defense system can be disabled by jamming from an EW system. The radar might also be disabled by a cyber attack. These are both non-kinetic means for defeating the radar, but they do not exemplify convergence between the EM Domain and cyberspace. They are merely two ways to defeat the radar – one through the EM Domain and one through the Cyberspace Domain. (In this example, we may be using the EM Domain to deliver a cyber effect. Yet this still isn't driving domain convergence. Again, think of the aircraft carrier example above.) You could also drop a JDAM on the radar and physically destroy it. Yet no one would say that cyberspace, the EM Domain and the Air Domain are converging, just because all three domains were used to deliver effects to disable the radar. So, to summarize, effects cannot drive domain convergence either.

When we use the word, "convergence," we should be very precise in our language and explain if we are referring to technological convergence or effects convergence. Too often, writers and speakers use "convergence" as a general term on its own to imply domain convergence between cyberspace and the EM Domain or some general concept of mission convergence between cyber operations and EMS operations. This is sloppy language, and it leads to sloppy thinking. Again, if you start off on the wrong foot and perceive the EM Domain through a technology lens, then it is easy to fall into this logic trap. So, how can this be avoided? Next month, we will continue this discussion and talk about a better way to look at the EM Domain.

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08:00 – 17:00 EDT | Oct 31 – Nov 1, 2019

Machine Learning for Electronic Warfare

Kyle Davidson
Saturday & Sunday
08:00 – 17:00 EDT | October 26 – 27, 2019

Electronic Countermeasures—Theory and Design

Kyle Davidson
Thursday & Friday
08:00 – 17:00 EDT | Oct 31 – Nov 1, 2019

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New EA Techniques Part 9

Impact of Pulse Compression on Self- Protection Jamming

By Dave Adamy

PULSE COMPRESSION

The nominal purpose of pulse compression is to improve the range resolution of long-range radars. For decades, the long-range anti-aircraft weapon radars have been acquisition radars such as SPOON REST or FLAT FACE. They achieve their long range with high transmitter power and long pulse duration. Radars work on energy, and the long pulses allow high skin-return energy. Energy is power multiplied by the time over which it is applied. The problem is that the range resolution is given by:

pulse width x the speed of light ÷ 2

Thus, the range resolution is significantly degraded for long pulses, so a radar with long pulses has difficulty detecting the presence of multiple targets, and its handoff of targets to other (typically tracking) radars may not have adequate accuracy.

For the radar, pulse compression reduces the effective pulse duration during processing. It can be achieved by frequency modulation (chirp) or phase shift keying (Barker Code), and it significantly improves range resolution. Chirp has been used for many years on long-range acquisition radars, and it is now also used on some tracking radars. Since this is the first approach employed, we will discuss it first.

This technique is called chirp because the frequency modulated pulses sound like a bird chirping when received by some kinds of receivers. As shown in **Figure 1,** chirp involves adding a linear frequency modulation over the duration of the transmitted pulse. This is called "Linear Frequency Modulation on Pulse," abbreviated as LFMOP. The received skin return pulse is passed through a so called "compressive filter" that delays the signal as a function of the instantaneous radio frequency. The frequency modulation slope (frequency vs. time) matches the delay vs. frequency of the compressive receiver.

The compressive filter can be designed for maximum delay with highest frequency or vice-versa. In this example, the pulse starts at the highest frequency and slopes down. Thus, when the pulse enters the compressive filter, it has the maximum delay (to the end of the pulse). Then, as the frequency of the pulse reduces, the reduced delay is still to the end of the pulse. The cumulative effect is to output a much narrower pulse from the compressive filter, as shown in the figure. Thus the pulse is compressed.

The compression factor is the total range of frequency modulation divided by the inverse of the characteristic bandwidth of the radar. The characteristic bandwidth is one over the pulse width.

The compression factor can be calculated as:

$$\text{Compression} = \frac{\text{FM Excursion}}{1/\text{Pulse Width}}$$

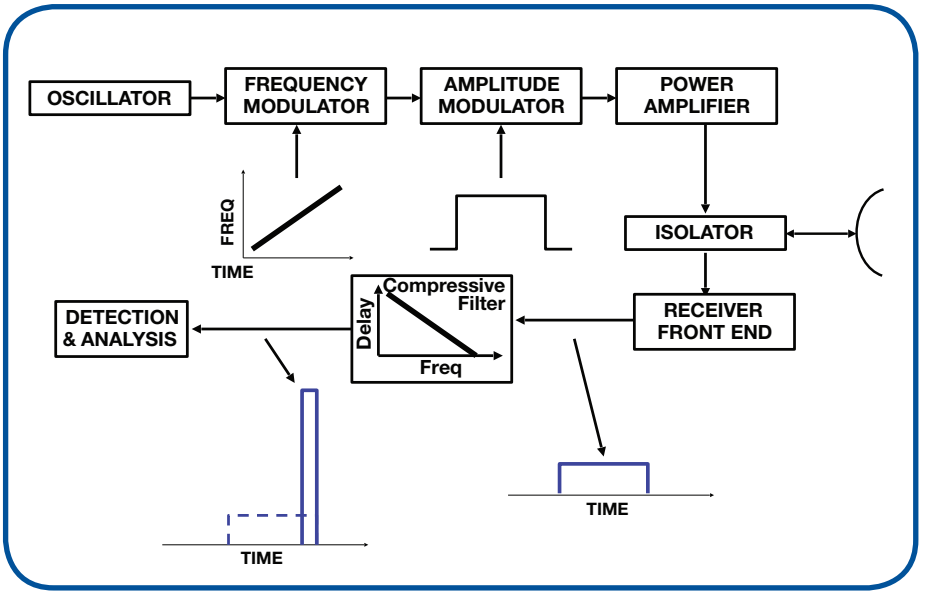

Figure 1. A chirped radar signal has a linear frequency modulation on its pulse which allows the received pulse to be shortened in receiver processing.

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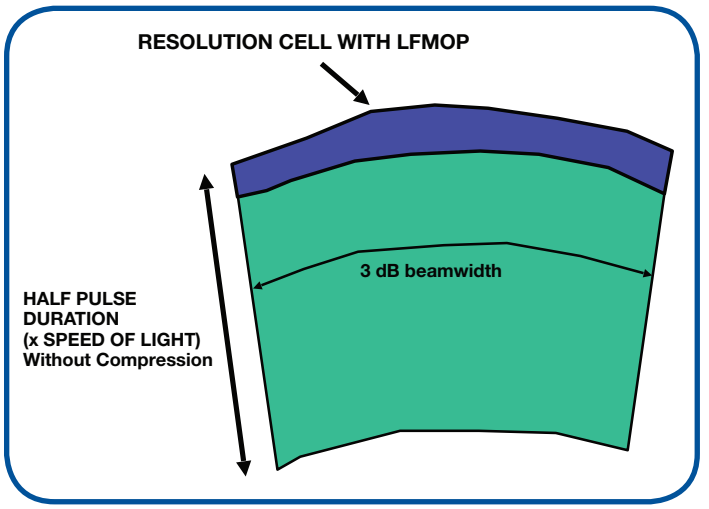

Figure 2. The radar's resolution cell is determined by the antenna beamwidth and the pulse duration. With LFMOP, the effective pulse duration is significantly reduced.

Also shown in this figure, is the reduced resolution cell dimensions when LFMOP modulation is applied. With this chirp modulation, the range resolution is reduced by a factor of 100, to 15 meters.

Consider this in the context of defense of an aircraft with a towed decoy following the aircraft on a 50-meter tow cable as shown in **Figure 3.** Without the compression, the hostile radar could not separate the decoy return from the aircraft return, so the decoy could capture the radar's tracking function and seduce the missile away from its target. However, with 15-meter resolution, the radar could see two returns – the aircraft and the decoy – as shown in the figure and would continue to track the leading return (i.e., its intended aircraft target)

The second purpose of pulse compression is to provide electronic protection (EP). As shown in **Figure 4** (and also in Figure 1 above), the energy of the compressed pulse is concentrated into the last part of the pulse during processing, and the processing part of the radar is optimized to this reduced processing window. Thus, a jamming pulse without the chirp waveform would effectively lose a percentage of its energy equal to the compression factor as shown in Figure 4. This would reduce the effective jamming-to-signal ratio by the compression factor. For this example, the compression factor is 100, so the J/S is reduced by 20 dB. In EW literature, it is stated that the compression factor can be as much as 1000, which would reduce the J/S produced by a jammer without matching chirp by 30 dB.

For example, if a 10-microsecond pulse has a 10-MHz frequency modulation excursion applied, the amount of compression would be 10 MHz/100 kHz or a factor of 100.

THE RESOLUTION CELL

The radar's resolution cell is shown (in two dimensions) in **Figure 2.** This is the area in which the radar can determine whether there is one target or more than one target present. In this example, the width of this cell is the 3-dB beam width of the radar antenna, and its depth is half of the pulse duration multiplied by the speed of light. Without compression, the range resolution for this signal would be:

5 µsec x 3 x 108 m/sec = 1500 meters

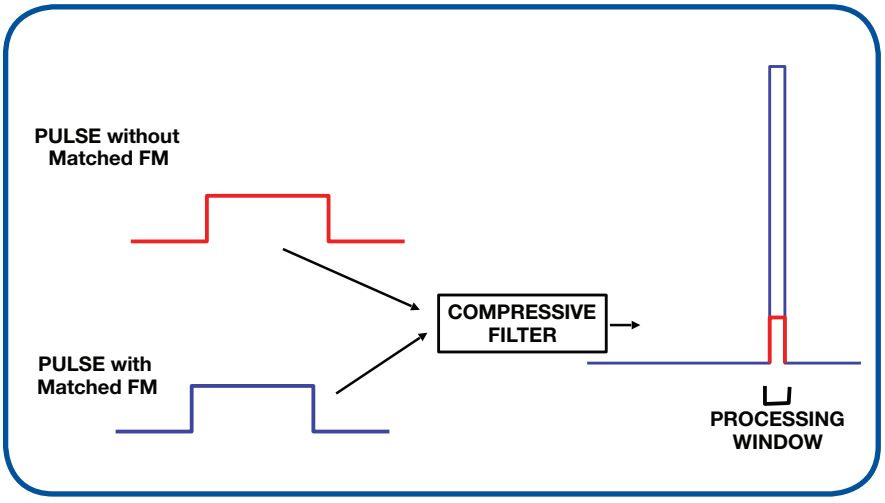

Figure 4. Unless jamming has the correct frequency slope, the effective J/S is reduced by the compression factor.

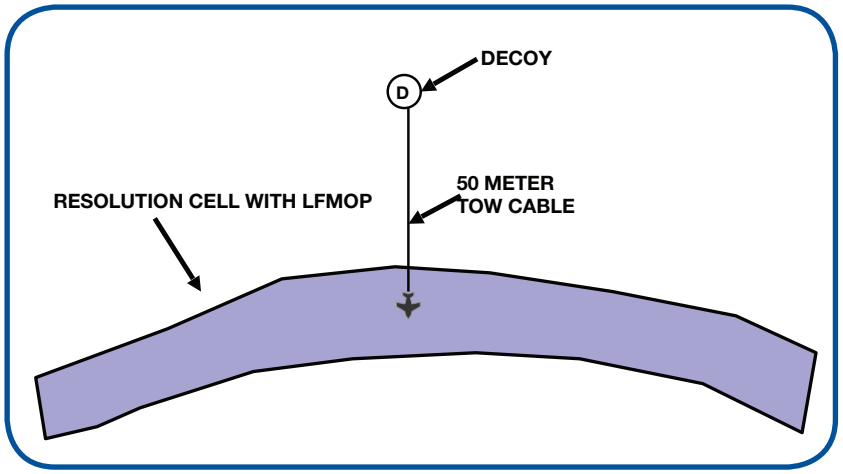

Figure 3. With pulse compression, the depth of the cell in this example is narrow enough that the radar can see both the plane and the towed decoy.

WHAT'S NEXT

Next month we will continue our coverage of the impact of pulse compression by discussing the "Barker Code" technique. For your comments and suggestions, Dave Adamy can be reached at dave@lynxpub.com.

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ULTRA-WIDEBAND DIRECTIONAL COUPLER

Krytar has introduced a new compact, ultra-wideband directional coupler for use in EW, radar, signal monitoring and measurement, antenna beamforming, communications and testing applications. The coupler, Model 106040010, operates over a 6-40 GHz frequency range, with 10dB Nominal Coupling and ±0.6 dB frequency sensitivity. This coupler measures 1.40 (L) x .45 (W) x .69 (H) in. *KRYTAR, Inc.; Sunnyvale, CA, USA; +1 877-734-5999; www.krytar.com.*

TRAVELING WAVE TUBE AMPLIFIERS (TWTAS)

dB Control has released two new rack-mount continuous wave (CW) traveling wave tube amplifiers (TWTAs), with applications in EW simulation, RFI susceptibility testing and RF components testing. The two new TWTAs include the dB-4345 S/C-band TWTA, operating between 2-6 GHz at 325W CW, and the dB-4311M I/J-band TWTA, operating between 6-18 GHz at 300W CW. *dB Control; Fremont, CA, USA; +1 510-656-2325; www.dBcontrol.com.*

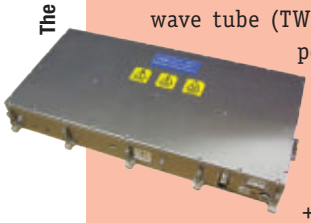
HANDHELD MICROWAVE ANALYZER

Keysight has announced the release of a next-generation series of handheld microwave analyzers, the FieldFox B-series, which offer wide band, gap-free, real-time spectrum analysis for electronic warfare (EW) testing. The B-series FieldFox analyzers offer a 100 MHz bandwidth and a 10dB improvement in displayed average noise level (DANL) for low noise signals measurement and weak interference detection. *Keysight Technologies, Inc.; Santa Rosa, CA, USA; +1 800-829-4444; www.keysight.com.*

WIDEBAND GAN POWER AMPLIFIER

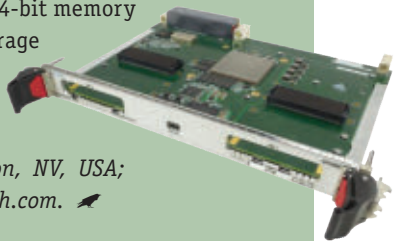
Qorvo has released the 10W TGA2222 wideband GaN power amplifier, covering a 32-38 GHz frequency range. The TGA2222 provides 40 dBm of saturated output power with 16 dB of large-signal gain, and achieves more than 22 percent power-added efficiency. Applications for this power amplifier include EW, radar and communications. *Qorvo; Greensboro, NC, USA; +1 336-664-1233; www.qorvo.com.*

MICROWAVE POWER MODULE (MPM)



TMD Technologies has announced the release of the PTX8807 microwave power module (MPM), intended for EW and radar systems applications. The PTX8807 MPM combines a high-power, Ka band helix mini traveling wave tube (TWT) with a high density switch mode power supply, allowing for a smaller system size in a single unit. This MPM operates at various frequency range options, from 26.5-40 GHz. *TMD Technologies Ltd; Hayes, UK; +44 20 8573 5555; www.tmd.co.uk.*

6U VPX DIGITAL SIGNAL PROCESSING BOARD



VadaTech has introduced the VPX580, a 6U VPX digital signal processing (DSP) blade suitable for radar, sensor management and signals intelligence applications. The VPX580 is based on the Xilinx UltraScale+ XCZU19EG FPGA carrier board with dual FMC+ sites. The boards provide 8GB of DDR4 through a 64-bit memory channel, allowing for the storage of large buffer sizes during processing and for queueing data to a host processor. *VadaTech, Inc.; Henderson, NV, USA; +1 702-896-3337; www.vadatech.com.*

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The VIAVI Ranger VSAG

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GREEN JACKET ROOST LANDS AT TECHNET AUGUSTA 2019

The Green Jacket Roost hosted the first ever Association of Old Crows Booth during the recent Augusta TechNet Augusta 2019. Over 4,000 attendees collaborated across Information Warfare consisting of Communications, Cyber, EW and Spectrum Management. With assistance from the U.S. Army Cyber Center of Excellence and industry experts, the conference is designed to open the lines of communication and facilitate networking, education and problem solving. Leaders and operators also discussed the procurement challenges the military, government, and industry face during a time of uncertain budgets and runaway technology advances.

As part of the event, the Green Jacket Roost also conducted a membership drive resulting in over 50 new members for the AOC (34 of those for the Green Jacket Roost). The AOC booth was well received, and the Green Jacket Roost would like to thank both the AOC National Membership Director, Glorianne O'Nielin, and the Southern Regional Director, Karen Brigance, for their outstanding support. Additionally, we want to thank Lisa Fruge from the Dixie Crow Chapter for her assistance. Job well done!

– *Dennis Leanhart/Keith Cantrell, Green Jacket Roost*

PALMETTO ROOST ESTABLISHES ROSEMARY WENCHEL MEMORIAL SCHOLARSHIP

The AOC Palmetto Roost chapter has established the Rosemary Wenchel Memorial Scholarship at Charleston Southern University in honor of Rosemary Wenchel, who served the defense community in various capacities throughout her life. The scholarship will support a female student enrolled in the Bachelor of Science in Cybersecurity program at Charleston Southern University. Mrs. Wenchel was a leader, mentor, and friend to so many, and the Palmetto Roost endeavors to honor her legacy through this scholarship program.

Full scholarship details can be found at www.palmettoroost.org/educational-foundation.

Would you like to make a contribution to this scholarship?

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AFCEA TECHNET BIRTHDAY CELEBRATION

Our AOC Director of Membership, Glorianne O'Neilin, celebrated her birthday in the AOC Booth at AFCEA TechNet on Wednesday, 21 August 2019 with a little help from Karen Brigance, AOC Southern Regional Director and Lisa K. Frugé-Cirilli, AOC Immediate Past President. Go Green Jacket Roost!!!

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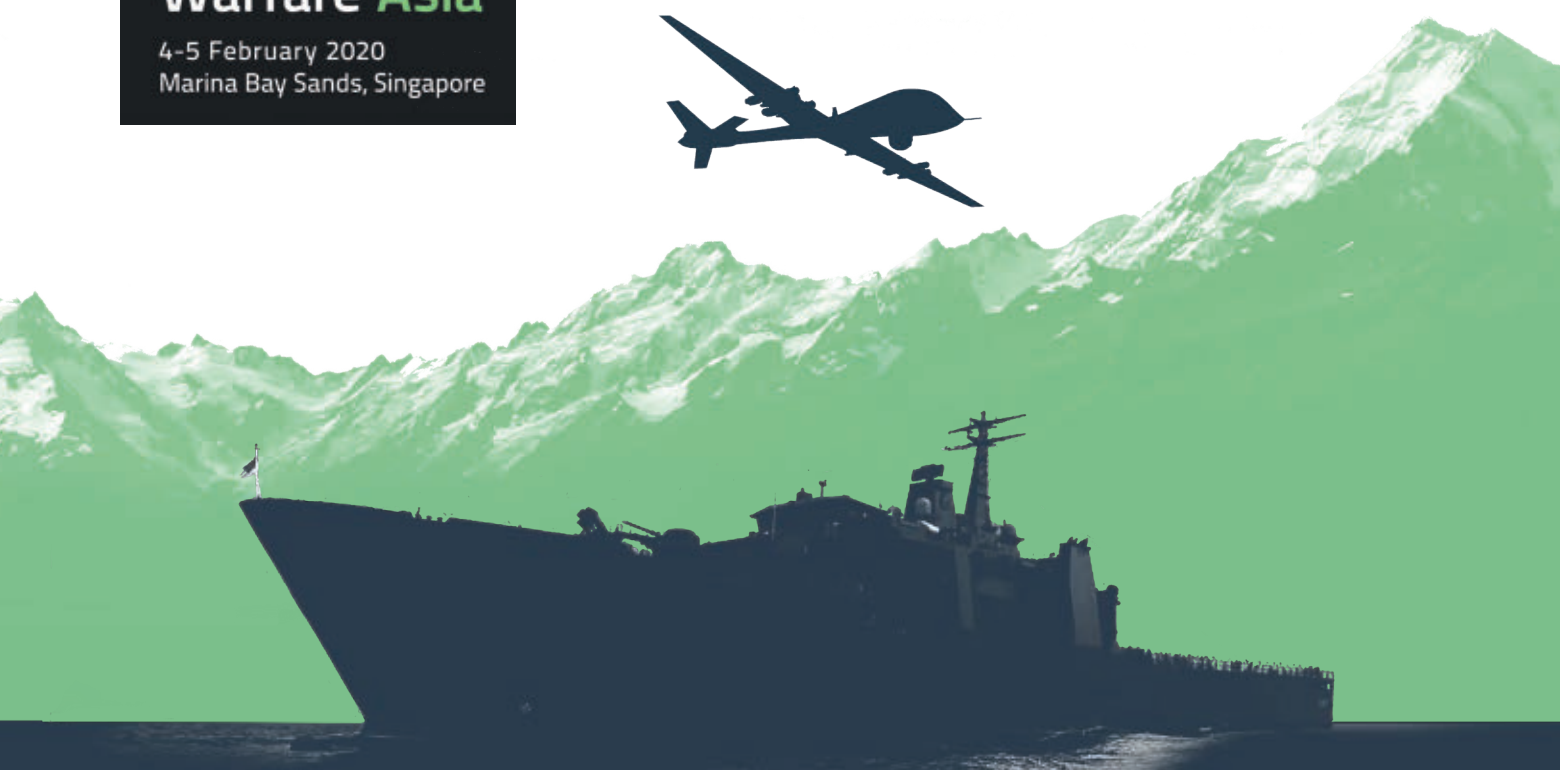

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UNITED STATES POSTAL SERVICE®

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