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December 2021 Vol. 44, No. 12

JED

Journal of Electromagnetic Dominance

US Army Helo ASE

- UK Ground EW
- EW 101: Propagation Formulas
- News: US Space Command Commits to Comms Jamming Upgrade

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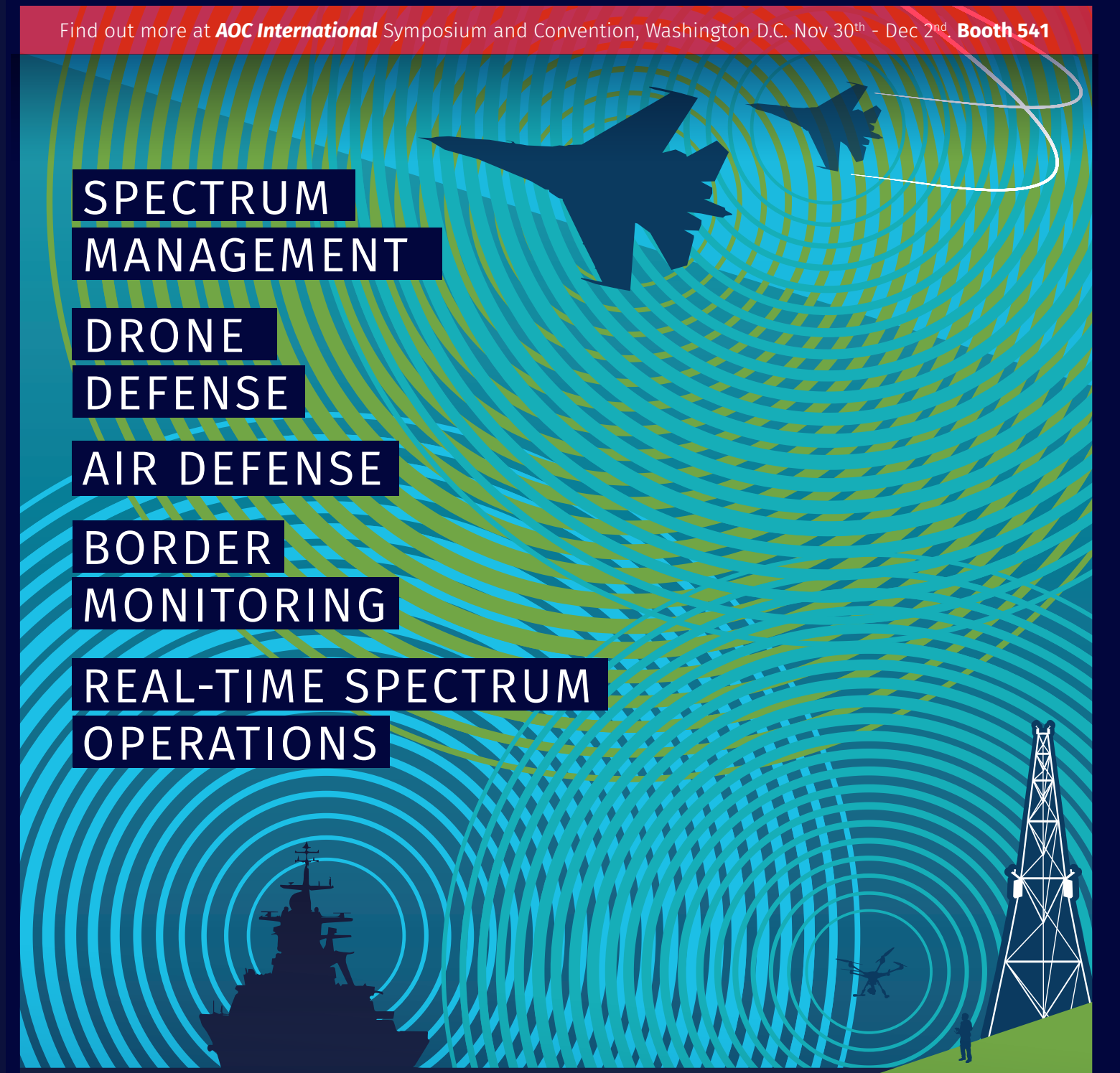

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US ARMY

Members of the 41st Expeditionary Electronic Combat Squadron (41st EECS) pose for a final group photo after the squadron's inactivation ceremony, at Al Dhafra Air Base, United Arab Emirates, Sept 28. The 41st EECS operated the EC-130H Compass Call, conducting 14,753 sorties totaling over ninety thousand hours of flight time for just under twenty years in support of US Central Command. Its sister unit, the 43rd EECS, inactivated at Ali Al Salem Air Base, Kuwait, in September 2019.

US AIR FORCE PHOTO BY MSGT WOLFRAM M. STUMPF

Departments

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GROUND EW

As I look back on 2021, one area where *JED* has focused a lot of its attention this past year is ground electronic warfare (EW). We have published several news articles and feature stories about ground vehicle active protection systems; Terrestrial Layer System (TLS) and C5/ISR Modular Open Suite of Standards (CMOSS); camouflage, concealment and deception (CCD); counter-small unmanned aerial systems (C-sUAS); and air and missile defense (AMD). This month's *JED* includes a pair of articles about US Army Aircraft Survivability Equipment (ASE) programs a report from the AOC Europe conference on the British Army's approach to EW. Why have we been so focused on ground EW? Because there are so many important ground-related EMSO developments taking place.

Three major threat trends are driving interest in ground EW. First, Russia, China and other potential adversaries are deploying a new generation of short- and medium-range surface-to-air missile (SAM) systems to protect their armored units. This is not a new concept, but these threats feature advanced radar and IR sensors, as well as robust C2 networks to link them into formidable integrated air defense systems. In response, western armies are looking at ways to upgrade the ASE suites on their rotary-wing platforms.

Another important trend is the continued evolution of Russian and Chinese communications EW capabilities. The past 20 years saw many western armies grow used to the permissive electromagnetic operating environments in Afghanistan and Iraq. While insurgents were effective at using remote-controlled improvised explosive devices (RCIEDs), they were not equipped to intercept and jam military communications. Russia and China, however, understand that developing communications EW is central to challenging western armies, which depend heavily on their command and control networks.

Finally, the continuing evolution and proliferation of cheap commercial drones – equipped with sensors and modified to carry munitions – is posing a unique challenge for air defense units that have relied solely on artillery and missiles for decades. We are seeing the growing capability of adversaries to launch and control swarms of drones that can detect, target and attack ground forces, and this is driving new air defense concepts that utilize non-kinetic weapons.

Fortunately, ground EW planners have been able to observe Russia's air defense, communications EW and C-sUAS operations in Eastern Ukraine and in Syria. These ongoing conflicts have provided some idea of how an adversary like Russia will use these capabilities. Within the US Army, for example, this knowledge has helped leaders to sustain focus on helicopter ASE, developing communications systems for contested EM environments and develop C-sUAS systems that use jammers, high-energy lasers and high-power microwaves to defeat drone threats.

It is clear that EMSO is finding applications in many new areas of ground operations. What is even more exciting is there is so much more to write about ground EW developments in 2022. Happy holidays! – *J. Knowles*

JED
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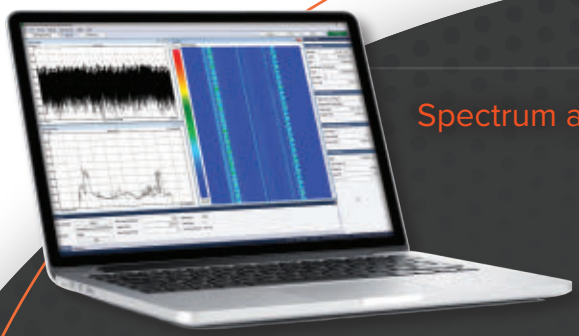

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Calendar *Conferences & Trade Shows*

JANUARY

Surface Navy Association 34th Annual National Symposium
Jan. 11-13
Arlington, VA
www.navysna.org

Asian Defense and Security (ADAS) 2022
Jan. 19-21
Manila, Philippines
www.adas.ph

DSEI Japan
Jan. 26-28
Makuhari Messe, Japan
www.dsei-japan.com

FEBRUARY

Modern Threats: Surface-to-Air Missile Systems Conference
Feb. 1-2
Secret / US Only
Redstone Arsenal, AL
www.crows.org

DEPS Joint Conference on T&E Support to Prototyping and Experimentation
Feb. 1-3
Albuquerque, NM
www.deps.org

Singapore Airshow
Feb. 15-20
Singapore
www.singaporeairshow.com

WEST 2022
Feb. 16-18
San Diego, CA
www.westconference.org

MARCH

AFA Aerospace Warfare Symposium
March 2-4
Orlando, FL
www.afa.org

Defexpo 2022
March 11-13
Gandhinagar, Gujarat, India
defexpoindia.in

Dixie Crow Symposium 46
March 20-23
Warner Robins, GA
www.dixiecrowsympsoium.com

DIMDEX 2022
March 21-23
Doha, Qatar
www.dimdex.com

IEEE Radar Conference
March 21-25
New York, NY
www.radarconf2022.org

Defence Services Asia
March 28-31
Kuala Lumpur, Malaysia
www.dsaexhibition.com

APRIL

AAAA Mission Solutions Summit
April 3-5
Nashville, TN
www.quad-a.org

Navy League Sea-Air-Space
April 4-6
National Harbor, MD
www.seaairspace.org

MAY

Cyber Electrometric Activities (CEMA) 2022
May 3-5
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*AOC conferences are noted in **red**. For more info or to register, visit crows.org. Items in **blue** denote AOC Chapter events.*

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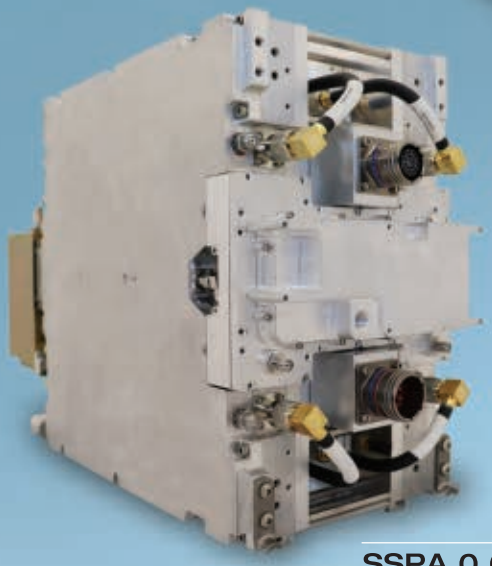

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Calendar *Courses & Seminars*

DECEMBER

AOC Professional Development Course: Machine Learning for Electronic Warfare
Dec. 3-4
Washington, DC
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AOC Professional Development Course: Space Electronic Warfare
Dec. 3-4
Washington, DC
www.crows.org

AOC Professional Development Course: Introduction to Satellite Communications (Satcom)
Dec. 6-10 (3 sessions)
www.crows.org

Infrared Countermeasures
Dec. 7-10
Atlanta, GA
www.pe.gatech.edu

JANUARY

Electro-Optic and Infrared Systems (Part 2)
Jan. 10-14
Shrivenham, Swindon, UK
www.cranfield.ac.uk

AOC Virtual Series Webinar: Microwave GPS Spoofing – History and Prevention
Jan. 13
2-3 p.m. EST
www.crows.org

AOC Virtual Series Webinar: Microwave Photonics Improving DRFM Capabilities Against a New Generation of Radars
Jan. 27
2-3 p.m. EST
www.crows.org

Radar EW
Jan. 31 – Feb.4
Shrivenham, Swindon, UK
www.cranfield.ac.uk

FEBRUARY

Communications EW
Feb. 14-18
Shrivenham, Swindon, UK
www.cranfield.ac.uk

AOC Virtual Series Webinar: Tactical ESM
Feb. 24
2-3 p.m. EST
www.crows.org

MARCH

Advanced Radar
March 7-11
Shrivenham, Swindon, UK
www.cranfield.ac.uk

AOC Virtual Series Webinar: How to Use Simulation to Align Your Work Team
March 10
2-3 p.m. EST
www.crows.org

Aircraft Survivability
March 14-18
Shrivenham, Swindon, UK
www.cranfield.ac.uk

Counter IED Capability
March 21-25
Shrivenham, Swindon, UK
www.cranfield.ac.uk

APRIL

AOC Virtual Series Webinar: EW and the Moscow Criteria
Apr. 7
2-3 p.m. EST
www.crows.org

*AOC courses are noted in **red**. For more info or to register, visit crows.org. Items in blue denote AOC Chapter courses.*

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A LOOK BACK AT 2021 AND FORWARD TO 2022

Greetings and Happy Hanukkah, Merry Christmas, Happy Kwanzaa and Happy Holidays to all. Where has 2021 gone? Even with the pandemic, this year has been extremely busy – both virtually and in person. The AOC continues to grow and even thrive in spite of COVID-19, and we have big goals for the next five years.

You may be reading this while we are holding our 58th annual symposium and swearing in our 2022 Board of Directors and Board of Governors. I thank Bob Andrews, Rich Wittsruck, Sam Roberts, Keith Everly and Jim "Hook" Pryor for their past service to the Board. I congratulate and welcome our President-elect, Brian "Hinks" Hinkley; Mid-Atlantic Director, Dennis "Mancub" Monahan; Central Director, James Utt; Mountain West Director, Wayne "Loaner" Shaw; and At-Large Directors, Nino Amoroso and Steven Oatman. Bob Andrews will be joining the staff as our International Events Coordinator.

When thinking about improving our outreach and engagement, I think back to my days in Strategic Air Command. Our crews were finely tuned and trained aviators. The wing worked as an integrated team that enabled the aircrews to fly: our maintenance teams ensured we had good aircraft to fly, logistics ensured we had the fuel and supplies, the flight kitchen provided us food, and the Security police protected the airfield and jets. The weapons loaders ensured that weapons were built and loaded properly. As a B-52 crew member, I remember flying low level at night, in mountainous terrain, facing backwards in the dark with no windows scanning the various displays and equipment, manipulating switches and knobs to defend the aircraft against surface-to-air and air-to-air threats, performing practice bombing runs at Ashland (near Loring AFB, ME), Wilder (Idaho), Holbrook (Arizona) and the Strategic Training Route Complex (STRC).

The most fun was live releases at Red Flag. The most stressful and intense was the Operational Readiness Inspection (ORI); we passed or failed as a Wing, and I experienced both the success and failure of these inspections – the littlest detail matters. We learned the most at debriefs and critiques of our missions: what went right, what went wrong and what needed to be improved. Debriefs were open, honest and detailed so that we could learn the most.

I need you, my fellow Crows, to engage as a team (academia, industry, government and military) to help us execute our new five-year strategy to enable AOC to be successful, grow and thrive in the future. We need your help to increase and improve membership engagement and involvement. I need all Crows to engage, openly communicate with your Chapters and their leadership, the Board and myself to ensure we keep the AOC moving forward as the premier EMS organization.

I am looking forward to 2022 and the opportunity to attend more events and conferences in person and visit with AOC chapters around the globe. We will continue to reach out to you with opportunities to mentor, support STEM and grow the next generation of Crows. – *Glenn "Powder" Carlson*

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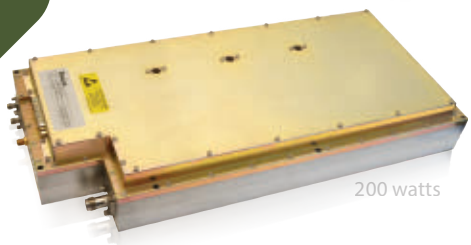

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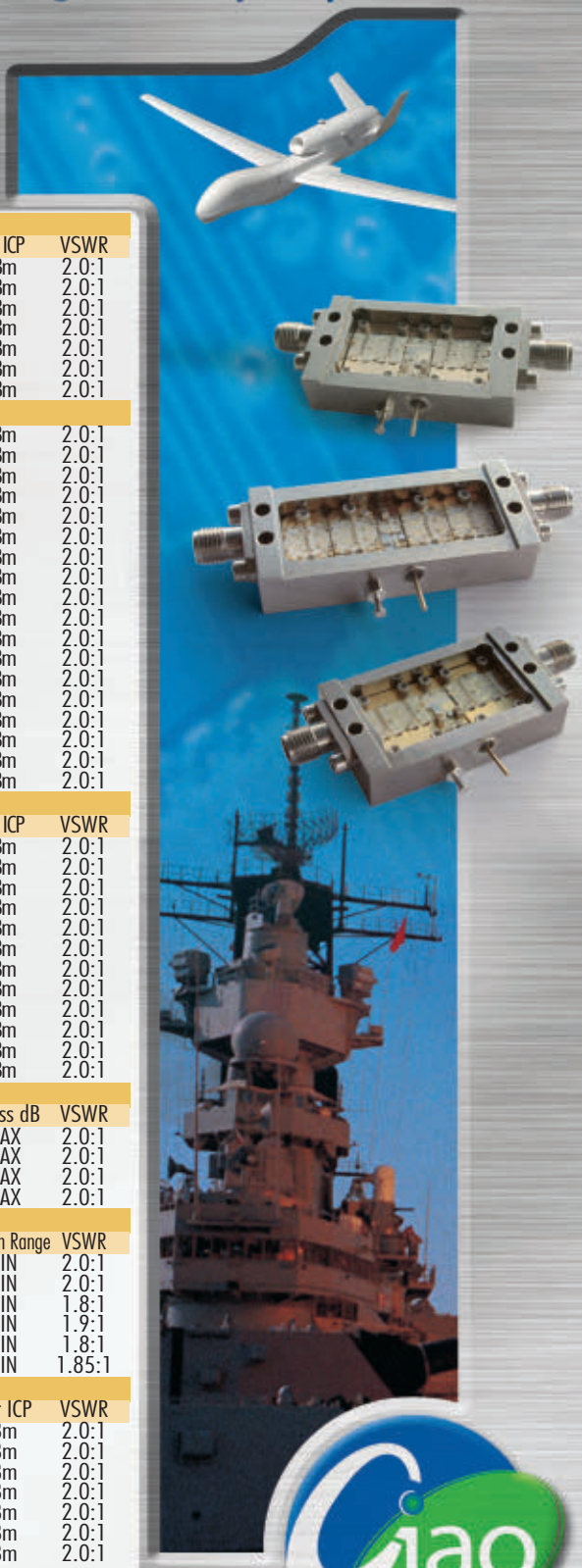

OCTAVE BAND LOW NOISE AMPLIFIERS

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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US SPACE FORCE COMMITS TO MEADOWLANDS PRODUCTION

L3Harris Technologies is to deliver a major upgrade to the Counter Communications System (CCS) ground-based EW system used by the US Space Force to deny adversary satellite communications.

The company was awarded a US$120.8 million contract by the Space Systems Command on for production of the CCS Meadowlands upgrade package. This transitions the existing CCS Block 10.2 system to a more modular and scalable Block 10.3 architecture – reducing the operational footprint from 14 racks of equipment to three or four racks – and introduces additional classified functionality.

Achieving Initial Operating Capability with the US Space Force in March 2020, CCS Block 10.2 constitutes a deployable, ground-based offensive EW capability providing operators with the ability to reversibly deny satellite communications, early warning and propaganda. A total of 16 systems are fielded, operating from Peterson Space Force Base in Colorado, Vandenberg Space Force Base in California, Cape Canaveral Space Force Station in Florida, and classified locations outside the continental United States.

L3Harris is to undertake CCS Meadowlands production in Melbourne, FL. Work is expected to be completed by the end of February 2025. – *R. Scott*

CONGRESS ADVANCES DEFENSE POLICY LEGISLATION

The US House or Representatives and the US Senate are working on their respective versions of the FY2022 National Defense Authorization Act (NDAA), both of which contain several provisions for Electromagnetic Spectrum Operations (EMSO)-related activities. As this issue of *JED* went to press, the House had passed its version of the FY2022 NDAA (drawn up by the House Armed Services Committee (HASC)), and the Senate Armed Services Committee (SASC) had passed its version and forwarded it for consideration from the full Senate. The House and Senate hope to pass a final NDAA by the end of the month.

The House and Senate versions of the NDAA bill (and their respective HASC and SASC NDAA committee reports) address a wide range of EMSO issues. Below is a selection of EMSO items from both committee reports.

Electronic Protection

The HASC report addressed " Assured Communications on Tactical Unmanned Aerial Systems in Highly Contested Environments." It stated: "The committee anticipates that future combat operations will involve increasingly hostile radio frequency environments requiring improved low probability of detection, low probability of intercept, low probability of exploitation, and anti-jam tactical communications capability." It went on to say, "The committee remains interested in continued efforts to mature assured communications technologies. Accordingly, the committee directs the Secretary of the Army, in coordination with Commander, Army Futures Command, to provide a briefing to the House Armed Services Committee not later than March 1, 2022, on plans to accelerate fielding of a next-generation protected wave-form. The briefing shall include the Army's plans to: (1) expand research and development efforts to scale terminals for multiple applications and to address adjacent functions, such as electronic warfare techniques; (2) port to small form-factor radios and demonstrate airborne testing on relevant tactical UAS platforms; (3) augment additional capabilities like multiple-access net- working or burst-mode transmission; (4) optimize processor architecture to improve size, weight, power, and cost; and (5) achieve any other critical next generation features. The briefing should also explain what steps the Department is taking to integrate next-generation secure waveforms with a multi- channel antenna for assured communications."

The HASC report also focused on "Development and Implementation of Digital Technologies for Survivability and Lethality Testing." It wrote, "Survivability and lethality are no longer constrained by simple ballistics and are instead today susceptible to contemporary non-kinetic threats including cyber; electromagnetic spectrum operations; chemical, biological, radiological, nuclear, high yield explosives; and directed energy weapons. These threats can interact in inventive ways to degrade, disable, deceive, and destroy a force or mission, and they can evolve continually. It is imperative that the Secretary of Defense take a whole of systems and whole of lifecycle approach in the identification of these threats and their effects to assess the full spectrum of survivability and lethality of any system.

"Digital technologies, including digital twins and modeling and simulation, have advanced and enable the Department to build high-fidelity models of systems to test and evaluate this full spectrum of threats, perform many more digital tests, and perform continuous vulnerability discovery and mitigation of the most prominent threats throughout the system's lifecycle. Data from physical and digital testing must be collected and fed back into the models to improve their fidelity and value over the system's lifecycle. Additionally, the Department has a legacy fleet with non-kinetic vulnerabilities and should consider model creation when appropriate and necessary. The committee believes the Department will benefit from broadening its view of survivability and lethality testing and evaluation to include non-kinetic threats. The Department should also broaden its view of live fire testing to include digital live fires through models and simulations, which may augment, or in some cases replace, live-testing, and allow for continuous survivability assessments over time. Taken together, these two modernization improvements should provide the foundation for a full spectrum surviv-

ability assessment approach throughout the system's lifecycle."

The SASC also emphasized the importance of electronic protection. Regarding "Multi-spectral sensor detection mitigation for body armor and individual equipment," the SASC report stated, "The committee notes that multi-spectral sensor detection is an emerging threat on the battlefield as near-peer competitors and non-state actors gain access to advanced thermal imagers. Given recent developments in sensor technologies, their increasing proliferation, and the incorporation of multi-spectral sensor detection mitigation in combat uniforms, the committee is concerned the military services are not developing multi-spectral sensor detection mitigation capabilities in body armor and individual equipment. Therefore, the committee directs the Secretary of the Army, in coordination with the Secretary of the Navy and the Secretary of the Air Force, to conduct a feasibility study on incorporating multispectral sensor detection mitigation technologies into body armor and individual equipment."

Other EP provisions in the SASC bill include a recommendation to add $3 million to the Navy's R&D budget (PE 62114N Power Projection Applied Research) to research "graphene electro-active metamaterials." The committee noted that "graphene-based electro-active metamaterials' properties can be tuned in a broad range of frequencies to meet specified performance requirements, including to act as radar absorbing materials for defense systems and platforms."

In a separate section of its report, the SASC recommended "a provision that would require the Director of the Defense Intelligence Agency to provide to the congressional defense and intelligence committees an annual briefing on the electronic warfare threats posed to the U.S. military from Russia, China, and other relevant nations through 2026."

Modular Open Systems Architecture (MOSA)

Over the past few years, the HASC has been very interested in the DOD's MOSA initiatives, and its report included new language: "The committee commends the Department of Defense's support for Modular Open Systems Architecture (MOSA) in recent years. The Air Force's Sensor Open Systems Architecture (SOSA) and the Army's Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) Modular Open Suite of Standards (CMOSS) are examples of mature military electronics standards initiatives that are proving that programs of record can be unified around common modular building blocks. Increased use of these standards has the potential to increase speed of technology refresh, foster industry competition, and reduce the U.S. Government's costs of modernization and sustainment.

"The committee notes that the SOSA and CMOSS standards are aligned in both hardware and software specifications, creating cross-service cooperation and cost savings for the Department of Defense (DoD). Nonetheless, the committee understands that despite this progress, Department of the Air Force software standards are still largely stovepiped along mission or capability areas

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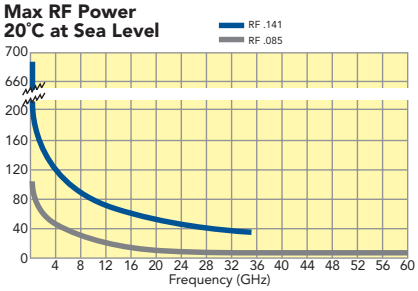

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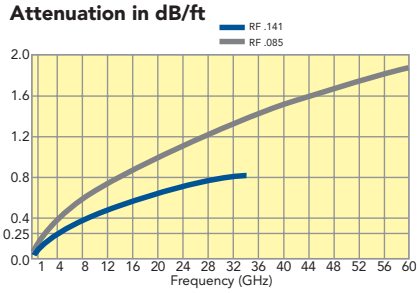

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and often not accessible to smaller or non-traditional defense contractors.

"The committee encourages the Air Force to consider leveraging SOSA software and hardware standards across high priority sensor and C4ISR programs in support of building a true open, common, multi-purpose backbone architecture able to incorporate new capability more quickly and at lower cost.

"Therefore, the committee directs the Secretary of the Air Force to submit a report to the congressional defense committees by March 1, 2022, on plans to accelerate and expand implementation of SOSA software and hardware standards."

Airborne Electronic Attack (AEA)

The HASC and SASC reports each showed an interest in the AEA mission. The HASC report described the Committee's concern over the Air Force's EC-37B Compass Call program: "The committee notes the Air Force commitment to improving electromagnetic spectrum (EMS) capabilities through its recently published EMS Superiority Strategy. However, the committee remains concerned that the Air Force's only dedicated electromagnetic warfare (EW) aircraft, the EC–130H Compass Call, is rapidly nearing the end of its service life, while the EC–37B Compass Call replacement program faces production and delivery delays. The committee is also aware that the Air Force underestimated the cost of implementing system-wide open reconfigurable dynamic architecture (SWORD–A) capabilities, forcing the Compass Call program to realign funding from procurement to research and development. All of these issues raise concerns that the Air Force will be unable to meet joint airborne EW requirements as legacy aircraft retirements outpace the availability of replacement capability.

"Given these concerns and the critical importance of airborne EW in support of joint military operations, the committee directs the Secretary of the Air Force to provide a briefing to the House Committee on Armed Services by March 1, 2022, on its plan to procure the full complement of ten EC–37B aircraft as defined in the program of record."

The HASC also focused attention on the next phase of the Navy's Next-Generation Jammer (NGJ) program: "The budget request included $243.9 million in PE 0604274N for Next Generation Jammer Increment 1 and $248.0 million in PE 0604282N for Next Generation Jammer Increment II, but no funding for a capability to counter the high band electronic warfare threat.

"The committee supports the ongoing development of the Department of the Navy's Next Generation Jammer mid and low band capabilities but notes that the Navy has yet to begin to address the high band threat. The committee is aware that the Navy's airborne electronic attack community views a high band capability as a top modernization priority and that the existing tactical jammer on the EA–18 Growler is not equipped to meet evolving threats. The committee concurs with this assessment and recognizes the need for an upgraded high band jamming capability for the Navy's EA–18 Growler." The SASC recommended a $10 million increase to PE 0604274N "... to begin risk reduction on a high band electronic attack capability for EA–18G aircraft." It also directed the Secretary

of the Navy to provide a report "on the technical requirements, estimated cost and schedule, and acquisition strategy for producing a high band capability for the EA–18 Growler."

Finally, the HASC and SASC included similar provisions that would require the Secretary of the Air Force to assess AEA gaps and capabilities and to analyze the feasibility of integrating the ALQ-249 onto Air Force tactical aircraft and include its findings in a report to both committees.

Once the Senate passes its version of the FY2022 NDAA, the House and Senate will appoint members to meet in conference and hash out a single version of the bill for consideration by both houses. Congress always aims to finish the NDAA by the end of the calendar year. *– J. Knowles*

NEW EW SOLUTIONS INTRODUCED AT AOC EUROPE

The AOC Europe 2021 EW conference took place October 11-12 in Liverpool and provided a venue for companies to introduce new EW offerings.

At the event, Saab (Järfälla, Sweden) revealed that it is working with MBDA (Stevenage, Hertfordshire, UK) to develop a miniaturized air-launched decoy/stand-in jammer as part of its Arexis airborne EW portfolio. The proposed Arexis air-launched decoy would integrate a Saab electronic attack (EA) payload into the air vehicle and wider weapons system architecture already being developed by MBDA for the UK's SPEAR-EW stand-in jammer program.

Saab first announced its concept for a small, long range/long endurance EW decoy in 2017, and it has kept the Swedish Air Force, the Defence Materiel Administration (FMV) and the Defence Research Agency (FOI) appraised of its work. However, the presence of an Arexis air-launched decoy model at AOC Europe 2021 was the first time that the company had publicly revealed that it was co-operating with MBDA to explore an adaptation of SPEAR-EW.

The two companies are working to explore how Saab's small form-factor EA payload could be integrated into the SPEAR-EW air vehicle and weapon architecture so as to satisfy the Arexis decoy/stand-in jammer requirement. The initial focus is on current and prospective customers for Saab's Gripen multirole fighter. Saab in 2020 revealed that it was including a so-called Lightweight Air-launched Decoy Missile (LADM) as part of the Gripen E package offered for Finland's HX fighter replacement program. Company officials at AOC Europe acknowledged that the proposed LADM and the Arexis decoy are one and the same: as part of the HX bid, Saab has proposed that the EA payload would be largely developed at its technology center in Tampere, Finland.

Evolved from MBDA's SPEAR network-enabled miniature cruise missile, SPEAR-EW has been conceived as a long-range stand-in jammer and decoy to support suppression of enemy air defenses. MBDA is currently nearing completion of a technology demonstrator program, funded by the UK Ministry of Defence (MoD), designed to de-risk the integration of a Leonardo compact jamming payload into the air vehicle and wider

weapon system, identify the necessary design adaptations, and inform the MoD's investment case.

Also at AOC Europe, Roke launched the latest member in it family of ground-based EW, designed to support forward-deployed units operating at the "tactical edge." The company unveiled the "Perceive Multi-Role (MR)" solution, which joins legacy systems including the Resolve Tactical EW Support System, Locate-S (strategic) and Locate-T (tactical/transportable) high frequency, direction finding solutions.

Featuring a wideband and integrated antenna head, Perceive MR provides tactical units with both Adaptive Digital Beamforming (ADBF) and Super Resolution Direction Finding (SRDF) in azimuth and elevation between 30 MHz to 6 GHz and intercept between 2 MHz and 30 MHz.

A company spokesperson confirmed Perceive MR would allow end users to "target, classify and identify frequency hopping sources operating at over 10,000 hops/second" in addition to providing an intercept capability against digital, mobile radios with real-time DF and the provision of up to 32 Direct Digital Drop Channels. "We've designed the form factor and environmental compliance of Perceive MR to operate on platforms, or be carried by soldiers for team transportable operation," the spokesperson added before conceding the solution is not yet capable of being operated on-the-move.

"Regardless of the choice of deployment," the spokesperson said, "sensors can be integrated together over the radio network for geolocation. Although it was designed for static mast mounting, we understand that on-the-move mobile mounting is a growing requirement for our military customers. With this in mind, we aiming to certify the unit for this capability in the future," he said. "Everyone in the Electronic Warfare Intelligence Surveillance & Reconnaissance (EWISR) domain talk about the near-peer/peer-peer conflict, and yet there has been no thought on the design of what is perceived to be the Congested, Contested and Constrained and Cluttered electromagnetic environment. We designed the system to include dual GNSS and Inertial Navigation, which is coupled to an electronic compass and magnetometer paired with a 1pps timing circuit. This allows the sensor to continue to operate in the GPS denied environment. By including SRDF techniques the operator can resolve multiple transmission on the same frequency separated in azimuth and elevation. When SRDF is paired with ADBF, this allows the sensor to both increase gain on a selected target but simultaneously null co-channel interference."

The final part of the design concept, company officials stated, allows the 1pps timing circuit to allow for time difference of arrival when meshed with other platforms. "This provides dynamic changes across angle of arrival to time difference of arrival, as you never really know where you are going to be operating or what the electromagnetic spectrum will look like. If you are going to operate in these types of environment then you need the ability to be able to stream multiple concurrent and simultaneous complex transmission." – *R. Scott and A. White*

IN BRIEF

The UK has signed an agreement with the US government that will keep the Royal Air Force's (RAF's) fleet of RC-135W Rivet Joint SIGINT aircraft in service out to 2035. Three RC-135W aircraft have been acquired by the UK under **Project Airseeker,** entering service between 2014 and 2017. Support for the type – operated by No 51 Squadron at RAF Waddington – is provided through the Rivet Joint Cooperative Program (a partnership established by the US Air Force and the UK Ministry of Defence). Airseeker support is formalized under a Sustainment and Follow-on Development Memorandum of Understanding (MoU) that underpins the Cooperative Program. Under an amendment to the MoU, the UK has now committed to invest £970 million in the program over the next 14 years.

The **Defense Advanced Research Projects Agency (DARPA)** (Arlington, VA) has issued a Broad Agency Announcement (HR001122S0004) from its Strategic Technology Office (STO) for two proof-of-concept initiatives. The first effort, dubbed Mosaic Infrastructure, is part of DARPA's larger Mosaic Warfare thrust. According to the BAA, Mosaic Infrastructure, calls for "...developing the tools and infrastructure to provide warfighters more combat options to adapt to opportunities, surprise, and disruptions with the speed and agility of mission planning. Additionally, STO's MW thrust is developing Mosaic Targeting technologies to take advantage of mosaic architectures. Assuming that Mosaic Infrastructure will enable distributed, disaggregated effects chains, Mosaic Targeting is re-imaging how sensors and electromagnetic war-

fare (EW) technologies may be designed for use in these novel architectures to provide new long-range kill chains for friendly warfighters and counters to adversary targeting." The second BAA area is titled "Shaping the Battlespace," which entails developing "...technology to provide military leaders options across the spectrum of peer competition. These concepts will enable military means to deter and impose cost to contain expansionism and ensure US and coalition partners freedom of operations and tactical advantage while driving de-escalation." The BAA lists more than 40 technology areas of interest, most of which are EMS-related. The BAA is open through October 2022.

DARPA's **Microsystems Technology Office (MTO)** issued a Request for Information (RFI) on October 22 for "Machine Learning Applied to Radiofrequency Signals," which seeks to identify organizations with "experience applying artificial intelligence (AI) and machine learning (ML) to radio frequency (RF) signals for defense applications." According to the RFI (DARPA-SN-22-04), "Applying ML technology to RF problems presents several unique challenges, including the high volume of input data, dynamics of the propagation environment, the complexity of controlling modern receivers and transmitters, and the computational constraints of embedded systems. Addressing these challenges requires RF domain-specific insights, which may include novel ML architectures, curation of RF training data sets through preprocessing and synthetic data augmentation, hybrid processing pipelines integrating traditional signal processing functions, network optimization for embedded processors, and advanced resource management techniques." Responses were due on November 10. The technical point of contact is John Davies, DARPA/MTO, DARPA-SN-22-04@darpa.mil.

The Intelligence Advanced Research Projects Activity (IARPA) (Washington, DC) has selected five companies to help it develop "...smart radio techniques that can automatically detect and characterize radio frequency (RF) signals potentially associated with attempted data breaches," under its Securing Compartmented Information with Smart Radio Systems (SCISRS) program, according to IARPA. **AiRANACULUS; BAE Systems; Expedition Technology, Inc.; JASR Systems; and Northrop Grumman** will conduct research and develop solutions to help IARPA "...safeguard information and data that is generated, stored, used, transmitted, and received in secure facilities and beyond. Program success will likely require breakthroughs in machine learning (ML) and traditional digital signal processing techniques (DSP)." "Our research goal is extremely challenging because we need to scan an enormous frequency range and analyze terabytes of data every second – we are looking for the proverbial needles in the RF haystack," said IARPA's SCISRS program manager, Dr. Paul Kolb in a press release. "If we want to deploy SCISRS everywhere, we must find a way to run hyper-efficient algorithms on modestly-priced hardware."

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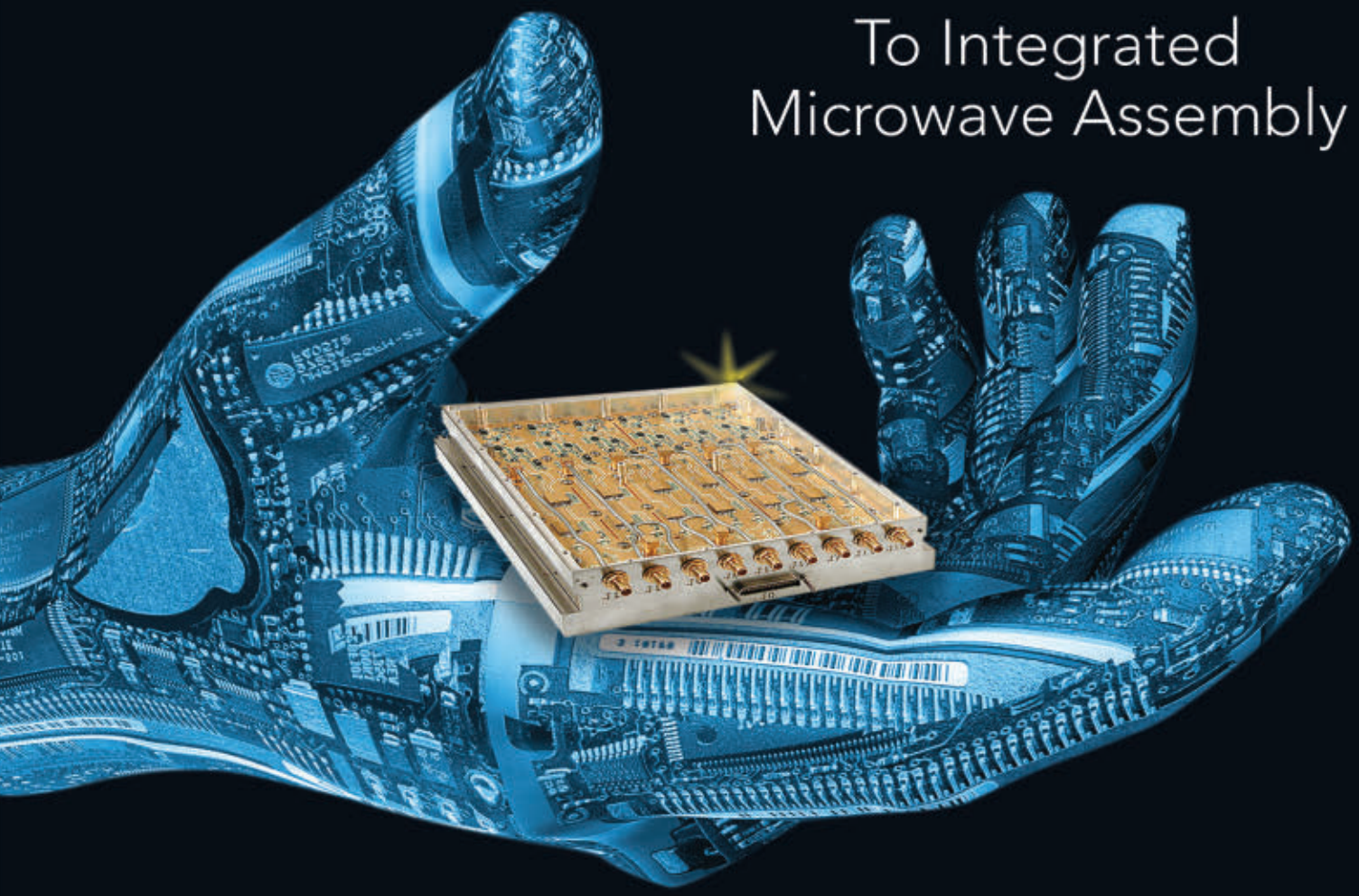

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Immediate Threats and Schedule Drive Army A

By John Haystead

Whether the Army's next generation of multi-spectral, multi-function, tightly-fused, interoperable Aircraft Survivability Equipment (ASE) sensors and systems are ready for fielding or not, the service is moving forward to provide both its "enduring fleet" of platforms (Apache, Blackhawk and Chinook), and the next-generation Future Vertical Lift (FVL) platforms, with the best capabilities available today. Determining the best-available capabilities at a particular point in time may seem to be a fairly straightforward task, but in actuality, it is anything but. Army aviation encompasses a number of different aircraft platforms, with many different ASE systems and packages installed. Some of these exist as a Program of Record (POR), while others have been developed and delivered through rapid acquisition vehicles with various numbers of units deployed. Also, there are ongoing technology-improvement initiatives in, and across, all ASE system areas, which must be coordinated with the maintenance and support of legacy systems.

The development and deployment of Army ASE capabilities is the responsibility of the Project Management Office for Aircraft Survivability Equipment (PMO-ASE) (Huntsville, AL) within the Army's Program Executive Office Intelligence Electronic Warfare & Sensors (PEO-IEW&S). It encompasses IR and RF threat and missile warning systems, laser detection systems and IR countermeasure systems.

One particularly significant impact of the decision to equip its aircraft with the best available ASE capabilities today, while providing a path for upgrade to new technology in future, is that instead of including the provisioning of ASE technology within the scope of the work requirement of the FVL platform development prime contractors, the Army has instead opted to equip the new FVL fleet with ASE as Government Furnished Equipment (GFE) composed of a mix of equipment already under the purview of PMO-ASE. Says COL Kevin Chaney, Program Manager of PMO-ASE, "Although FVL will be something that we transition new technology to in the future as it becomes available, we're not going to hold those efforts back right now. FVL wants mature systems, so that's why we're proposing GFE for Increment 1 of the Future Long Range Assault Aircraft (FLRAA) and Future Attack Reconnaissance Aircraft (FARA) FVL platforms. The proposed GFE equipment are the Limited Interim Missile Warning System (LIMWS) on the missile-warning side, the Common IR Countermeasures (CIRCM) system on the IR

US ARMY

FVL Deployment SE Fielding Decisions

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missile defeat side, the AN/APR-39E(V)2 Radar Warning Receiver (RWR) for RF threat detection, and the AN/AVR-2B system for laser detection."

MISSILE WARNING

Looking first at missile warning, the AN/AAR-57 Common Missile Warning System (CMWS) detects IR-guided missiles such as Man Portable Air Defense Systems (MANPADS), as well as providing Hostile Fire Indication (HFI) of small-arms fire and rocket-propelled grenades. In addition to providing visual and aural cueing to aircrews, it also automatically cues flares and/or interfaces with a high-energy IR or laser-based countermeasure system. Developed and built by BAE Systems (Nashua, NH), CMWS was initially fielded in 2005, with now more than 3,000 systems delivered and installed on over 40 different platforms worldwide.

According to Colonel Chaney, the Army is currently in the process of qualifying the next software drop, "K-A" for the system, "which will be a more-enduring software drop because it captures a lot of the legacy threats that we were trying to do and allows us to stay relevant for quite a few more years." Meanwhile, Chaney says they're working on the transition-to-sustainment (t2s) of the capability over to the Army Communications-Electronics Command (CECOM) which will maintain the capability going forward. They're also finishing the qualification of the GEN3X Electronic Control Unit (ECU) processor that will support AAR-57 Foreign Military Sales (FMS) customers.

LIMITED INTERIM MISSILE WARNING SYSTEM (LIMWS)

The Limited Interim Missile Warning System (LIMWS) was developed as a Quick Reaction Capability (QRC) for a missile detection system with a greater capability than CMWS to meet new threat technology and tactics. It integrates fiber-optic cabling for high-speed data transmission from sensors to the system processor and provides increased detection range, improved detection in clutter and more agile algorithms to rapidly respond to emerging threats.

Initially intended for a limited set of Army and Special Operations aircraft, Colonel Chaney says they are now in the process of completing the qualification and install of LIMWS on Apache, Blackhawk and Chinook helicopters and "will be deploying it shortly." PMO-ASE is also currently working on transitioning the LIMWS QRC effort into a POR. Known as the Improved Threat Detection System (ITDS), it is intended to

US ARMY

provide a more enduring capability going forward. Says Chaney, "One of the challenges that we're having right now is transitioning a lot of Overseas Contingency Operations (OCO) efforts with the base program effort that will be the program going forward in terms of funding. We'll start the Materiel Development Decision (MDD) request later this year or early next, and that will determine the pathway that we go down in terms of the acquisition approach." Chaney says they hope to have an industry day shortly to see where industry is in terms of the "art of possibility" going forward. "As a POR, we want to make sure that it's addressing where we see the threat going and that it is viable for quite a few more years."

Colonel Chaney says he expects ITDS to definitely be provided for FVL as part of Increment 2. "If we can get it matched up and do reverse compatibility, then it would also be able to operate on Increment 1 FARA and FLRAA platforms. If we can get the A-kit right on both the future and enduring fleets, then we can implement a CMWS sensor, a LIMWS sensor, or an ITDS sensor. Wherever the most stressing threat is, is where we will put out the best capability and have those other capabilities readily available for the rest of the fleet."

LASER DETECTION

Laser designators and targeting systems have long posed a major threat to the Army's rotorcraft fleet. To warn pilots of the presence of such illumination, the AN/AVR-2B Laser Detecting Set (LDS) receives, processes, prioritizes, and displays threat information via a federated bus system on either the platform's AN/APR-39 Radar Warning Receiver (RWR) or its CMWS system display. Colonel Chaney says, however, that going forward, the ideal approach, particularly for FVL, will be to provide this functionality via a platform-wide "digital backbone," with all of the threat information accessed and pulled down to Multifunction Displays (MFDs).

PMO-ASE has already developed this capability on the airborne side for the AN/AVR-2B, but it is now also partnering with the Army's Product Development Manager for Vehicle Protection Systems

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(PdM VPS) within PEO-Ground Combat Systems (PEO-GCS) (Warren, MI), which is responsible for providing laser warning functions for ground vehicles as well. Says Chaney, "Since the threat is very similar, and they're also very concerned about size, weight and power (SWaP), they're leveraging our work, and we've formed a partnership where they are using our contract vehicle right now with Danbury Mission Technologies [(Danbury, CT) a former business unit of United Technologies that was divested in 2020 as a result of the Raytheon-UTC merger] to help them kick off the "VVR-4 "ground portion of this and accelerate their acquisition timeframe. It's an area where you will see a true air-to-ground partnership taking effect. Once their system is matured, if Army aviation needs to continue acquiring airborne laser detection systems, we'll purchase more of their variant, which would become the AVR-4. We've already finished an air worthiness and form-fit-factor qualification of it. It's a great opportunity for air and ground to share in the development of new modernization capabilities to both help reduce costs and to move forward faster. We hope to expand these opportunities in future."

RF THREAT WARNING

The latest upgrade activity in Army ASE radar warning capability is the AN/APR-39E(V)2 Modernized Radar Warning Receiver (MRWR). An Engineering Change Proposal (ECP) to the AN/APR-39D(V)2, the MRWR is a fully-digital version of the RWR providing enhanced threat discrimination and increased overall receiver performance against newer frequency-agile RF threats and AESA radars.

As described by Colonel Chaney, "The MRWR allows you to see more of the spectrum than the D(V)2, which although it provides the required ranges, is not fully digital. I describe the -D(V)2 as like a soda straw looking up and down the spectrum, while the E(V)2 is like seven soda straws performing the spectrum search and is much more likely to catch initial pulses."

Although the Army received a full materiel release in July of 2020 for the APR-39D(V)2 variant and is now in the process of fielding that capability, Chaney says there will actually only be 2-3 units of that system fielded. "Meanwhile, we're going forward with the APR-39E(V)2 version, and are currently in the process of starting the qualification of the system beginning with testing of prototypes received from Northrop Grumman, and on to subsequent user testing and materiel decisions. The APR-39E(V)2 will serve as the long-term capability for both the enduring and FVL fleet. It may also go onto the fixed-wing fleet as well, because that mission profile probably faces an even bigger threat from radar-guided SAMs."

IR COUNTERMEASURES

The latest capability on the IR countermeasure side of aircraft survivability is the Common IR Countermeasures System (CIRCM). Primarily intended to provide protection from MANPADS threats, the system received full-rate production approval in April, and full-scale production is now underway at

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manufacturer, Northrop Grumman (Rolling Meadows, IL).

CIRCM is replacing the Advanced Threat Infrared Countermeasures (ATIRCM) system, which was built and fielded by BAE Systems (Nashua, NH) on a limited basis as a Quick Reaction Capability (QRC) in 2009 for CH-47 Chinook aircraft. CIRCM is a laser-based countermeasure system that will interface with CMWS, LIMWS and other future missile-warning systems and will be installed on all enduring fleet rotary-wing aircraft, as well as some small fixed-wing aircraft. According to Colonel Chaney, the first unit equipped (FUE) was completed in February of 2020, and the system is already on UH-60 Blackhawk and CH-47 Chinook helicopters. "We're just now finishing up, with the Apache being the last platform to be equipped with the system. Next, the focus will be on getting it installed on Special Operations Aircraft (SOA)."

Chaney says they are also looking at potentially accelerating the divestment of ATIRCM and shifting it over to CIRCM quicker. "That will equate to future cost avoidance by not having to maintain both systems and the associated funding for maintenance and repair, Field Support Reps (FSRs), etc." They are also working with Northrop Grumman toward getting the system configured for FMS customers. "We have several countries that are already interested and are finalizing the documentation. The hope is to get an FMS case in the books soon," says Chaney.

US ARMY

FUTURE VERTICAL LIFT (FVL)

Although the Army's and PMO-ASE's approach to rapidly fielding new ASE capabilities for both the enduring aircraft fleet and the next-generation FVL fleet seems to make all the sense in the world, it also appears considerably less ambitious than the expectations and plans discussed just last year, at least in terms of FVL. In fact, the title of a piece on the subject in the April 2020 issue of *JED,* was "FVL Program Aims for Overwhelming Advancement of Aircraft Survivability Capability." Among the critical requirements identified at that time was the need for tightly-integrated multi-spectral and multi-function ASE sensors and systems built upon a common, flexible Modular Open Systems Architecture (MOSA). Though the Army had not decided whether the FVL ASE equipment would be GFE or platform-contractor-developed at the time, the implication was that these advanced capabilities would be provided for the new FVL platform.

The April 2020 JED article covered ongoing initiatives such as "Project Convergence," and the modular open system approach for architecture, autonomy, automation, and interface (MOSA for A3I), both aimed at expediting the technology development-to-acquisition process with a much greater emphasis on prototyping and in-the-field operational testing. Said Colonel Chaney at the time, "MOSA for A3I and Project Convergence is a new paradigm of development and acquisition streamlining – bringing in capability faster than previously done."

Of course, in the world of military technology, initial desires and plans (or even identified critical requirements), don't always track with the realities imposed by other factors in the acquisition process, such as changing priorities, available funding, schedule demands, etc. Today, just a year and a half later, a much more immediate threat posed by peer adversaries and an FY2022 defense spending bill that is yet to be passed by Congress, are among these "other factors." And in fact, Colo-

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nel Chaney also said at the time that "there are obviously some challenges with bringing in a new capability this way, and it will still have to go through a lot of the '-ilities' testing."

Currently, Chaney says they are focused on working through the integration and qualification requirements for the FLRAA and FARA platforms. "Those programs will obviously need actual hardware to ensure that their ballast and drag numbers etc. are correct as they go forward, but they don't necessarily need flightworthy equipment for that right out the door. A lot of the initial capabilities that they will need from PMO-ASE are the actual processors to ensure compatibility and interoperability in the laboratory and then just mockups of the actual systems that they can install quickly to identify any issues, such as parasitic drag and the impact on Center of Gravity (CG)."

At the same time, there are multiple initiatives under way at PMO-ASE to expedite the development and fielding of advanced technology and capabilities for FVL. In addition to what was described earlier within the ASE system areas, Colonel Chaney points to their continued emphasis on accomplishing certain overall goals. For example, "On the MOSA front, we're trying to do the processor convergence piece to reduce the footprint on the platform of the number of dedicated processors. We're trying to provide more multi-function capability, and to work with PEO Aviation and PEO IEW&S in trying to get those two organizations to more closely align. In that way, we can truly gain some air-to-ground type MOSA approaches. PEO IEW&S is big on the C5ISR/EW Modular Open Suite of Standards (CMOSS) portion of it, while on the PEO Aviation side, you have standards such as the Future Airborne Capability Environment (FACE) and Hardware Open Systems Technologies (HOST). There are commonalities across these standards, and the two organizations are really starting to talk with each other to see where these reside and resolve the best path forward for the Army."

Another overall focus area is to make greater use of the FVL platform's Aviation Mission Common Server (AMCS). "One of the things that we're looking at is, 'can we do processor convergence?' Right now, we have four independent processors supporting four different capabilities, they're all federated and aligned with their particular systems. Can we start collapsing those down? One example is an approach that takes the AVR-2B LDS and makes it an application that is hosted somewhere else on the platform, such as in the AMCS. That will be one more black box that we can pull off the platforms."

The office is also working to reduce the size of the CIRCM System Processor Unit (SPU) to a card-level capability that can be hosted within the AMCS. "If we can do that, then potentially we can go from four processors down to two, or perhaps, in future, to a single processor. One of the challenges right now is that the APR-39E(V)2 radar warning system is still in development and still maturing, and we don't want to jeopardize its timeline, so really the first step is to combine the other systems' processors plus the

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LIMWS system processor. That would be the first step in trying to get from four down to two, with the LDS, CIRCM, and LIMWS in one box and the APR-39E(V)2 as a separate one, and eventually working on getting its processor into the common server as well."

So, although as Chaney now says, "going forward, we're still going down that pathway (to overwhelming ASE advantage), the real challenge is that Increment 1 of FARA and FLARA requires mature systems, which is why we have proposed the GFE list of equipment described. Meanwhile, however, if we can do things beneficial for them, like processor convergence to bring the number of processors down, and if that aligns with their Increment 1 timeline, and doesn't jeopardize their schedule, we'll go down that pathway, prove it out, and go forward with it."

Ultimately says Chaney, they're still looking at better ways to get to multispectral systems and sensor fusion, etc. with Increment 2 of FVL. "We have to get there at some point in time. Ideally, what I'm trying to do is to get PMO-ASE to be focused in future on just sensors, emitters, and software/algorithms. I would almost like to get completely out of the processor piece, having AMCS host all of our capabilities, and also get out of the A-kit in pieces. If we can do this right, then we can rapidly and truly meet the intent of MOSA of being able to pull out one sensor, and plug in another without any major overhauls of the aircraft. This obviously takes time, effort and funding however."

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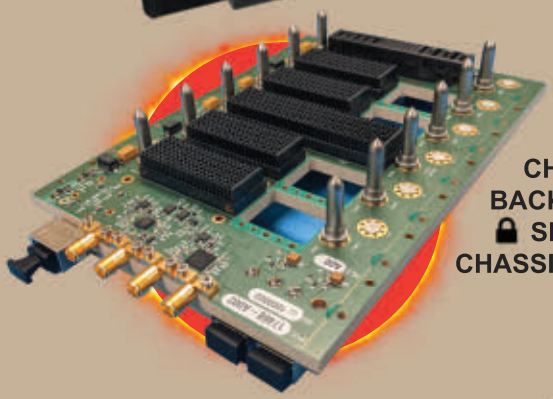

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EW Europe

The Challenges Facing Ground EW – a UK Perspective

By Andrew White

As the world dives deeper into the information age, armed forces are considering how best to maintain, and in some cases regain, the technological advantage, particularly when facing highly capable and well-equipped adversaries. Examples include members of the "Five Eyes" intelligence alliance (Australia, Canada, New Zealand, the United Kingdom and United States) – many of which are investing heavily in a variety of emerging and disruptive technology areas to counter cyber and electromagnetic activities (CEMA) being undertaken by the likes of the People's Republic of China (PRC) and the Russian Federation. One perspective from this group was provided by the British Army's 14 Signal Regiment (EW) during the AOC Europe conference held Oct. 12-13 in Liverpool.

As stipulated in the UK Ministry of Defense's (MoD's) "Defense in a Competitive Age" strategic paper, published in March 2021, the UK Armed Forces' "historic technological advantage is being increasingly challenged by targeted investment in capabilities designed to counter our strengths and challenge strategic stability."

The document warned: "Some countries are also adopting a military-civil fusion approach towards the development of new technologies, harnessing civilian innovation for the benefit of their defense capabilities. Conversely, the imaginative employment of relatively low-cost capabilities is challenging highly capable air defense and electronic warfare [EW] systems or heavily armoured forces, as we have seen in Libya and Nagorno-Karabakh respectively."

In response, the MoD has pledged to invest £3 billion in "new equipment" for the British Army to make it a "more agile, integrated, lethal and expeditionary" force. Specifically, this includes "new electronic warfare and cyberspace capabilities" designed to transform the army's equipment over the next decade. As the strategic document stated, the MoD will invest £200 million over the same time period to deliver an enhanced EW and signal intelligence [SIGINT] capability. "An increase in new personnel able to collect and exploit SIGINT will demonstrate a significant uplift in our electronic warfighting capability in all formations," the document explained before confirming the UK's 6th Division will deliver cyber, electronic warfare, information operations and unconventional capabilities designed for warfight-

The British Army's 14 Signal Regiment is shifting its focus from counter-insurgency operations in Afghanistan to operating environments with more sophisticated communications systems. BRITISH ARMY PHOTO

ing and for operations conducted below the threshold of war.

EMERGING THREATS

As highlighted by the MoD, recent operational campaigns in Libya and Nagorno-Karabakh have illustrated the importance of EW, particularly conducted on the ground and at the tactical edge by mounted and dismounted units alike. Similarly, defense sources confirmed how EW remains a significant capability for Russian armed forces and Russia's proxy partners in eastern Europe. The Russian Federation has pledged to invest US$1 billion on EW between 2015 and 2025 and to date, has created specialist EW brigades who, thanks to ongoing operations in eastern Ukraine and elsewhere, now boast high levels of operational experience.

Addressing delegates at the AOC Europe conference Commanding Officer of the British Army's 14 Signal Regiment (EW), Lt Col Chris Fogarty MBE, described a "very difficult past few decades" for EW operations in the Middle East and Afghanistan. Highlighting the emergence of Russian EW capability at the tactical edge, Fogarty warned of Russian military advances in EW, including "impressive network sensors and channels" in addition to optimized command structures, doctrine, training, and tactics, techniques and procedures (TTPs). "These EW systems have entered service at the tactical, operational and strategic levels," he said. "Indeed, there are now five EW brigades covering the military districts. And this has been a focused and deliberate effort aimed at EW modernization from 2009 onwards, a year after the Russia-Georgia conflict.

"This developmental approach has been assisted by the conflict in Crimea [Ukraine] and Russia's involvement in Syria where much of this new technology has been trialed and tested. In Ukraine. EW systems were integral to Russia's kinetic and non-kinetic effects and were integrated into wider networks to support proxy forces working independently.

"They enabled freedom of maneuver within the electromagnetic spectrum [EMS] for both Russian and separatist forces and also integrated information operations through widespread mass SMS, as well as more targeted messaging," Fogarty continued.

> "Electronic surveillance will continue to be the cornerstone of identifying enemy forces, equipment and movement, to help UK troops plan operations and share intelligence."
>
> *– Lt Col Chris Fogarty*

He also highlighted reports of Android applications being exploited by Russian armed and proxy forces – something which led to Ukrainian artillery and fires units being geo-located and targeted by precision munitions. "This is a very blended approach and combines an array of EW sensors from ground-based to fixed-wing to strategic as well as cyber exploits and open-source intelligence," Fogarty added before also describing how additional EW capability had also been tested by Russian in Syria. "There have been instances of Russian EW capabilities having an effect on GPS jamming, affecting both shipping vessels and air frames, as well as in countries including both Norway and Sweden."

Similar threats on the ground continue to emerge from the PRC with more than $239 billion being invested into the "Integrated Network EW" concept and the new 145,000-strong Strategic Support Force, established in 2015 to exploit tactical through strategic advantage across the EMS. However, the People's Liberation Army lacks significant direct operational experience in terms of ground-based EW at the present time – despite consolidating computer network attack and other capabilities. "[The PLA] viewed that early electromagnetic dominance is critical in addition to kinetic targeting of adversaries. This led to the development in December 2015 of the Strategic Support Force, which combines Space, Cyber and EW," Fogarty warned.

"According to the 2020 US Department of Defense report on the PRC, China's EW strategy emphasizes suppressing, degrading, disrupting or deceiving enemy electronic equipment. They routinely practice and exercise jamming and anti-jamming elements, looking at GPS, conventional communication systems and satellite capabilities. The report goes on to discuss intelligence warfare, which looks to implement AI-assisted network vulnerability analysis, countermeasure identification, and image management.

"That said, the Chinese lack recent operational experience and have only been testing the systems through exercises rather than the Russian approach of testing on operations – although the Chinese dominance in Space and Maritime around the Asia-Pacific region with a three-dimensional capabilities is a real concern," Fogarty added.

UK MODERNIZATION

"Looking at things historically, and currently from a UK perspective," Fogarty explained, "EW has been championed through conflicts in Iraq and Afghanistan, where small, light EW teams were heralded as battle assets. The difficulty with this is that they were pushed down to [the] very low tactical level – not necessarily networked – and people didn't see the large-ticket platform that was in support." He further said, "The target sets were not complex: simple push-to-talk radios that operated in clear voice and did not challenge our use of the EMS. This led to false economy and shifted the land equipment program for a significant period. In fact, in the UK, we still do not have fully integrated equipment on board platforms now, but our capabilities are much better. And that works, I'm pleased to say."

Highlighting EW advances across the Five Eyes community to dominate the EMS and shorten the OODA [Observe, Orient, Decide and Act] targeting cycle, Fogarty emphasized how the commercial sector remains the primary driver behind capability injections. (See Five Eyes sidebar and page 40.) "Network-centric warfare is now becoming a reality," he said. "It's only

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in 2021 that we can say that every soldier and platform is truly a networked sensor. In fact, if we look at how other states and actors are using technology, it's not just every soldier that is a sensor but also every digital citizen is through applications [on their smart phones]. Anyone who has a smartphone application can geo-locate, tag and add imagery of multiple personnel and equipment. This [capability] was heavily used in Crimea."

Upgrades to the UK's EW capability continue to be pursued as the MoD seeks to build an "asymmetric army for the digital age," according to Fogarty. According to a British Army statement published on April 27, EW is helping the service to "prepare for the future battlespace and the invisible fight" to exploit the EMS. As part of the British Army's strategy, assets exploiting the EMS across a multi-domain battle space are set to become more integrated. It also states, "Armoured vehicles will have sensors which can feed data to the commander on the ground, to the strategic headquarters, to other vehicles, or to government departments, giving a rich, real-time picture of events, and allowing more informed decision making. As we embrace this complexity and introduce robotics and automated systems, machine learning and artificial intelligence – linking sensors and weapons with decision makers – the reliance on open access to the electromagnetic spectrum will be crucial. Electronic surveillance will continue to be the cornerstone of identifying enemy forces, equipment and movement, to help UK troops plan operations and share intelligence. At the same time, air and sea assets will also be collecting and sharing information, enhancing co-operation and enriching our understanding to inform better decisions. EW and cyber effects will prevent the enemy from communicating effectively, confuse their targeting capabilities, and prevent the use of electronically-triggered devices," the statement continued while referencing similar advances in the area of counter-improvised explosive device (C-IED) technologies over the past two decades of operations in Afghanistan and Iraq.

According to Fogarty, integration of EW assets across the multi-domain battlespace is "central" to the army's modernization effort, supported by a "digital backbone" that will shorten the OODA targeting cycle and enable interoperability with partner forces. "The digital backbone will generate a single information and intelligence environment. This open platform allows all methods of data manipulation and analytics leveraging AI and the Project Morpheus labs will have approved end-to-end shared situational awareness, increased bandwidth and open architectures enabling interoperability."

Fogarty also highlighted emerging capabilities in "cognitive EW," which would allow tactical solutions to sense, automatically characterize and exploit the EMS. Referring to the availability of "exquisite sensors and machine learning" tools, he said, "We will be learning the lessons of all listening adversaries, nations' radars, emitters and transmitters. EW forensics and signal development personnel allow us to develop electronic forms of battle sensors and jammer profiles and through a blending of machine

learning algorithms, supporting forward and rear analysts, we're able to understand how new adaptive radars work; develop new countermeasures to better sense and more and fundamentally identify; and attribute the new signals of noise critically to find that needle in a haystack of needles."

Fogarty also called for capacity to improve speed of collection, processing, export and dissemination of big data across the battlespace. "From a 14 Signals perspective, I focused heavily on developing expertise and tradecraft of my soldiers to reinvigorate their SIGINT skills, increasing the complexity of types of content that my soldiers can deal with. There's increased ability to collect at the front end with processing, exploitation and dissemination at the rear, which enables the fusion of other sources in a multi-domain fashion. It also maintains a smaller footprint forward, but clearly not everything can be done at reach and therefore we have the flexibility to [provide] more paired up content," Fogarty continued. He also described increasing levels in cyber warfare skills, with operators becoming experts in the EMS and radio frequency.

"FUTUREPROOFING"

To support the further enhancement of the army's tactical EW capability in the future, Fogarty described a list of priorities currently being pursued by 14 Signal Regiment. These include ongoing modification of platforms and sensors using software defined systems and "other novel ways" to ensure truly multi-domain capability. "We need to be able to configure software defined sensors [with upgrades] conducted in person at an operating base or remotely over the air. Although in a congested EMS, we need to be able to do this securely," he warned.

Fogarty also called for improved data processing skills to handle increasingly vast amounts of collected intelligence: "AI and machine learning algorithms are vital. But we still need the skills to either write these algorithms or at least be able to inform them correctly to ensure we get the right data calls and can identify that signal in the noise. This, therefore requires a secure network to conduct the management of the collection systems as well as the processing of data." He also called for greater integration with local source intelligence communities, which would allow forward-deployed tactical units to conduct operations with a greater understanding of the local EM Operating Environment at every stage of an operation.

Finally, Fogarty suggested greater ease of use of EW systems to enhance the operational effectiveness of EW units at the edge. "The ease of use of sensors will become more comprehensive and target the higher end of the spectrum, perhaps focusing on land and more focus on the manipulation of the spectrum with spoofing and also having targeted effects."

However, Fogarty did concede there would be challenge associated with achieving this desired end state of a multi-domain EW capability at the tactical edge. "There are still many challenges to the community which we all need to grapple with. Firstly, how do we differentiate between electronic attack and offensive cyber? This is one of the great-

est challenges I see in the next decade. Secondly, we have an multispectral range which can simulate your deployed operational environments, allowing us to train against almost any target set. This is good for specialists, but what about [attached personnel]? There are no true multi-domain training environments for them." Finally, Fogarty demanded further consideration of EW capabilities in the urban environment: "These are incredibly complex multispectral environments incorporating so much noise and congestion."

THE NEXT DECADE

Looking ahead to the future character of warfare and the role of tactical EW over the next decade, Fogarty suggested it was necessary to look back at how EW has evolved: "In 1998, we saw the introduction of network centric warfare and the move from platform primacy to the network. I'd argue that due to technological advances, we've moved towards more efficient sensor-to-shooter engagements, but not necessarily true network centric warfare. There are still information silos, some of which sadly exist to this very day. There's been a plethora of UK and US doctrine produced about information advantage and multi-domain operations and speed in decision-making has been one of the critical factors. The ability to conduct ISR to understand the situation, and importantly, an adversary, then make an informed decision, will ultimately allow us to act faster and in a more coherent fashion than our adversary," he concluded.

FIVE EYES PARTNERS TACKLE EW MODERNIZATION

Roke's Resolve communications ESM system is finding customers among Five Eyes users . ROKE PHOTO

Speaking to the audience at the AOC Europe Conference, Lt Col Chris Fogarty MBE of the British Army's 14 Signals Regiment stressed the importance of how the Five Eyes and its NATO/Non-NATO partners must interoperate and integrate capabilities across the EMS and not only when deployed on overseas operations. In Australia, for example, the army's Land 555 project continues to proceed with procurement of EW systems integrated into armored vehicles, with a projected in-service date of 2023. Under LAND 555 Tranche 1, the army integrated Roke's Resolve COMINT system into six Thales Bushmaster vehicles. In May 2020, the army announced Tranche 2, under which it would fit new electronic attack systems into these vehicles or into trailers. Specifically, the Australian Army has called for jamming, electronic support and command and control capability at the tactical, operational and strategic levels. Requirements also call for full interoperability with EW systems already in service with the Royal Australian Air Force and Royal Australian Navy in addition to Five Eyes partners. A Tranche 2 contract is expected to be signed by the end of 2021, with the selected solution providing an electronic attack capability for ground mobility forces.

In New Zealand, the army is looking at expanding its Network Enabled Army (NEA) program to include an intelligence, surveillance and reconnaissance (ISR) initiative that would focus in part on electronic warfare. The EW effort, valued at NZ$5-10 million (US$3.5-7 million), would represent a new ground EW capability for the New Zealand Army. In September, the New Zealand MoD issued a notice for companies to register their interest in the EW program and based on its review of responses, it will invite selected companies to provide further information.

The Canadian Army is pursuing a comprehensive Canadian Forces Land EW Modernization (CFLEWM) program that calls for the acquisition of new ground EW systems, as well as decision support tools, intelligence fusion tools, and training services. Valued at CAN$250-$500 million ($US200-$400 million), this effort is currently in the definition approval stage, and the army is looking for initial deliveries in the 2026-2027 timeframe.

In the US, the army has invested nearly US$10 billion in EW with specific efforts including the Terrestrial Layer System (TLS) for brigade-and-above operations. Also being pursued is the EW Planning and Management System (EWPMT); Tactical EW System (TEWS); in addition to efforts to integrate tactical EW capability on board MQ-1C Gray Eagle uncrewed aerial vehicles.

In August 2021, the US Army awarded General Dynamics a contract to develop an EW technology demonstrator

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The Canadian Army's 21 EW Regiment is looking to replace its venerable Bison LAVs under the Canadian Forces Land EW Modernization (CFLEWM) program. DEPARTMENT OF NATIONAL DEFENSE PHOTO

for integration onboard its new 4x4 Infantry Squad Vehicle (ISV). General Dynamics' Multi-Domain Operations Weapon System will be integrated on board the General Motors platform to provide a mobile EW capability at the tactical edge, referred to by the army as the TEWS-I (Integrated Brigade Combat Team) concept.

Sources suggest that the "TEWS-I" solution will comprise a next-generation capability of legacy TEWS and TEWS-Light variants, which are already deployed to eastern Europe on board Stryker armored vehicles and Flyer 72 tactical ground vehicles. It is also envisaged that TEWS-I will be integrated on board other tactical ground vehicles in the US Army's inventory to support units operating at the tactical edge, particularly satisfying electronic sensing and attack requirements. A total of six technology demonstrators will be manufactured by General Dynamics for test and evaluation. – *A. White*

Integrated Brigade Combat Team Stryker platforms have already been equipped with a tactical EW solution for operations in eastern Europe. GENERAL DYNAMICS PHOTO

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5G Communications – Part 9

Review of Propagation Formulas *cont'd.*

By Dave Adamy

This month, we complete our review of common propagation formulas before we return to our 5G discussion next month.

FRESNEL ZONE

Signals propagated near the ground or water can experience either line-of-sight or two-ray propagation loss – depending on the antenna heights and the transmission frequency. The Fresnel zone distance is the distance from the transmitter at which the phase cancellation becomes dominant over the spreading loss (i.e., the range at which two-ray propagation applies). As shown in Figure 1, if the receiver is less than the Fresnel zone distance from the transmitter, line-of-sight propagation takes place. If the receiver is farther than the Fresnel zone distance from the transmitter, two-ray propagation applies. In either case, the applicable propagation applies over the whole link distance.

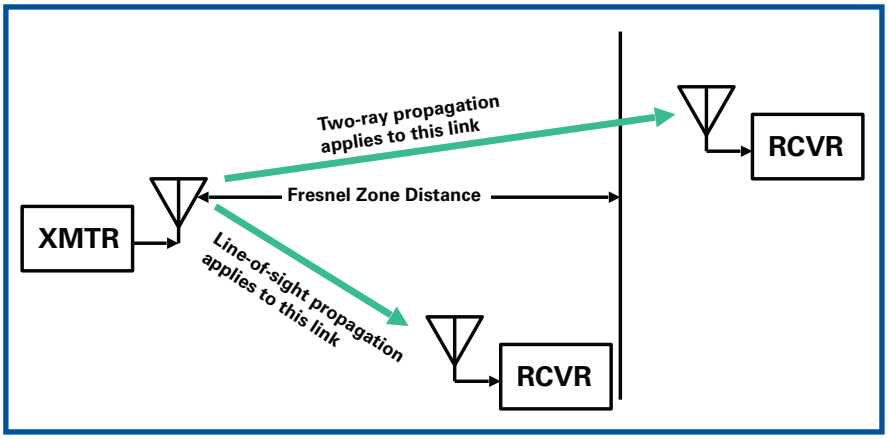

Fig. 1: *If the link is shorter than the Fresnel zone distance, it uses line-of-sight propagation. If it is longer than the Fresnel zone distance, it uses two-ray propagation.*

The Fresnel zone distance is calculated from the following formula:

$$FZ = 4\pi \times hT \times hR / \lambda$$

Where: FZ = the Fresnel zone distance in meters
hT = the transmitting antenna height in meters
hR = the receiving antenna height in meters
λ = the transmission wavelength in meters

A convenient version of this formula is:

$$FZ = [\, hT \times hR \times F] / 24{,}000$$

Where: FZ = the Fresnel zone distance in km
hT = the transmitting antenna height in meters
hR = the receiving antenna height in meters
F = the transmission frequency in MHz

KNIFE-EDGE DIFFRACTION (KED)

Non-line-of-sight propagation over a mountain or ridge line is usually estimated as though it were propagation over a "knife edge." This is a very common practice, and many EW professionals report that the actual losses experienced in terrain closely approximate those estimated by equivalent knife-edge-diffraction estimation.

The KED attenuation is added to the line-of-sight loss as it would be if the knife edge were not present, as shown in Figure 2. The geometry of the link over a knife edge is shown in Figure 3. H is the distance from the top of the knife edge to the line

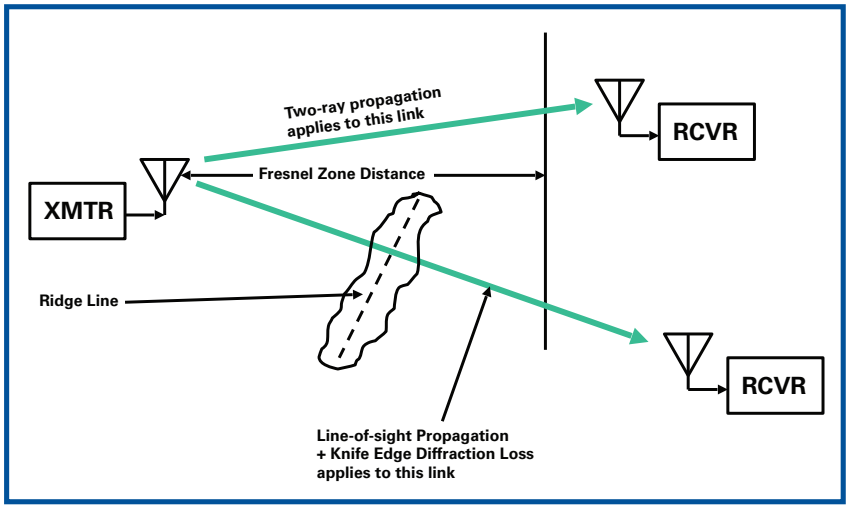

Fig. 2: *Even if the link distance is greater than the Fresnel zone distance, line-of-sight propagation applies if there is an intervening ridge line, however there is an additional diffraction loss.*

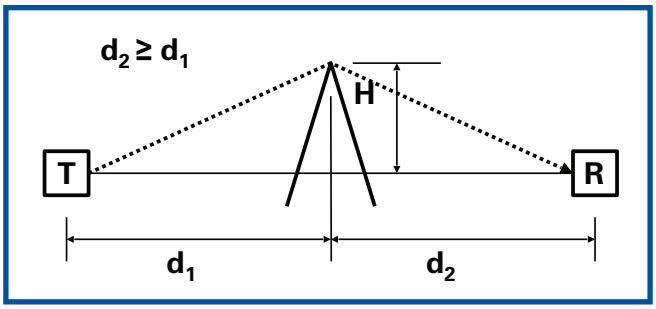

Fig. 3: The knife edge diffraction geometry is set by the distance to the knife edge, the distance past the knife edge, and the height of the knife edge relative to the line of sight path.

of sight. The distance from the transmitter to the knife edge is called d1 and the distance from the knife edge to the receiver is called d2. For KED to take place, d2 must be at least equal to d1. If the receiver is closer to the knife edge than the transmitter, it is in a blind zone in which only tropospheric scattering (with significant losses) provides link connection.

Figure 4 is a KED calculation nomograph. The left-hand scale is a distance value "d" which is calculated by the following formula:

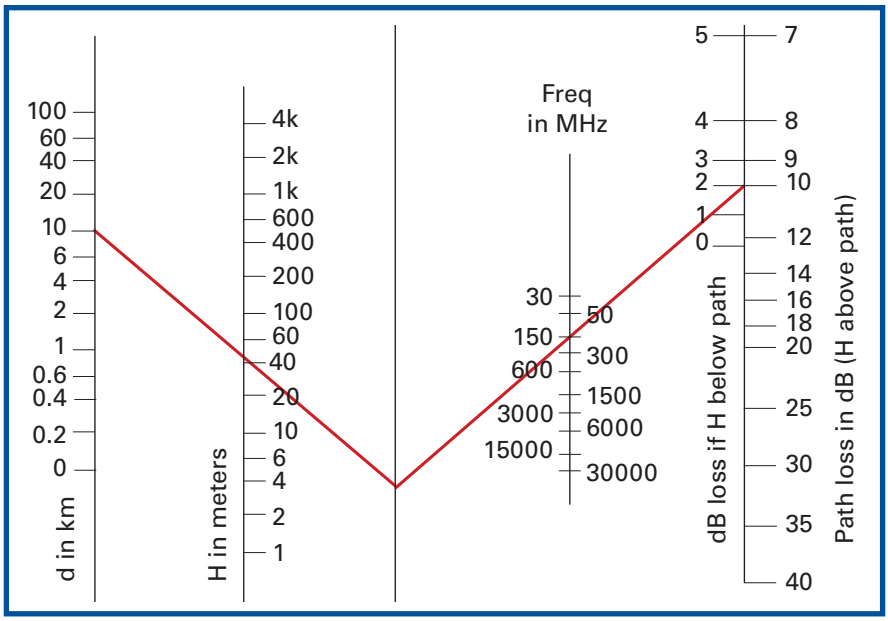

Fig. 4: Knife-edge diffraction can be determined graphically from the values of d and H and the frequency.

Table 1: Knife-edge "gain" is a function of "v"

v	G_d (dB)
$v \geq 1$	0
$0 \leq v \leq 1$	$20 \log_{10}(0.5 + 0.62\ v)$
$-1 \leq v \leq 0$	$20 \log_{10}(0.5 \exp[0.95\ v])$
$-2.4 \leq v \leq -1$	$20 \log_{10}(0.4 - \text{sqrt}[0.1184 - (0.1v + 0.38)^2])$
$v \leq -2.4$	$20 \log_{10}(-0.225 / v)$

Editor's Note: If this formula is in a format that is difficult to use, I have created a duplicate formula below that only has one anchored image (the square root symbol).

$$d = [\ \sqrt{2} / (1 + d_1/d_2)]d_1$$

If you skip this step and just set d = d1, the KED attenuation estimation accuracy will only be reduced by about 1.5 dB.

The line from d (in km) passes through the value of H (in meters). At this point, we don't care whether H is the distance above or below the knife edge. Extend this line to the center index line.

Another line passes from the intersection of the first line with the center index through the transmission frequency (in MHz) to the right-hand scale – which gives the KED attenuation. At this point, we identify whether H was above or below the knife edge. If H is the distance above the knife edge, the KED attenuation is read on the left-hand scale. If H is the distance below the knife edge, the KED attenuation is read on the right-hand scale.

Consider an example (which is drawn in red onto the nomograph): d is 10 km and the line-of-sight path passes 45 meters below the knife edge. The frequency is 150 MHz. If the line-of-sight path were 45 meters above the knife edge, the KED attenuation would have been 2 dB. However, since the line-of-sight path is below the knife edge, the KED attenuation is 10 dB.

The total link loss is then the line-of-sight loss without the knife edge + the KED attenuation.

CALCULATION OF KED

The math for calculation of KED is very complex, so a piece-wise approximation is suggested on page 1187 of the Communications Handbook (ISBN: 0-8493-8394-8).

First you must calculate a value "v" from the formula:

$$v = H \sqrt{\frac{2(d_1 + d_2)}{\lambda d_1\ d_2}}$$

Where: the d1, d2 and H values are the same as in Figure 3 above, and λ is the transmission wavelength.

Table 1 then gives the KED "gain" as a function of the variable "v." Note that the KED loss in dB is the negative of the gain in dB.

WHAT'S NEXT

Next month, we will return to the 5G discussion. For your comments and suggestions, Dave Adamy can be reached at dave@lynxpub.com.

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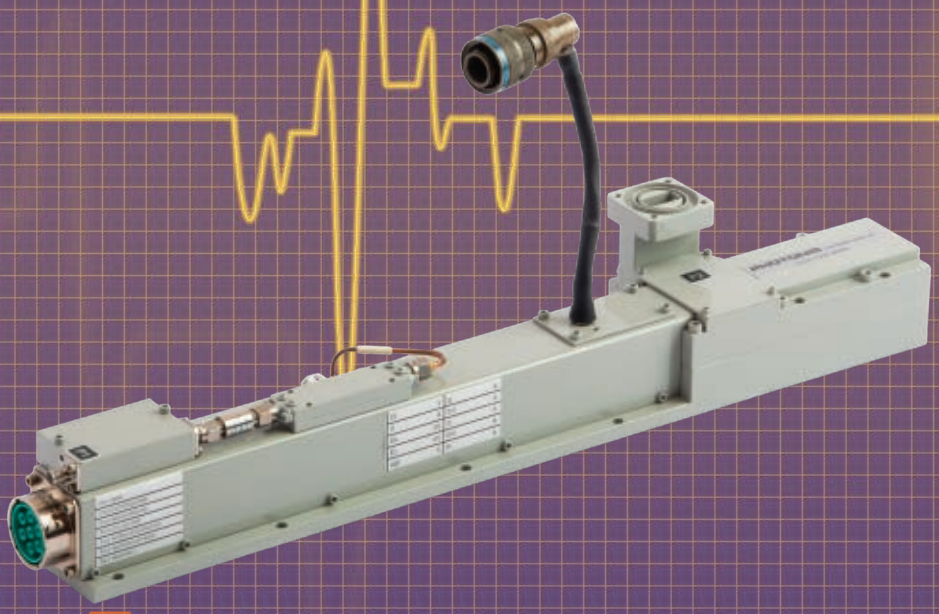

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PASSING OF A CROW: DR. JOHN O'HARA

Dr. John O'Hara lived a very full life taking advantage of every moment to make the world a better place for his family and his country. He passed away on Oct. 11 from prostate cancer.

Dr. O'Hara was born on Jan. 13, 1934 in the tiny Appalachian town of Bunola, Pennsylvania, where he developed his diehard love for all Pittsburgh sports teams.

At the age of 17, after graduating from Elizabeth High School, he decided to serve his country and joined the US Air force during the Korean War. He served as a bombardier/navigator on B-47 strategic bombers. While in the Air Force, John was stationed in Tucson, Arizona, where he met the love of his life, Merrily.

Eventually the O'Hara family settled in Bowie, Maryland, where John accepted a job with the NSA in 1962. He served in technical and management positions, then after attending the National War College, he was elevated to the rank of Senior Executive. He served in several senior leadership capacities and was NSA's Deputy Chief Scientist when he retired in 2000.

Throughout life, he was able to accomplish many goals, including traveling the world, getting anti-smoking laws passed, receiving many lifetime achievement awards, earning a patent and helping to launch satellites. He earned a bachelor's degree from the University of Arizona, master's degrees from University of Pennsylvania and the National War College and his PhD from the Catholic University of America, becoming a professor at George Washington University.

OFFICIAL AOC NOMINATIONS & ELECTIONS REPORT FOR 2021 ELECTIONS

The following information contains the Nominations & Election (N&E) Committee's tabulated results of the 2021 Election held during October 2021. The results have been validated and presented to the Association of Old Crows Board of Directors.

Thank you to all those who ran for an office this year, the quality of the volunteers and their dedication to the organization really shows how fortunate we are to have such leadership available to us.

Also, thank you to everyone that voted!

Total number of eligible voters – 12,256
Total members voted – 1,207
Percentage of Voters – 9.85%

President Elect
Brian Hinkley – 68.27%

At-Large Director – Three Candidates
Mid-Atlantic Region – Two Candidates
Only two could be selected (% based on 200%)
Dennis Monahan – 68.04%
Steve Oatman – 74.73%
Nino Amoroso – 70.51%

Central Region – Two Candidates

Mountain Western Region – Unopposed
James Utt – 64.18%
Wayne Shaw

ASSOCIATION OF OLD CROWS

DIXIE CROW CHAPTER OF THE ASSOCIATION OF OLD CROWS FEEDS HABITAT FOR HUMANITY

An All-Star Dixie Crow Chapter Chuck wagon crew led by our own Chef Roadkill, aka Mark Leslein, assembled on Oct. 23 to feed the Habitat for Humanity Crew in Warner Robins, Georgia. The crew prepared and served more than 20 volunteers with grilled brats with peppers and onions, BBQ chicken and hot dogs served with baked beans, fresh fruit salad, homemade brownies, water and soda.

Dixie Crow Members in attendance were: Brooke Horka, Rod and Robyn Brooks, Adam Delestowicz, John Shawhan, John Lewis, James Miller, Linda Ray, Irena Ethridge, Lynwood and Betsy Moore, Ken Cirilli and Lisa Frugé-Cirilli, Debbie Koenig, Tom Miller, Mark Leslein, Scott Wolf and Bob and Mary Thrower.

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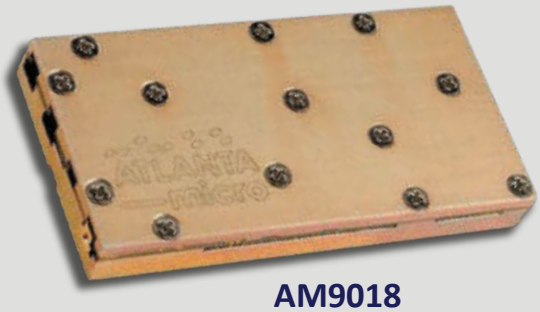

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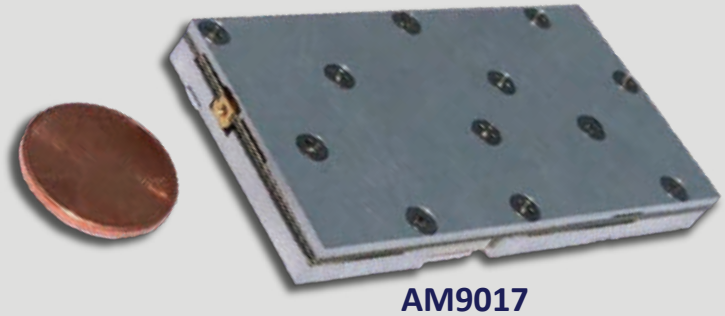

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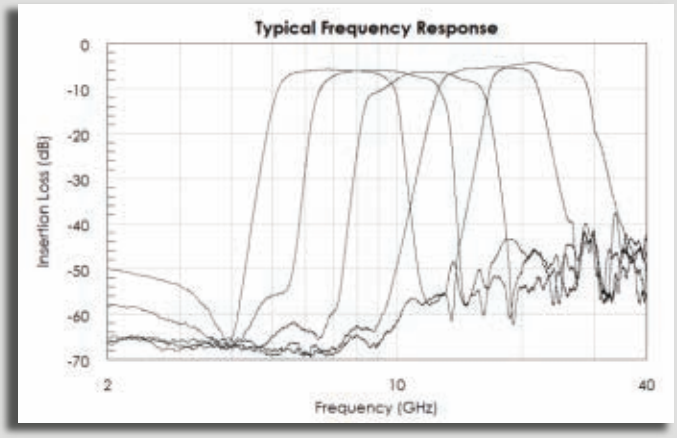

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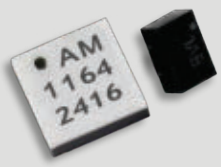

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STAY CONNECTED

Welcome to AOC 2021, the Association of Old Crow's International Symposium & Convention! If you are joining us this week in D.C., here's a few ways to keep up-to-date on everything happening. If you are not able to join us, you can still get a taste of the convention experience.

EVENT APP

It's never been easier to stay up-to-date of everything going on at this year's event! The AOC 2021 event app let's you keep track of every symposium session, every major event, you can even search for exhibitors and plan meetings!

Pull out your smartphone camera and point it at the QR code to start the download process. You can also search **AOC 2021** in your phone's app store.

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PODCAST

From the Crows' Nest

Our From the Crows' Nest podcast host, Ken Miller, will be recording live with many of our speakers from a studio located right in the exhibit hall. Start listening now and be sure to tune in for his daily recaps right from the event. Episodes will be available after the event for all to enjoy.
Find out more at crows.org/podcasts.

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CONGRATULATIONS 2021 AOC Award Winners!

Please join AOC in recognizing this year's award winners presented during the Opening Keynote Session on Tuesday morning and during the Assembly of Delegates on Wednesday.

PRESTIGE AWARDS

AOC GOLD MEDAL AWARD

The Gold Medal Award is AOC's highest and most prestigious award. It is presented to a senior U.S. or International government, military, or industry official in recognition of outstanding and dedicated service to promote and advance the discipline of Electronic Warfare.

Mr. Stephen D. Kreider

AOC presents the 2021 Gold Medal to Mr. Stephen D. Kreider for his outstanding contributions to the warfighter over a sustained period of nearly four decades of military and civilian service.

In a career that spanned 36+ years of active duty and civil service, Mr. Stephen Kreider made significant contributions that ensured U.S. superiority in the electromagnetic spectrum. Mr. Kreider was selected to the Senior Executive Service in 2008. He held numerous leadership positions that involved using the EMS to provide overmatch capabilities. Mr. Kreider culminated his career as the Program Executive Officer Intelligence, Electronic Warfare & Sensors (PEO IEW&S), where he had the vision and foresight to begin reintroducing electronic warfare capabilities into Army formations ever since these capabilities were allowed to atrophy to the point of non-existence in the late 80's post-Cold War era.

During his tenure as PEO IEW&S, Mr. Kreider was responsible for over 80 Title 10 weapon system programs and quick reaction capabilities in support of cyberspace operations, force protection, military intelligence, surveillance, reconnaissance, and electronic warfare. These highly sophisticated capabilities continue to support military operations around the globe today. For example, rotary and fixed-wing aircraft rely on infrared countermeasure technology to protect against advanced surface-to-air missile threats; Position, Navigation and Timing (PNT) and Assured PNT capabilities enable situational awareness and reduce warfighter vulnerabilities by ensuring accurate information is always available; radio frequency jammers protect personnel, platforms, and bases against lethal improvised explosive devices (IEDs); sophisticated counter target acquisition radar technology helps neutralize the deadly threat of mortar and rocket attacks; offensive cyber operations protect against a spectrum of adversaries; and aerial and terrestrial signal collection platforms continue to support intelligence gathering to provide the battlefield commander a decisive edge. From a Joint and Coalition perspective, Mr. Kreider served as the DOD Single Manager for Ground-Based CREW and served as the Chair of the NATO Team of Experts on radio-controlled IEDs.

Mr. Stephen Kreider's leadership and vision in advancing EW, SIGINT, Cyberspace, and Information Operations for the Army and Joint Force Commander has had an enduring impact, as evidenced by the world-class warfighting capabilities that continue to operate worldwide to this day.

THE HAL GERSHANOFF SILVER MEDAL AWARD

The Hal Gershanoff Silver Medal Award is both a tool of recognition of deeds and a beacon of appreciation for the spirit of dedication, commitment, contribution, and selflessness that were uncommonly tangible in Hal's service to the EW community and to AOC. **AOC presents the 2021 Hal Gershanoff Silver Medal to Mr. Steve "Tango" Tourangeau** for many decades of support to AOC and the EW community and for his passion and commitment to advancing the art and science of EMSO.

Mr. Steve "Tango" Tourangeau

Tango's membership in AOC spans over 30 years, spawned by his assignment as an F-4 EWO in 1985. He is a retired USAF officer, master navigator, and EWO with operational and flight test experience in fighter, mobility, and special ops aircraft. He has served as an appointed member of the AOC Board of Governors, served on the Board of the Kittyhawk Chapter, and after revitalizing the Granite State Roost Chapter, he served as President from 2015-2018 and again 2020-Present.

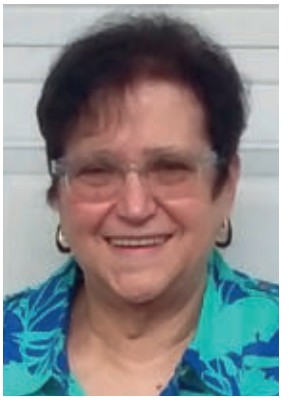
Tango is a long serving member of the JED Editorial Advisory Committee and has led the Granite State Roost to several Chapter of the Year and Regional Membership Growth awards. During his time on the Chapter Board, he established a sponsorship program, developed a partnership with the local IEEE chapter, and initialized numerous chapter activities that have become annual events. In addition, while serving as the AOC Scholarship Chair in 2015, Tango developed the prestigious annual Raytheon grant of $25,000, established the criteria for the scholarship applicants and saw that the award process was formalized and followed. This scholarship grant is still implemented today.

What is probably most notable contribution in the past year is last October 2020, during the COVID crisis, Tango traveled to the Pentagon for a meeting with Mr. Dave Tremper, OUSD A&S Director of EW Programs and Executive Secretary of the EW EXCOM to discuss the importance of EP features on every spectrum-dependent system. Following this interaction, Mr. Tremper has been on a crusade, speaking at every possible venue on the importance of EP features in the EW community.

In 2019 Tango and his wife, Melinda, established Reginald Victor Jones (RVJ) Institute as an International Center of Excellence for EMSO. He is also the Vice President, Warrior Support Solutions, LLC.

COL ANTON D. BREES LIFETIME SERVICE AWARD

This award recognizes AOC members who have rendered exemplary sustained service to the association on a national or local level. The award is named after Colonel Tony Brees, USAF (Ret.) who truly exemplified the attributes of the AOC Lifetime Service Award. **AOC presents the 2021 Col Anton D. Brees Lifetime Service Award to Mrs. Irene Biddy and Mrs. Lisa Frugé-Cirilli.**



Mrs. Irene Biddy

Mrs. Lisa Frugé-Cirilli

AWARD RECIPIENTS

JOSEPH W. KEARNEY PIONEER AWARD

The Joseph W. Kearny Pioneer Award recognizes an individual's notable pioneering activities and long service to the discipline of Electronic Warfare. The award is named after Joe Kearney who was a technical leader at AIL and very instrumental with the Crows in the 1970s and early 1980s. **AOC presents the 2021 Joseph W. Kearney Pioneer Award to MSgt Seth M. Anderson, USAF.**

AOC TECHNOLOGY HALL OF FAME AWARD RECIPIENT

The Technology Hall of Fame recognizes individuals who have been prime innovators in technology development and whose achievements have resulted in enhanced survivability of forces and equipment. **AOC presents the 2021 Technology Hall of Fame Award to Mr. Duane Beaulieu.**

THE JOHN CLIFFORD AWARD FOR THE ADVANCEMENT OF THE ELECTROMAGNETIC DOMAIN AWARD

The John M Clifford Award for the Advancement of the Electromagnetic Domain recognizes individuals who have promoted and instilled advocacy and leadership in EW and EM spectrum operations. **AOC presents the 2021 John Clifford Award to Mrs. Melinda Tourangeau.**

ELECTROMAGNETIC SPECTRUM OPERATIONS (EMSO) AWARDS

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MILITARY SERVICE AWARD – ARMY
CW4 Michael Ebinal, USA

MILITARY SERVICE AWARD – NAVY
CPO Nicholas Davis, USN

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Unit 513 of the IDF

OUTSTANDING UNIT – NATO
NATO Electronic Warfare Doctrine and Policy Panel (EWPDP)

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2021 REGIONAL CHAPTER GREATEST INCREASE AWARDS

Congratulations to the following chapters for having the largest membership increase in their region.

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SOUTHERN REGION
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INTERNATIONAL REGION I
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OVERALL GREATEST INCREASE WINNER
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Nominations for 2022 AOC Awards will open in January. Deadline for award nominations is May 1, 2022. For more information, please visit crows.org.

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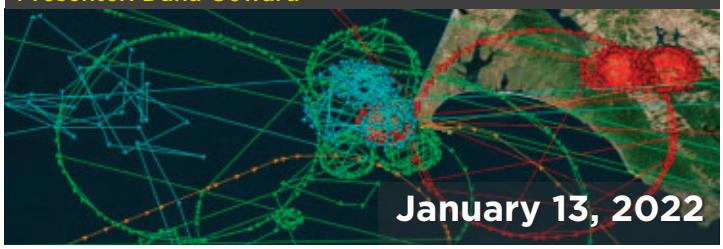

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Tactical Electronic Support Measures (ESM)
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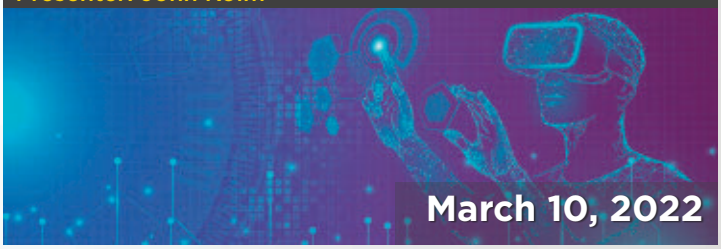

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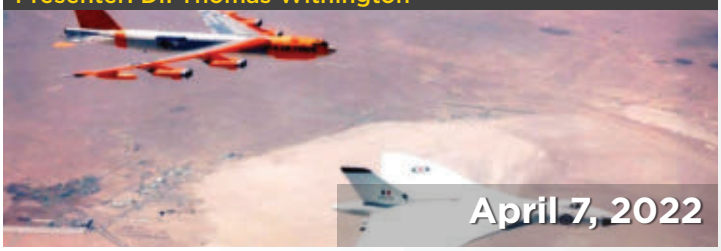

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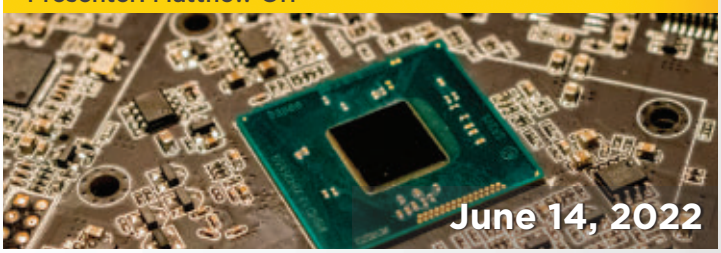

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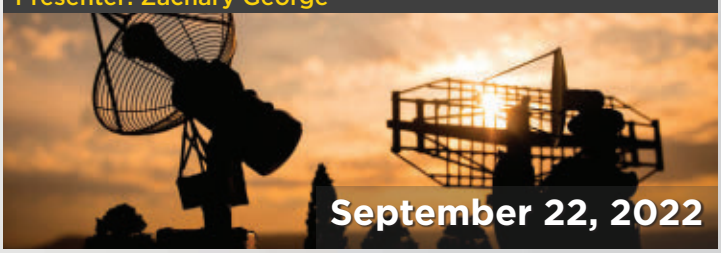

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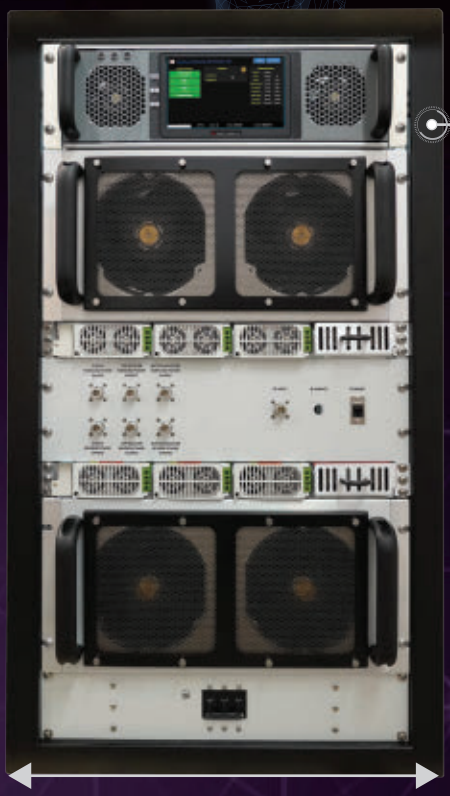

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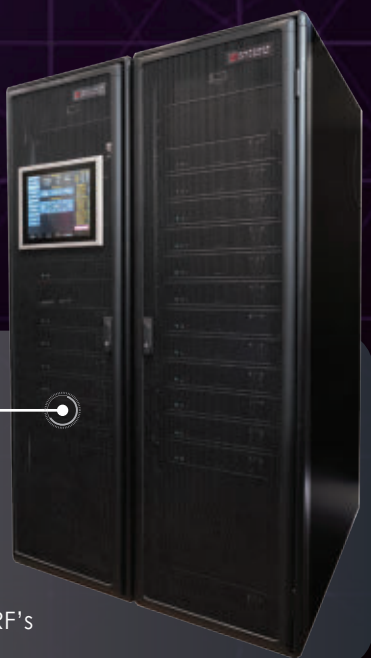

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