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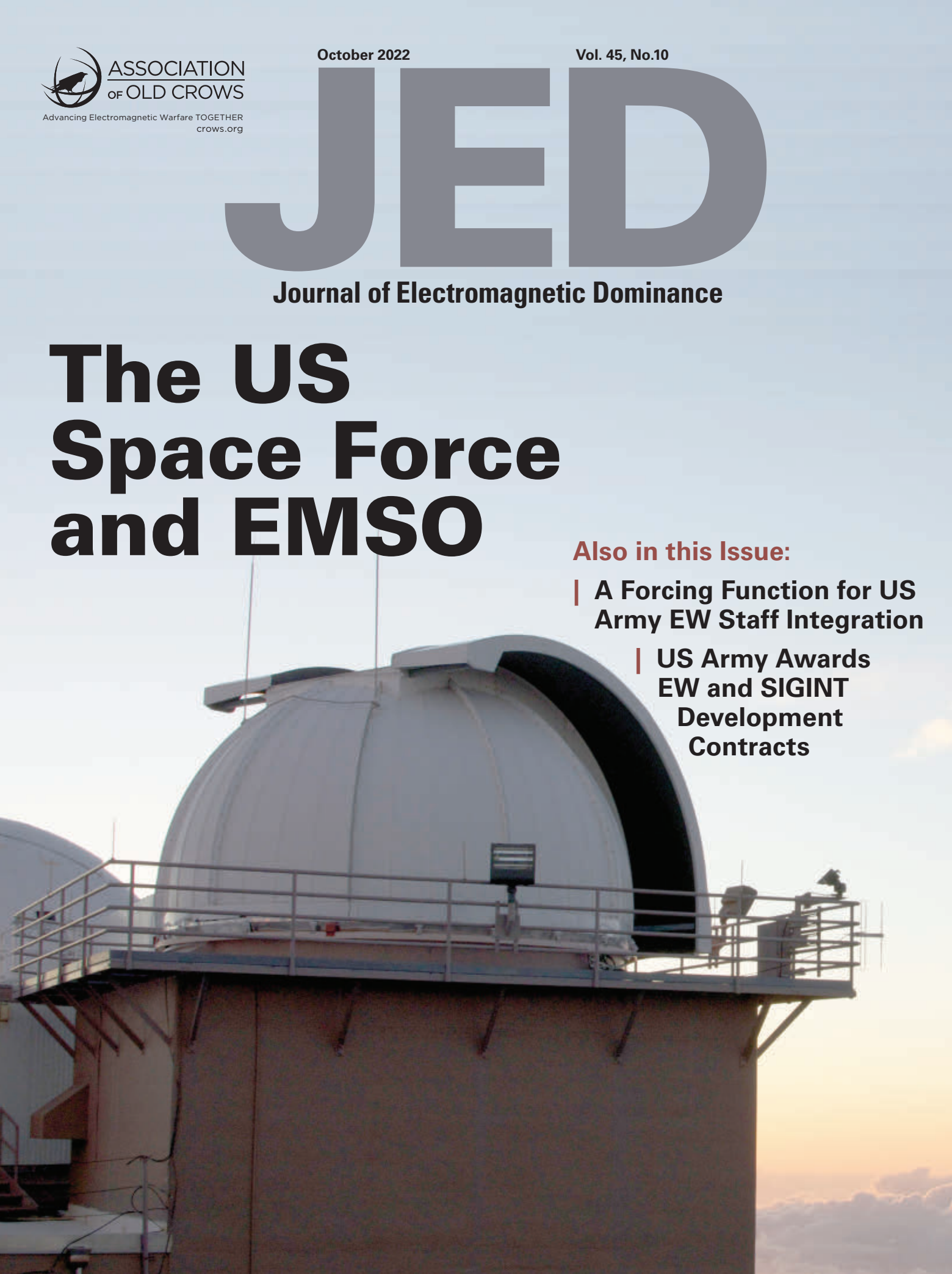
October 2022 Vol. 45, No.10

JED

Journal of Electromagnetic Dominance

The US Space Force and EMSO



Also in this Issue:

- A Forcing Function for US Army EW Staff Integration
- US Army Awards EW and SIGINT Development Contracts

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JED
Journal of Electromagnetic Dominance

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October 2022 • Volume 45, Issue 10

On Aug. 17, the US Air Force's 55th Electronic Warfare Group (Davis-Monthan AFB, AZ) received a visit from a new EC-37B Compass Call aircraft. Photos of the visit provided the first good look at the new Compass Call model, which will eventually replace the Group's EC-130H Compass Call fleet. Three EC-37Bs are currently building or undergoing ground and flight tests. The 55th EWG is expected to field the first five (of possibly 14) EC-37Bs by the end of next year. (USAF photo by Airman 1st Class Vaughn Weber)

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Departments

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HOLISTIC INTEGRATION

For the US Army, 2022 has been quite an eventful year, so far. Russia's invasion of Ukraine is giving the Army a good look at how the Russian Army fights, how well its weapons systems work, how well its units perform alone and together and the quality of its leaders it has up and down the chain of command.

While the Russian Army's battlefield performance has been weaker than expected over the first 200 days, it still retains formidable combat power – if it figures out how to use it. What is perhaps most significant is the ways in which Russia's Army, despite its materiel advantage, has struggled during the conflict. Its shortfalls appear to spread across a number of areas, including training, operational planning, logistics and leadership.

From an EW perspective, Russian forces have also not performed as expected. Ukrainian forces have used their guided anti-tank weapons to blunt Russia's armor advantage since the opening phase of the invasion; Russian artillery is exposed to return fire from Ukrainian artillery (thanks in part to counter-fire radars); and Russia's air power – including its helicopters – has not been a significant factor in the war because its aircraft are at risk from Ukraine's long- and short-range air defense systems. ISR assets (both Ukrainian and other western nations) also have played a significant role in the conflict by helping to provide precision geolocation and identification of Russian targets on the ground. In short, Russia hasn't been able to use combined arms tactics because each of its components, including EW systems, can be put at risk by Ukrainian forces.

While continuing to monitor the Russia-Ukraine war and learn lessons from it, the US Army continues to refine its Cyber Electromagnetic Activities (CEMA) concept and modernize its electromagnetic warfare (EW) and tactical signals intelligence (SIGINT) capabilities. Over the past few months, the Army has moved forward with developing two variants of Terrestrial Layer System (TLS) family of ground-based electromagnetic support (ES) and electromagnetic attack (EA) systems. It has also continued developing its Multi-Domain Sensor System (MDSS), which will provide the Army's next-generation airborne SIGINT capability. The Army still needs to nail down its airborne EA program(s), after slowing its Multi-Function EW-Air (MFEW-Air) program last year. In general, however, the Army is shifting away from its quick-reaction approach to EW system development in favor of more stable programs of record.

Equipment modernization is just one piece of the puzzle, however. Introducing new EW capabilities only matters if an army can also integrate EW into its training, planning and operations. This is the point that US Army officers LTC Matthew Haynes and MAJ Luke Plante make in their article, "A Forcing Function for US Army EW Staff Integration," in this month's issue of *JED*. As the authors explain, if the US Army wants to get the most out of its current and future EW capabilities, it needs to integrate EW holistically across its force. The US Army has an opportunity to take a free lesson from the Russians (and perhaps see a good example from the Ukrainians): EW integration is essential wherever you can do it. – *J. Knowles*

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Journal of Electromagnetic Dominance

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AUSA Annual Meeting
Oct. 10-12
Washington, DC
www.ausa.org

Precision Strike Technology Symposium 2022
Oct. 18-20
Laurel, MD
www.ndia.org

AOC Pacific IO and EW Symposium
Oct. 18-21
Honolulu, HI
www.fbcinc.com/e/aocpacific/

EURONAVAL
Oct. 18-21
Paris, France
www.euronaval.fr

International Telemetry Conference 2022
Oct. 24-27
Glendale, AZ
www.telemetry.org

59th Annual AOC International Symposium and Convention
Oct. 25-27
Washington, DC
www.crows.org

NOVEMBER

2022 Aircraft Survivability Symposium
Nov. 1-3
Monterey, CA
www.ndia.org

Navy Information Warfare Industry Day 2022
Nov. 9
Springfield, VA
SECRET/NOFORN
www.afcea.org

Bahrain International Airshow 2022
Nov. 9-11
Sakhir Air Base, Bahrain
www.bahraininternationalairshow.com

2022 Directed Energy Systems Symposium
Nov. 14-18
La Jolla, CA
www.deps.org

I/ITSEC 2022
Nov. 28 – Dec. 2
Orlando, FL
www.ndia.org

Electronic Warfare Conference
Nov. 29-30
Swindon, UK
www.cranfield.ac.uk

MILCOM 2022
Nov. 29 – Dec. 2
Valparaiso, Chile
www.exponaval.cl

EXPONAVAL 2022
Nov. 29 – Dec. 2
Valparaiso, Chile
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JANUARY

Surface Navy Association 35th Annual National Symposium
Jan. 10-12
Arlington, VA
www.navysna.org

FEBRUARY

Aero India 2023
Feb. 3-5
Bengaluru, India
www.aeroindia.gov.in

DIMDEX
Feb. 5-7
Doha, Qatar
www.dimdex.com

*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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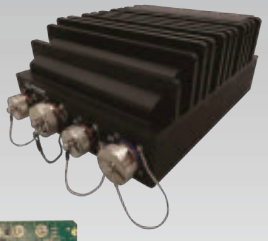

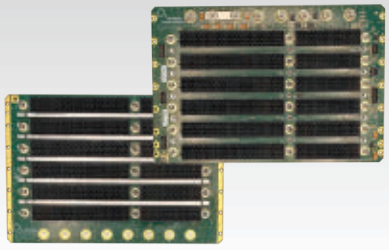

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Online
www.pe.gatech.edu

Basic RF EW Concepts
Oct. 25-27
Atlanta, GA
www.pe.gatech.edu

NOVEMBER

AOC Virtual Series Webinar:
Testing Your RWR – Accuracy Matters
Nov. 3
2-3 p.m. EDT
www.crows.org

AOC Virtual Series Webinar:
Electromagnetic Maneuver:
Towards a Theoretical Underpinning
Nov. 10
2-3 p.m. EST
www.crows.org

Cyber Warfare / Electromagnetic Warfare Convergence
Nov. 15-17
Atlanta, GA
www.pe.gatech.edu

RWR System Design and Analysis
Nov. 15-17
Atlanta, GA
www.pe.gatech.edu

Infrared Countermeasures
Nov. 15-18
Atlanta, GA
www.pe.gatech.edu

AOC Virtual Series Webinar:
Two-Way Time-Transfer Digital Design for Distributed Array Operations
Nov. 17
2-3 p.m. EDT
www.crows.org

DECEMBER

Electromagnetic Warfare Data Analysis
Dec. 6-7
Atlanta, GA
www.pe.gatech.edu

AOC Virtual Series Webinar:
In the Flat Field: Did Russian Army EW Underperform in Ukraine
Dec. 15
2-3 p.m. EDT
www.crows.org

JANUARY

AOC Virtual Series Webinar:
Regaining the Spectrum Offensive
Jan. 5
2-3 p.m. EDT
www.crows.org

AOC Virtual Series Webinar:
2023 GPS Spoofing – History and Prevention
Jan. 19
2-3 p.m. EDT
www.crows.org

FEBRUARY

AOC Live Course: 21st Century Electronic Warfare – Systems, Technology and Techniques
Feb. 1 – Mar. 1
8 Session, 3 hrs. each
www.crows.org

AOC Virtual Series Webinar:
Joint All-Domain Command and Control (JADC2)
Feb. 23
2-3 p.m. EDT
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*AOC courses and webinars are noted in **red**. For more info or to register, visit crows.org.*

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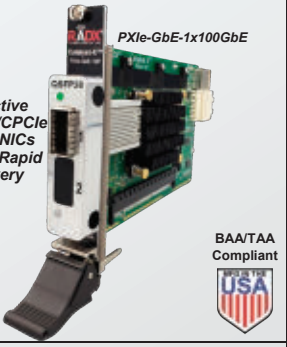

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OWNING THE EMS HIGH GROUND

Space is the current "High Ground" and provides unique opportunities and challenges for EMSO. Throughout history, the ones who hold the "high ground / high terrain" have an advantage; in fact, both Clausewitz and Sun Tzu discussed *terrain* in their writings and talk about the advantages of an elevated position.

Space and EMSO are key when we look at the ability to sense, attack, defend and win in future conflicts. Space assets are deployed in various orbits, Low Earth Orbit (LEO), Medium Earth Orbit (MEO) and High Earth Orbit (HEO), Geosynchronous and Polar orbits, which enable a matrix of "High Ground" locations for these capabilities to enable EMSO.

As we look at Space assets and EMSO, we must also consider potential vulnerabilities of where these assets operate. LEO, MEO and HEO assets have predictable orbits, and that predictability could be a vulnerability, though these can maneuver if required. Geosynchronous and Polar assets could be viewed as "fixed" which is a vulnerability, but their extreme distance improves survivability. As more nations develop and utilize Space, it sets the stage for a congested and contested environment, just as we have seen in the other physical domains of land, sea and air. This also raises challenges for EMSO superiority and dominance. Space assets must be maneuverable and resilient to survive not only the environmental conditions, but also include appropriate EP. Space assets must also be better integrated into Joint and Coalition operations and be creative in how these assets are used and could be used; and this is happening today.

At the recent *2022* Space and Missile Defense Symposium, General Dickinson (USSPACECOM Commander) highlighted that SPACECOM is integrating "non-traditional" sensors originally built for tracking and targeting ballistic missiles, into its network for keeping tabs on satellites and spacecraft and provide increased fidelity to the understanding of the space environment. SPACECOM has "Joint integrated space teams" at the other 10 combat commands to support the Joint Force.

The Army is developing an influence triad through fusing the effects of space-based cyber and SOF capabilities across the spectrum of conflict. In this new triad concept, US Special Operations Command and US Cyber Command personnel are embedded with staff from the USSPACECOM to link the three triad elements – intelligence from space-based assets, cyber detection and special operations forces – to amplify and synergize all three capabilities when monitoring, influencing or deterring an adversary.

The "High Ground" will need to continue to evolve and adapt like the other warfighting domains to ensure successful EMSO across all domains.

Our flagship event, the 59th Annual International Symposium, in Washington, DC, occurs at the end of this month. So, if you haven't registered there is still time. I am hoping to see many of you in person at this great event, especially as we swear in our new AOC President, Brian Hinkley, and our 2023 Board of Directors and Governors. – *Glenn "Powder" Carlson*

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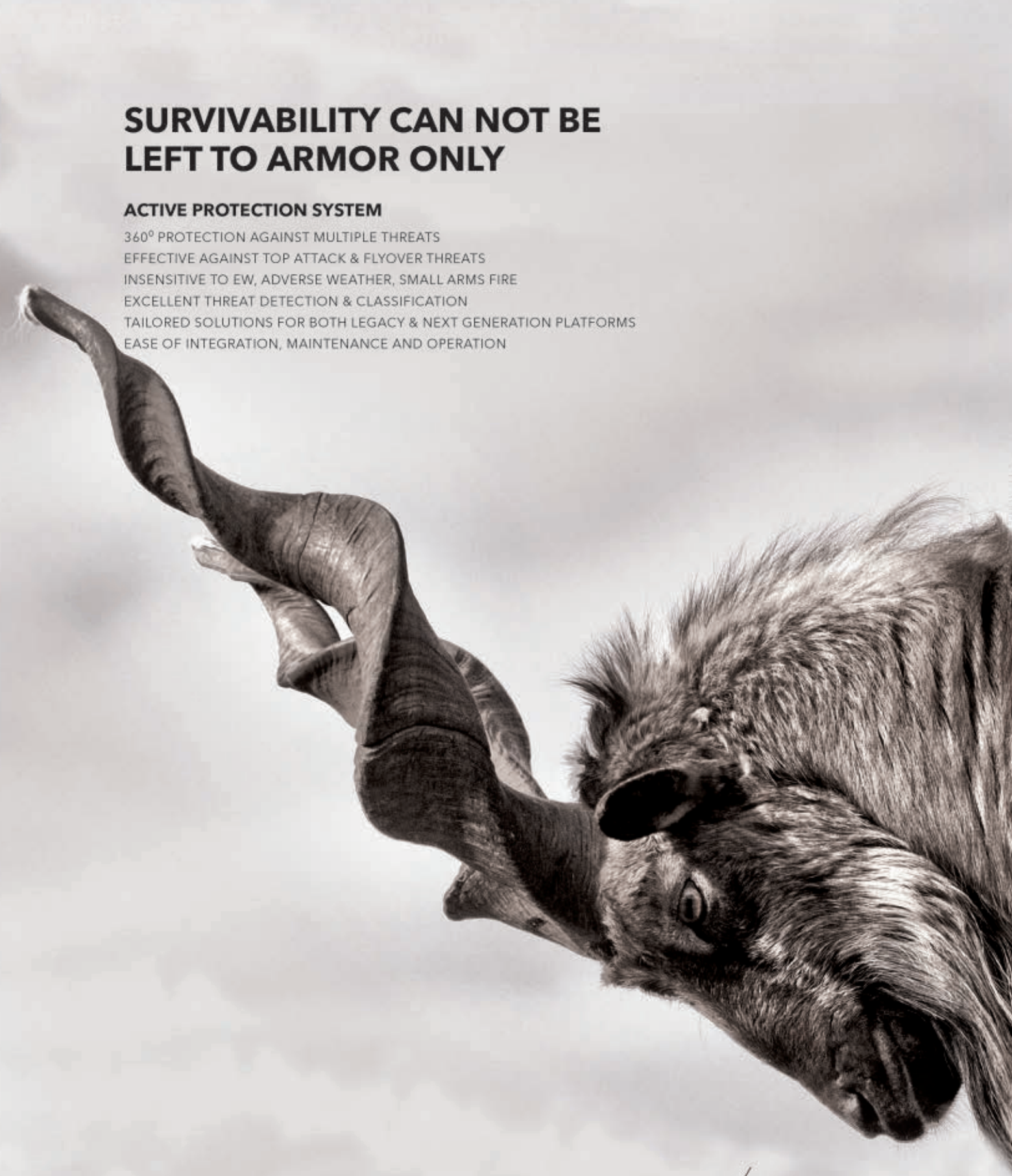

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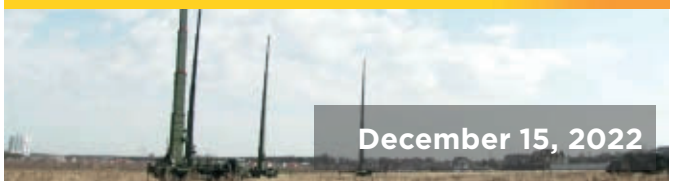
Testing Your RWR - Accuracy Matters
Presenter: Giovanni D'Amore

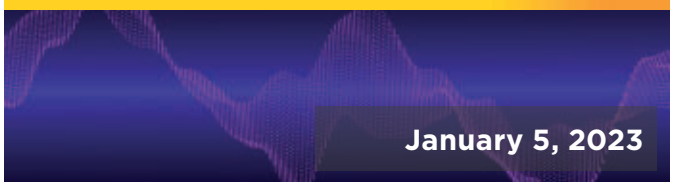
Electromagnetic Manoeuvre: Towards a Theoretical Underpinning
Presenter: Thomas Withington

Two-way Time-transfer Digital Design for Distributed Array Operations
Presenter: Jonathan D. Chisum

In the Flat Field: Did Russian Army Electronic Warfare underperform in Ukraine?
Presenter: Thomas Withington



Regaining the Spectrum Offensive
Presenter: Bryan Clark



2023 GPS Spoofing – History and Prevention
Presenter: Dana Goward

Joint All-Domain Command and Control (JADC-2)
Presenter: Thomas Withington

Chinese Thinking on the Establishment of "Information Dominance"
Presenter: Dean Cheng

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D5320	12-Way	470-860	500	5,000	0.30	1.30:1	All N-Female
D10119	4-Way	700-4200	2,000	15,000	0.30	1.35:1	13-30 DIN-Female, N-F
D10603	32-Way	900-925	50,000	150,000	0.15	1.25:1	WR975, 7/16-Female
D10795	32-Way	900-930	25,000	150,000	0.25	1.20:1	WR975, 4.3-10-F
D9710	8-Way	1000-2500	2,000	10,000	0.30	1.40:1	1 5/8" EIA, N-Female
D8182	5-Way	1175-1375	1,500	25,000	0.40	1.35:1	1 5/8" EIA, N-Female
D6857	32-Way	1200-1400	4,000	16,000	0.50	1.35:1	1 5/8" EIA, N-Female
D11896	4-Way	2000-2120	4,000	40,000	0.25	1.40:1	WR430, 7/16-Female
D11828	4-Way	2400-2500	3,000	25,000	0.20	1.25:1	WR340, 7/16-Female
D10851	8-Way	2400-2500	8,000	50,000	0.20	1.25:1	WR340, 7/16-Female
D11433	16-Way	2700-3500	2,000	20,000	0.30	1.35:1	WR284, N-Female
D11815	16-Way	2700-3500	6,000	40,000	0.30	1.35:1	WR284, N-Female
D12101	6-Way	2750-3750	2,000	20,000	0.35	1.40:1	WR284, N-Female
D9582	16-Way	3100-3500	2,000	16,000	0.25	1.50:1	WR284, N-Female
D12102	6-Way	5100-6000	850	4,500	0.35	1.35:1	WR159, N-Female
D12484	6-Way	8200-8600	600	700	0.35	1.25:1	WR112, SMA-Female
D12485	6-Way	9000-11,000	500	700	0.40	1.35:1	WR90, SMA-Female

Specifications subject to change without notice.

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US ARMY AWARDS EW AND SIGINT DEVELOPMENT CONTRACTS

The US Army's Program Executive Office for Intelligence, Electronic Warfare and Sensors (PEO IEW&S) has awarded contracts for development of a ground-based electromagnetic warfare (EW) system, as well as an airborne signals intelligence (SIGINT) sensor.

In August, the PEO's Program Manager for Electronic Warfare and Cyber (PM EWC), acting through the Consortium for Command, Control, and Communications in Cyberspace (C5), awarded two Phase 1 development contracts for the Terrestrial Layer System – Echelon Above Brigade (TLS-EAB) program. TLS is a family of ground-based ES and EA systems that is being developed in three configurations: a manpack version that is still in the requirements stage, a Stryker-mounted version that will support Brigade Combat Teams (TLS-BCT) and the "heavy" TLS-EAB version that will perform long-range electromagnetic support (ES) and provide communications electronic attack (EA), as well as counter-UAS EA to protect rear assets, such as command posts. The TLS-EAB contracts were awarded to General Dynamics Mission Systems, which has a long record supporting the Army's Prophet Ground family of vehicle-mounted EW and SIGINT systems, and Lockheed Martin, which recently won a prototype development contract for the TLS-BCT program.

The two TLS-EAB Phase 1 contracts, with a combined value of $15 million, will run for 11 months. This phase will focus on concept design, system design review and developing and demonstrating a TLS-EAB software architecture. Potential follow-on contracts for Phase 2 will focus on TLS-EAB prototype development. The overall development and prototype phases of the TLS-EAB program are valued at $163 million.

On the airborne SIGINT front, the PEO's Project Director Sensors – Aerial Intelligence (PD SAI) said it entered into separate Phase 2 agreements with L3Harris Integrated Mission Systems and Raytheon Applied Signals Technology to continue development of communications intelligence (COMINT) and electronic intelligence (ELINT) sensors for its Multi-Domain Sensing System (MDSS) program. The MDSS effort will provide a sensor suite for the Army's High Accuracy Detection and Exploitation System (HADES) airborne ISR program, which is slated to eventually replace the Army's RC-12 Guardrail SIGINT aircraft, among others. Unlike the turboprop-powered RC-12s, HADES is expected to be modified business jet, which can provide faster dash speed and fly at longer ranges than the RC-12.

These MDSS Phase 2 contracts, totaling more than $18 million over a two-year performance period, call for the companies to further their designs and build prototype ELINT and COMINT sensors, with a focus on "performance/sensitivity at higher altitude, range, and speed," according to an Army press release. In Phase 3, which will run for one year, PM EWC will select one or both contractors to integrate their prototype SIGINT sensors into contractor-owned, contractor-operated (COCO) aircraft for flight testing. *– J. Knowles*

US NAVY PLANS FREQUENCY EXTENSION FOR NGJ-MB POD

The US Navy has disclosed plans to expand the frequency coverage of the AN/ALQ-249(V)1 Next Generation Jammer – Mid Band (NGJ-MB) airborne electronic attack pod.

In an August 5 pre-solicitation notice, the Naval Air Systems Command (NAVAIR) said it planned to award a cost-plus fixed fee modification to the NGJ-MB Engineering Manufacturing & Development (EMD) contract to Raytheon Intelligence & Space (El Segundo). The sole-source award will cover "trade studies of various implementation approaches focused on the potential expansion of the Mid-Band 2 (MB2) frequency coverage to be utilized for potential implementation into the [NGJ-MB] pod," said NAVAIR, adding: "These studies will include various implementation approaches and risk reduction analyses with respect to this expansion [and] will include studies and impact assessments necessary to support critical design decisions associated with the NGJ-MB program."

Raytheon was awarded the main NGJ-MB EMD contract, valued at US$1 billion, in April 2016. The NGJ-MB pod – two of which will be carried by the EA-18G Growler – is part of a larger AEA suite that will augment and ultimately replace the EA-18G's legacy AN/ALQ-99 Tactical Jamming System.

Deliveries of production-representative AN/ALQ-249(V)1 pods to the Navy began in early July. Two fleet representative test articles were delivered to the Naval Air Warfare Center Aircraft Division (NAWCAD) at Patuxent River, MD. They will be used to complete the developmental test (DT) program and commence operational test (OT) that requires the use of operationally representative hardware and software

NAWCAD's Air Test and Evaluation Squadrons VX- 23 and VX-31, based at the Naval Air Warfare Center Weapons Division, China Lake, California, will perform DT activities. OT will be conducted by VX-9 at Naval Air Weapons Station China Lake.

To date, NGJ-MB has successfully completed more than 300 hours of developmental flight testing and has more than 5,000 hours of chamber and lab testing using engineering development models that were designed specifically for DT.

Based on digital GaN-based active electronically scanned array technologies, the NGJ-MB system is designed to address advanced and emerging threats in the middle frequency bands of the electromagnetic spectrum (typically surveillance and target indication radars).

According to the Navy, the system's increased power and capacity to target multiple systems will offer a significant enhancement over the Growler's existing ALQ-99 Tactical Jamming System pods.

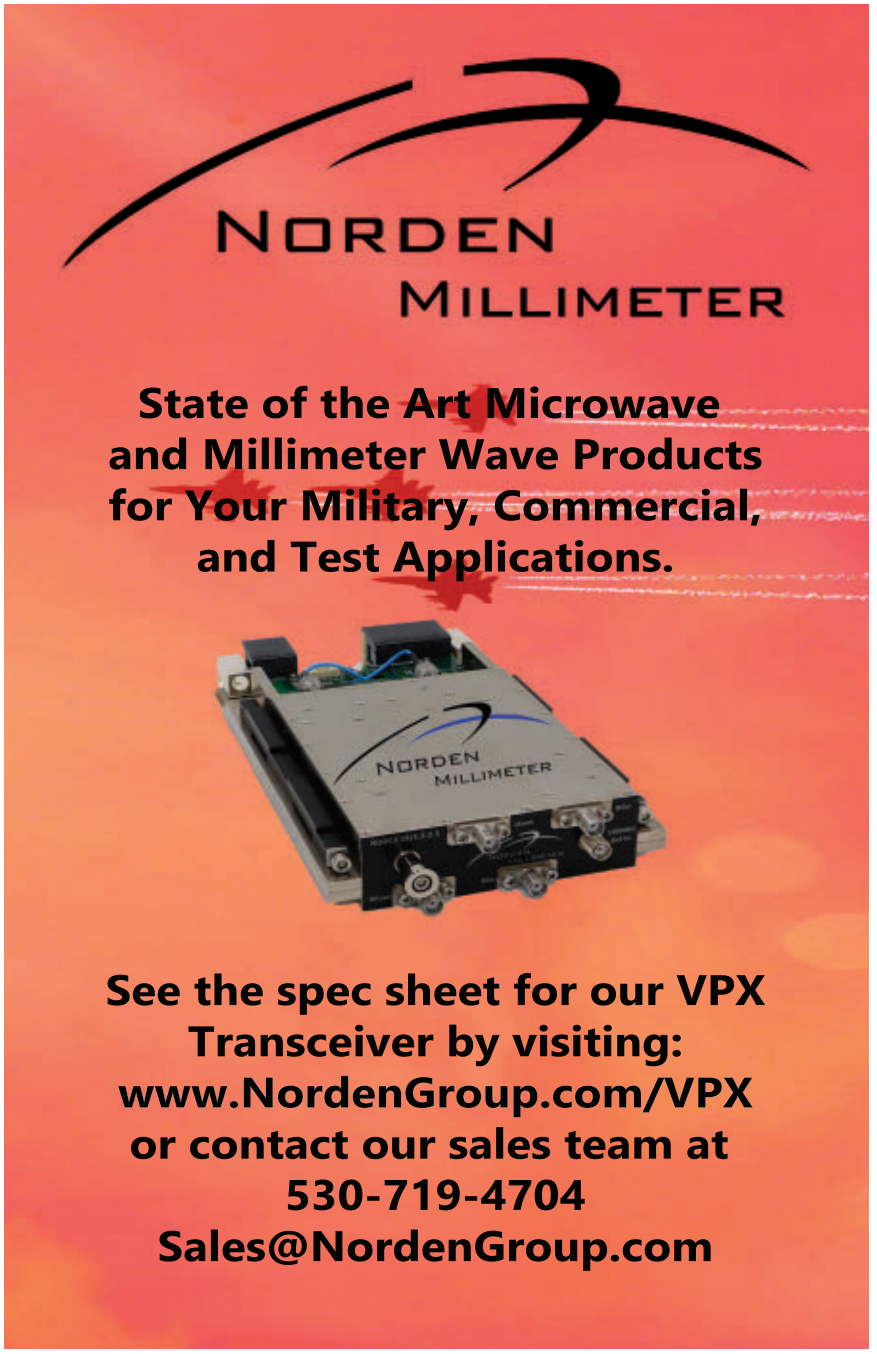
The US Navy will receive six AN/ALQ-249(V)1 shipsets from Raytheon. Once the flight test program is complete, the pods will be sent to the fleet in conjunction with the first Low-Rate Initial Production shipsets for Initial Operational Capability, which is scheduled for late 2023. – *R. Scott*

IN BRIEF

Correction: The feature article, "Staying the Course – Maintaining the Path to Advanced Marine Corps EMSO," in the August *JED,* incorrectly identified the Marine Corps next-generation ground EW program on page 28. The correct name is Marine Electromagnetic Ground Family of Systems (MEGFoS).

On a related note, the **Marine Corps Systems Command (MCSC),** Portfolio Manager Command Element Systems (PfM CES) Product Manager Electronic Warfare Systems (PdM EWS) announced that it is holding an industry day on October 13 at Marine Corps Base Quantico for the Marine Electromagnetic Ground Family of Systems (MEGFoS). The purpose of the Industry Day is to "determine the level of industry interest in Research and Development (R&D) projects that involve future contract opportunities to deliver the initial dismounted and mounted MEGFoS variant designs and prototypes. The dismounted variant will be comprised of two versions: a Dismounted Backpack (D-BP) and b) Dismounted Small Form Factor (D-SFF)." The contracting point of contact is Brittney Moore, 703-432-8737, e-mail brittney.moore@usmc.mil.

The Air Force Research Lab has awarded four contracts for the Defense Advanced Research Projects Agency's (DARPA's) Coded Visibility program, which aims to develop new "one way" optical obscurants that enable friendly sensors to "see" through the obscurant material while denying visual sensing to an adversary – a concept known as asymmetry. More specifically, the program wants to develop obscurants that are tailorable (in terms of absorbing and scattering photons), tunable (active modulation) and safe for soldiers to inhale (don't rely on the metal flakes that are common in current obscurants). The program's two thrust areas are passive asymmetry (i.e., achieving an asymmetric vision capability through tailorable obscurants) and active asymmetry (i.e., using active modulation obscurants to achieve a tunable, asymmetric vision capability). For the passive symmetry thrust, **Raytheon Technologies Research Center** (East Hartford, CT) received a $3.5 million contract for an effort titled, Metal Oxide and silicon based Respirable Plume with High Extinction for Unidirectional Sight (MORPHEUS). Three contracts were awarded for the active symmetry research. **Northeastern University** (Boston, MA) received $3.4 million for an effort titled, Generating Asymmetric Obscurants Using Adaptive Janus Aerosols (GOJA); **Georgia Tech Research Institute** (Atlanta, GA) was awarded $5 million to work on Superior



Asymmetric Visibility enabled by Intelligent Obscurants (SAVIOr); and **Signature Research, Inc.** (Calumet, MI) won a $6.6 million contract for work under an effort dubbed Directional Imaging via Orientable Dipole Engineering (DIODE).

Naval Information Warfare Systems Command (NAVWAR) announced plans to introduce an EW-related topic at the Information Warfare Research Project (IWRP) 2 Consortium Quarterly Industry Day on October 19 in Charleston, SC. Project Tarkin will be one of the "Pre-Solicitation Collaborations" discussed at the event. According to a NAVWAR IWRP description, the aim of Project Tarkin is to develop "capabilities allowing multiple sensor systems to coordinate effects across various mediums. The system will be distributed across multiple platforms; ashore, afloat and overhead." More information is available at the IWRP Consortium Web site, www.theiwrp.org.

The **Training and Readiness Accelerator (TReX) Consortium** has issued a Request for Information (RFI) for US Special Operations Command's (USSOCOM's) Joint Threat Warning System (JTWS) Air Direction Finding Omni Directional Antenna Prototype Project. The project, which is executed by USSOCOM's Program Manager for Integrated Sensor Systems (PM-ISS), seeks DF antenna solutions that can cover 20 MHz – 6 GHz and provide less than 3 degrees RMS error on calibration frequencies (10 degrees RMS error between calibration frequencies). Responses are due by October 12 and can be sent to TREX@nstxl.org. Companies are not required to be members of the TReX Consortium on order to respond to the RFI.

The TReX Consortium also awarded three EW-related contracts last month in support of the DOD's Test Resources Management Center (TRMC). **Vadum Inc.** (Raleigh, NC) won a $7.4 million contract for the Advanced T2OURNAMINT Technology Development (AT3D) effort, which will support improvements to the TRMC's EW Arena RF Hardware-in-the-Loop (HITL) simulation architecture to provide effective test of EW systems in dynamic "many versus many" environments. A second TRMC-related contract, valued at $11.8 million, was awarded to **Santa Barbara Infrared** (Santa Barbara, CA) for its Universal Large-Format High-Temperature Rapid Array (ULTRA) prototype project. Under this effort, the company will evolve IR scene generation technology beyond the its current state – 1024 x 1024 format IR arrays with a temperature range of 1000 degrees K driven at 200 frames per second (FPS) – by developing solutions with larger pixel formats, higher frame rates, and the ability to operate at higher effective temperatures. Finally, **Star Dynamics Corp.** (Hilliard, OH) won a $5.2 million contract for the TRMC EW test topic, Ka-Band Transmit/Receive Aperture (KaTRA) prototype. Under this effort, the company will improve test capabilities at outdoor radar cross section measurement facilities by developing technologies that optimize tunable coherent transceivers covering 34-36 GHz that exhibit SNR of 10 dB or greater when measuring -20 dBsm targets at ranges of 20 miles.

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MODEL 527C

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0-5kHz

2.0-3.6GHz
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6%
0.07-100us
0-400kHz

MODEL 176S

MODEL 1051X

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0.2-0.7us
0-4kHz

3.6-6.5GHz
1.7kW
6%
0.07-100us
0-400kHz

MODEL 176SC

MODEL 174L

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2kW
0.32%
0.07-1.0us
0-5kHz

6.5-10.0GHz
1.1-1.4kW
6%
0.07-100us
0-400kHz

MODEL 176CX

MODEL 1051X

7.6-8.5GHz
185kW
0.13%
0.3-0.6us
0-2143Hz

33-36GHz
700W
8%
0.05-10us
0-100kHz

10.0-18.0GHz
1.6-2.0kW
6%
0.07-100us
0-400kHz

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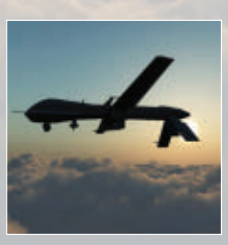

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2022 Future 5

Association of Old Crows

Each year, AOC showcases five young professionals as the year's Future 5, recognizing those who actively innovate and strive for excellence as they build their careers in the EMS/EW/IO industry.

To be selected, applicants must have been 29 or younger by Dec. 31 of the year of application and employed full-time in the EMS/EW/IO industry. The Future 5 is selected based on a written application, demonstration of leadership, their career, references and a short video, which can be viewed at crows.org/page/2022Future5.

Awardees receive an award, certificate and be recognized on stage at the AOC convention.

Please join us in celebrating this year's Future 5!

Rachel Brody, Radar Staff Systems Engineer

Maxar Technologies

Master of Science in Engineering – MSE, Electrical and Computer Engineering

Career Goal

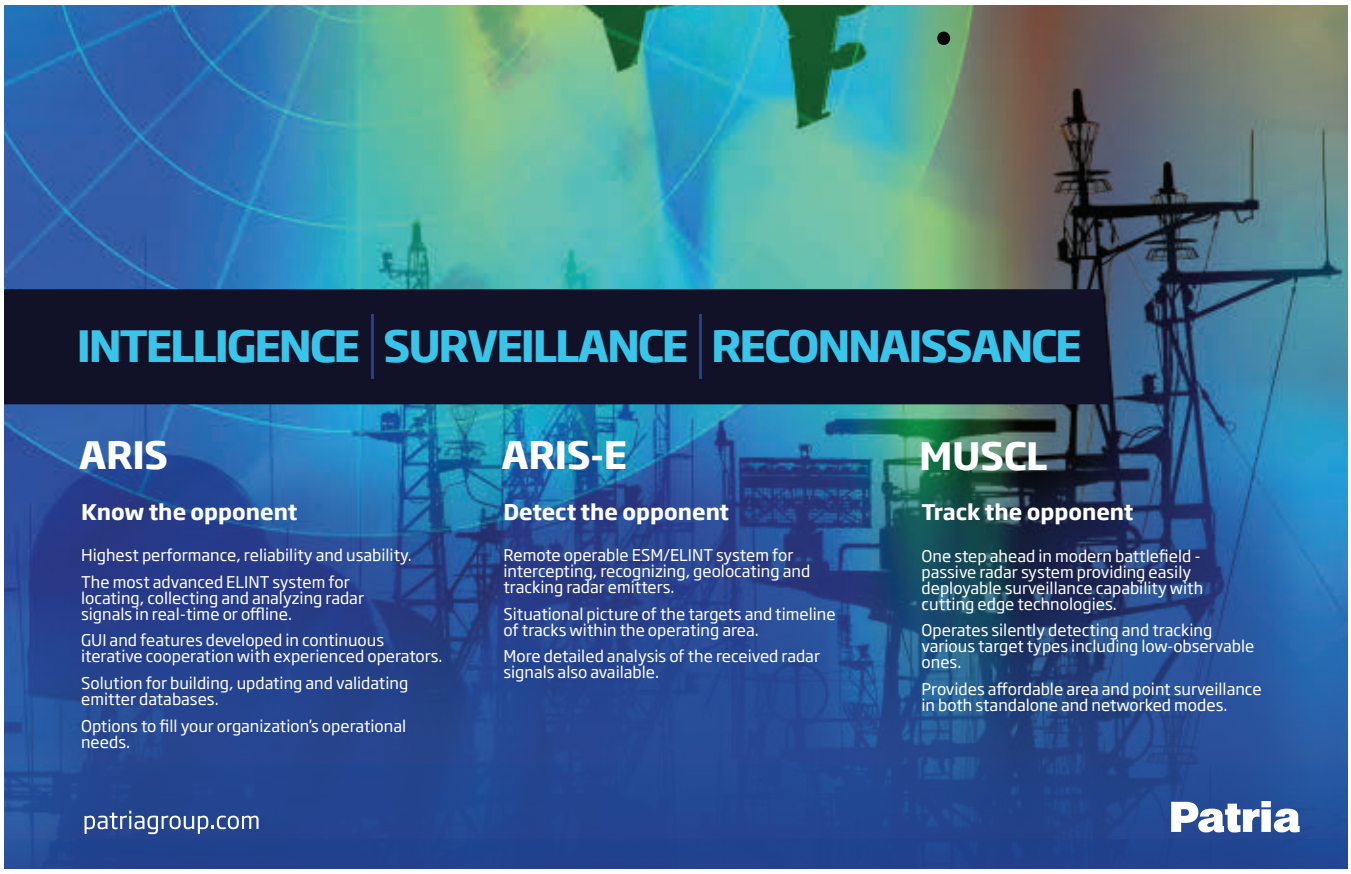
I intend to become a technical program director and continue to be active in customer symposia, industry meetings and conferences, youth and student outreach and community service. I hope to influence not only the projects my company chooses to pursue but the priorities of the field and the technologies in which our customers choose to invest. Electromagnetic signals and systems enable faster, smarter decisions to be made without risking life and property, but technology developed within a defense context can also be leveraged beyond the traditional needs of the warfighter. I plan to facilitate the use of radar and imaging to defend human rights and the safety of our home and resources through environmental observation and prediction. The more innovative and versatile our instrumentation solutions, the stronger and safer our world will be for the generations to come. For these reasons, I have chosen a long-term career in the EMS industry and they motivate me to spend time and effort encouraging STEM creativity in my own company and beyond.

Joshua Kozak, Signals Analysis NCOIC

USAF / 694th Intelligence Surveillance and Reconnaissance Group
Currently enrolled in electrical engineering

Career Goal

The future roles I desire to fill are not oriented around single specific positions, but more so guided by my desire to maintain superiority in the electromagnetic spectrum for the US in the ways I see most fitting to my values. Ultimately, the preservation of American lives and the ability to respond safely to emerging threats is something I value immensely. After the Persian Gulf War, our near-peer adversaries took notice of our effectiveness in conventional warfare and have launched decades-long military modernization efforts in an attempt to close the power gap – modernization efforts that highlight the use of asymmetric weapons in particular. Sustainability of allied C4ISR in light of adversary electronic attack is a cornerstone in our Joint Doctrine. Without it, rival powers may get the upper hand in the wars of the future. The development of electronic protection measures and the enhancement of electronic warfare support will be a lynchpin facet in ensuring our country can survive the next great conflict. Ensuring the preservation of our ability to utilize the EM spectrum freely is a ubiquitous need across all aspects of the Department of Defense and something that must be strived for by younger generations to ensure the protection of American lives and hegemony.



Piotr Kulik, Senior RF Engineer

Metamagnetics, Inc.

Doctor of Philosophy in Electrical Engineering

Career Goal

My ultimate career goal is to start my own business focused on helping the warfighter. As an immigrant blessed by the opportunities of the United States and as an active patriot through my participation in scouting and earning Eagle Scout, I've always had a passion for helping our nation. Leveraging my devotion to technology through obtaining a Ph.D. in RF devices targeted toward the military and commercial communication (5G) sectors and experience in working in small businesses, I believe I can have a much larger impact if I become an entrepreneur. Employed by a small business (Metamagnetics), I am learning how to manage financial and human resources, obtain government contracts (SBIRS) and help transition research efforts into programs of records. Furthermore, traveling to various government locations and attending government conferences such as GOMACTech has allowed me to see some of the opportunities that are in the EMS/EW/IO industry, such as environment RF spectrum sensing. Such an application has potential to utilize my experience in MEMS and RF magnetic devices from my Ph.D. research to build new types of devices for the industry. To achieve my ultimate career goal, I am also pursuing an MBA at Boston University part-time to have a much broader understanding of business while building a much larger network and applying it to the defense and aerospace industry.

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Ryan Loehrlein, Engineer

Naval Surface Warfare Center, Crane Division

Master of Business Administration, Bachelor of Science in Engineering, Bachelor of Science in Mechanical Engineering

Career Goal

Maya Angelou once said "You can only become truly accomplished at something you love. Don't make money your goal. Instead, pursue the things you love doing and then do them so well that people can't take their eyes off you." When I first saw this quote, it resonated with me immensely causing me to rethink my career goals. I realized that I needed to follow my passion, work hard and not let anyone limit my aspirations. I took this newly founded mentality into my first internship at NSWC, Crane. I quickly grew to love my workload, which emphasized delivering innovative solutions to the warfighters via advanced technical capabilities. My internship was filled with challenging research and development projects, a community that encouraged mentoring and colleagues that cared about my future. I quickly realized that I found my calling and continued honing my skills within the Airborne Electronic Attack Division over the past six years. After learning about Crane's organization and opportunities within the EMSO/EW community I decided that I am aiming to become NSWC Crane's Advanced EW Senior Scientific Technical Manager (EW SSTM). I've been honored to watch Crane's EW SSTM inspire, mentor and encourage future EMSO/EW members. This position requires passion, dedication, humility and a profound depth of technical knowledge. I alone cannot change the entire EMSO domain, however, I can strive to inspire, mentor and encourage the next generation of EMSO experts. If I can impact one person, I have succeeded in achieving my ultimate career goal.

Ethan Skemp, Chemical Engineer

NAVAIR – Navy

Bachelor of Science in Chemical Engineering

Career Goal

Information is the currency of the modern age, but this paradigm has barely begun to permeate the EW industry. It has failed to establish an effective foothold on the government side. This leaves the DoD lagging behind the commercial industry and its international peer competitors, placing it at avoidable risk. I aim to bring this paradigm to NAVAIR and help to implement it in such an effective manner that would allow us to maintain our asymmetric EW advantage. Part of this implementation is the necessary training and demonstration of the capabilities of data as a source of actionable information to guide and assess decisions. The DoD often struggles to overcome its complacent acceptance of "the old way" of doing things, which hinders its ability to adapt to a rapidly evolving field of cognitive and interconnected radars and IADS. I have, in my short time with the Navy, begun to bring awareness of this deficit to my workgroup and reach higher levels, presenting to a Rear Admiral, the Office of the Secretary of Defense and other administrators to help broaden the impact of my efforts. As I advance, I continue to reach higher and proselytize the advantages afforded by data-centric decision-making.

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Image: Lockheed Martin

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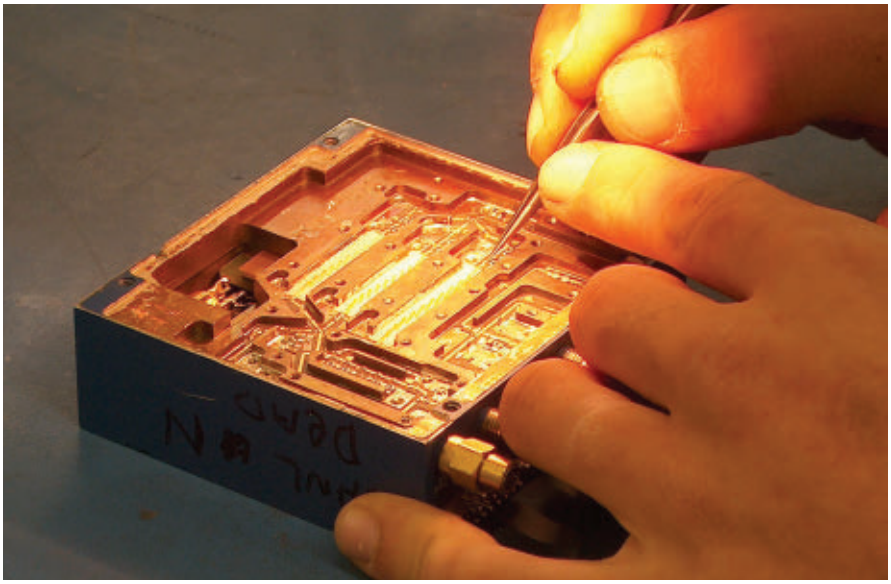
Partnering to Meet the EW Sustainment Challenge

With so much energy focused on EW systems development, it can be easy to forget that when an EW system is initially fielded, it is just at the beginning of its operational life. Prior to fielding, most of the attention is on defining requirements, developing the component technologies, integrating them into a full system, and then rigorously testing the system. Once the EW system is fielded, however, the attention shifts to sustaining it for the next 20, 30, and even 40 years.

In that timeframe, threats evolve, the component parts in the EW system begin to wear out and need replacement, and, as microwave and semiconductor technologies evolve, many of the companies that once manufactured those parts eventually stop making them. These realities lie at the heart of the military customer's sustainment challenge. That's why Elbit America is focused on solving our partners' problems with innovative strategies that help them extend the operational lifespans of their EW systems. This doesn't just save our customers money; it translates into higher system availability and more operational flexibility for the warfighter.

THE REALITY OF EW SYSTEM ACQUISITION AND SUSTAINMENT

With tight budgets, competing priorities and constant parts obsolescence issues, military customers must carefully plan how to repair and replace the unique components in each of its electronics systems. Most logistics organizations support dozens, if not hundreds, of EW systems, radars, radios, GPS receivers, IFF systems and other electronic systems – each posing its own sustainment challenges. The Air Force Life Cycle Management Center's EW and Avionics Division, for example, sustains 460 different electronics systems installed across 60 aircraft models. Many of these are EW systems, such as the ALR-20 panoramic receiver bought for the B-52 in the 1960s, the ALR-69 radar warning receiver acquired in the 1970s, or the ALQ-131 jamming pod that was procured in the 1980s. Despite their age, these systems still provide significant operational utility – even as threats have evolved – because of smart sustainment strategies.



Even new electronics systems are challenged by technology obsolescence issues. Because it can take five or more years to develop, test and field a new EW system, some components (especially COTS-based components) in these developmental systems can become difficult to source before they achieve IOC. When the F-35's ASQ-239 EW system was still in development, the system's FPGA supplier moved on to the next generation of FGPAs and stopped manufacturing older models. The ASQ-239 developer ended up selecting a newer FPGA and

modifying the ASQ-239 design to accommodate it.

Sustainment is also an important consideration for export customers. While buying an EW or radar system through Foreign Military Sales (FMS) program channels can enable that partner nation to leverage domestic sustainment initiatives, occasionally they need to buy small quantities of spares on their own schedule. If the US depot or the original equipment manufacturer (OEM) do not have spares available, the cost of manufacturing a small quantity of components can be prohibitive. This is where agile partners, such as Elbit America's Sustainment and Support Solutions (S&SS) business, can provide quick and cost-effective manufacturing solutions.

Finally, it's important to point out that sustainment isn't about keeping an EW system or a radar working. Throughout its operational life, an EW system must counter new threats and upgraded threat systems. A good sustainment strategy, involving hardware components and software releases, can incrementally improve an EW system's performance and extend its operational life.

IDENTIFYING THE CHALLENGES

Several factors, such as cost, time and data rights, drive today's sustainment challenges. Often, the military customer does not own the data rights for the electronic components it wants to buy. When it does, it can issue "build to print" contracts for those spares. Most of the time, however, the system OEM or subcontractors, holds those data rights. This means the military customer must consider buying the spares through the OEM, which may decide to manufacture the items itself or license the manufacturing with a partner, such as Elbit America. However, the OEM is usually a defense electronics systems house that is focused on developing next-generation systems, rather than servicing legacy products it manufactured decades ago. The cost for an OEM to manufacture legacy components is considerable in terms of money, time and engineering resources, and this cost is passed to the military customer.

As Chris Hickey, general manager of Elbit America's S&SS business, explains, "I think we're going to continue to see sustainment of legacy EW systems really be a challenge. The OEMs are focused on new development, so the legacy systems are going to get neglected."

It's worth pointing out that this is not intended to fault the OEMs' intent – they try to provide the best options the can to sustain their legacy systems, but their priorities and incentives are focused on new system development rather than refurbishing or manufacturing legacy components. In these situations, where the military customer does not own all the data rights, it can contract with electronics manufacturing companies, such as Elbit America, to re-engineer the components and deliver new parts for the system.

Hickey goes on: "I think there's going to be continued pressure on defense budgets, and so there's going to be a demand for increased competition. We think we're well-positioned not only to service the legacy space but to compete in that space as well, providing additional savings for the government under tighter budgets. I think the government is going to be forced because of those same budget restrictions to look for updating legacy systems to make sure they stay effective against current and emerging threats. That's another opportunity at that point to add different capabilities from an upgrade, as well as redesigns to address obsolescence. We think there is a significant market opportunity there, and we think Elbit America is strongly positioned to address it."

PARTNERSHIP

The critical element of electronic systems sustainment is understanding that it is a partnership between the military customer, who has need and funding; the OEM, who has experience and system data; and electronics component manufacturers, such as Elbit America, who have unique engineering expertise and state-of-the-art manufacturing capabilities and who are focused on solving tough sustainment challenges.

"We take a strong partnership approach when working with our customers," explains Jimmy Johns, vice president of operations at Elbit America's Talladega Operations (TDO). "We must ensure that we are a trusted partner, that we're agile, and we don't make doing business with us complicated. We sit down as a partner and say, 'How do we do this together?' so that we both come out with a win-win solution."

For its part, Elbit America takes two approaches to the sustainment market. One approach is to work directly with the military customer, who issues a manufacturing contract for components. If the customer can provide the required specs and data, this can be as simple as a build-to-print contract. If the required system data package is incomplete, Elbit America can re-engineer the component, test the new part and qualify it in the EW system before delivering it to the customer.

If the OEM controls the system data and specs, Elbit America

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can work with the company either as a vendor or under license to manufacture the part and sell it directly to the military customer. J.J. Arnold, vice president of business development for Elbit America's S&SS business, explains that sometimes an OEM just wants to completely divest its sustainment work on a particular system.

"So, what we set up is a licensing agreement where we go to the market and work directly with the OEM, utilizing, on the back end, their pedigree and their data," he said. "We are repairing assets, and then, in essence, we have a financial arrangement with them. The OEM can diminish their footprint in the marketplace, focus on new product, and we take ownership of that legacy product, and they're pretty hands off in that approach. In some instances, the OEM needs to second source because they just don't have that capacity anymore."

One important aspect of being a trusted partner is to ensure security. Elbit America has maintained a long-standing Special Security Agreement (SSA) with the DOD that has required it protect classified information and operate with a separate board of independent directors who are US citizens. Arnold adds, "What we do in the United States stays in the United States. We're audited by DCSA, and we have a superior rating. Our processes and procedures, internally and externally, meet regulations to ensure the products that we serve and the data that we hold stays in the United States for the benefit of us and the host nations when we're repairing these assets."

Whichever sustainment strategy a client pursues, Elbit America is a trusted partner to its military customers and the OEMs it has worked with for more than 50 years.

EW HERITAGE

Elbit America's TDO business traces its EW roots back nearly 40 years to its work repairing EW modules for the ALQ-131 RF jamming pod, which was originally manufactured by Northrop Grumman (then Westinghouse) in the early 1980s. The Air Force bought approximately 1,600 ALQ-131 pods to replace the ageing ALQ-117 pods it was flying on its F-16s. The ALQ-131 was significantly more complex than the ALQ-117, with a larger number of components, which made for a bigger sustainment challenge. Although Teledyne made about half of the components for the ALQ-131, the Air Force decided to compete some of the repair contracts to cultivate second sources, increase competition and mitigate the risk of supply chain disruptions. Elbit America's TDO business (then known as International Enterprises Inc.) won some of the first ALQ-131 repair contracts in 1984 and this marked the beginning of a strong EW focus of the company over the next 15 years. In that time, the company repaired thousands of EW parts and components, including RF modules, VCOs, power amplifier components, RF cables, switches, high voltage power supplies and RF cables. In addition to the ALQ-131, many of these products were made for RWRs such as the ALR-66, ALR-69 and ALR-56, as well as the ALQ-117 jamming pod and the B-1B's ALQ-161 EW system.

After 2014, when Elbit America acquired IEI, the company moved away from the EW components market due to a variety of factors. But TDO has retained most of its EW expertise, and today the company sees new opportunities in legacy EW programs. Interestingly, the first of these new opportunities has been the ALQ-131 pod.

RE-ENGINEERING COMPONENTS FOR THE ALQ-131

Sometimes, a military customer will pursue a sustainment strategy without possessing the relevant data package needed to manufacture the legacy component. This occurs when the government does not own the required data and specs, the OEM's cost to use their proprietary data is too high, or the data package is simply incomplete, which can happen with extremely old systems developed in the 1960s and 1970s. A lack of data, however, does not need to prevent the military customer from buying new spares. In these situations, a sustainment expert such as Elbit America can re-engineer the component using modern manufacturing techniques, which are usually more precise, less expensive and can contribute to more reliable system performance.

When the AFLCMC EW and Avionics Division recently began a program to upgrade some of the ageing components in the ALQ-131 jamming system, it surveyed industry and determined that its best option was to re-engineer some of the components. Elbit America TDO worked with the ALQ-131 program office and entered into a bailment agreement that provided the company with various ALQ-131 modules, which was made possible by of the company's SSA and its status as a secure facility that could handle classified material.

After receiving the ALQ-131 modules, members of TDO's engineering team set about re-training itself on the system and focusing on innovative repair methodologies. The TDO team is now on course to rigorously test and qualify this repair process with the AFLCMC customer at Robins AFB, GA. customer.

EW-FOCUSED STRATEGY

The ALQ-131 sustainment effort represents the beginning of a new strategy for Elbit America TDO to help customers develop EW sustainment strategies for other legacy EW systems, such as the ALR-20 and ALQ-172 on the B-52H, the ALQ-161 on the B-1B, the ALQ-184 on Block 40/50 F-16s, the ALR-56C and ALQ-135 on F-15 C/D aircraft, as well as the ALR-69 on the A-10 and ALE-47 countermeasures dispensers that are used across the Air Force fleet.

As Arnold explains, this includes the US Air Force as well as export customers that use some of these systems. "As these platforms continue to age and are sustained for longer, the systems that are on them will need to be sustained, as well," he said. "And even if we send these platforms to other nations, those nations aren't going to have the money to upgrade the radar, radio and other avionics systems, and/or the EW suites that go along with them. They're going to have to keep what they have and sustain what they have. There's going to be a long sustainment tail as long as these platforms are flying."

ALQ-131 Band 5 Min Control and Band 5 VCO Test Station

BUILDING AND IMPLEMENTING A STRATEGY AROUND EW SUSTAINMENT

Building on its recent success throughout the EW industry, Elbit America TDO is focused on being the leader in the EW sustainment market. It has built a strategy around being cost-competitive to meet its customer's budgets, developing a smart team of design engineers who can solve tough problems, and providing state-of-the art manufacturing facilities that enable fast turnaround of re-engineered and legacy components.

What Elbit America brings to its customers is the experience that allows its engineers to examine a piece of hardware when it comes in, figure out the available documentation for that component, understand the thinking behind the original component design (including its flaws), and forge the optimal solutions that meet the requirement and the budget. Because Elbit America has such a wide range of sustainment experience across so many defense electronics programs, it can identify and implement solutions that other companies with less component design experience and fewer manufacturing resources cannot offer.

"We take a collaborative approach with the customer to solve problems to create solutions," explains Arnold. "We're agile in the volume – either low- or high-volume parts – and we have an agile workforce that allows us to do low-volume [contracts] up to high-volume repair and overhaul of assets. In the EW space, we have a seasoned, dynamic workforce, which allows us to scale up and down, either in capability development and/or the repair and overhaul process. So, from our technicians to our deep engineering bench here at the Talladega facility, we can solve our customers' complex problems and support their repair and overhaul needs. All of this makes us very cost-competitive compared to the OEM."

This strategy is more than words on paper, however. Elbit America TDO has top-down buy-in from its corporate leaders, and it has been making the investments it needs – in people, in its test equipment, and on its manufacturing floor – to realize its goal of becoming the leading EW sustainment specialist in the market.

"We've increased our recruitment and acquisition of engineering talent, with a focus on re-engineering to help support the legacy EW repairs," says Chris Hickey. "As we ramp up in this space, we can increase our capacity, both at the facility we're currently in and in the local area. We're looking at growing those spaces in accordance with the growth of our footprint in this market. We're also looking at getting support for a radar center of excellence. There's a gap in that space in our part of the country, and we think there's a significant opportunity to partner with the local universities in developing the talent to support the center of excellence, and we think that will attract additional opportunity to grow in that space."

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Space Delta 3 Gu Electromagnetic

By John Haystead

Today, space is without question a critical operational domain for US military forces and one in which superior military capabilities and operational dominance must be assured. Speaking before the Senate Armed Service Committee in September, incoming US Space Force Chief Lt Gen Bradley Saltzman told the committee members, "The most immediate threat, in my opinion, is the pace with which our strategic challengers, first and foremost, the Chinese, are aggressively pursuing capabilities that can disrupt, degrade and ultimately even destroy our satellite capabilities and disrupt our ground infrastructure. It is one of my earliest priorities to make sure that we're on track to build and field effective capabilities and then train the Guardians to operate in a contested [Space] domain so that we can counter this activity by our strategic competitors."

Earlier this year, speaking at the 37th Space Symposium in Colorado Springs, CO, US Space Force Chief of Space Operations Gen John W. "Jay" Raymond also emphasized this point stating that, "The cornerstone to US security and prosperity is keeping space accessible, stable and secure. That is why the US, its allies and most of all, the United States Space Force, must move aggressively to modernize space hardware and re-orient thinking and practices in the domain."

Clearly, an essential element of assuring US dominance in the space domain is achieving and maintaining parallel assured dominance of the electromagnetic spectrum (EMS). And this is where Space Force's Space Delta 3 (DEL 3) organization comes to the fore.

SPACE DELTA 3

To understand the role and mission responsibilities of Space Delta 3, it's helpful to describe where it falls within the overall organizational structure of US Space Force (USSF). In order of hierarchy, the USSF echelons are named field commands, deltas and squadrons. There are three field commands aligned with specific mission focuses: Space Operations Command (SpOC), Space Systems Command (SSC), and Space Training and Readiness Command (STARCOM). SpOC and SSC are commanded by three-star general officers, while STARCOM is led by a two-star.

In the press release announcing the new organizational structure, Space Force outlined that SSC, currently under Lt Gen Michael A. Guetlein, will be "responsible for developing, acquiring, and fielding lethal and resilient space capabilities for warfighters. Additionally, SSC will be responsible for launch, developmental testing, on-orbit checkout, and sustainment and maintenance of USSF space systems, as well as oversight of USSF science and technology activities." STARCOM's role, currently under Maj Gen Shawn Bratton, will be to "train and educate space professionals, and develop combat-ready space forces to address the challenges of the warfighting domain of space."

Space Delta 3 falls within the third field command – SpOC – under Lt Gen Stephen Whiting. In October 2020, SpOC was the first field command to be activated, as "the primary force provider of space forces and capabilities for combatant commanders, coalition partners, the joint force and the Nation." With headquarters at Peterson AFB, (Colorado Springs, CO), it was formed primarily from a combination of the former 14th Air Force and Air Force Space Command units. Under SpOC are a number of mission-oriented, numbered "Delta" units, sometimes described as similar in size and scope to Brigades in the Army.

Among the Delta units, Space Delta 3 (DEL 3) is heavily focused on Electromagnetic Spectrum Operations (EMSO). With personnel deployed worldwide,

ardians Embrace Warfare

Space Delta 3 is responsible for "preparing and presenting assigned and attached forces to execute electromagnetic warfare (EW)." As further described by Maj Rachel Harris, Director, Space Delta 3 Commander's Action Group, their mission is to "provide combat-level professionals able to be sent downrange to support joint fires by providing EW effects to those forces." Space Delta 3 currently has north of 400 personnel, but Major Harris, says they "expect to boost

Space Delta 3 Commander, Col Christopher Fernengel (second from left), led the ceremony on April 15 to re-designate the 4th, 5th and 16th Space Control Squadrons to the 4th, 5th and 16th Electromagnetic Warfare Squadrons. USAF PHOTO

The Counter-Communications System Block 10.2 achieved IOC with the 4th Space Control Squadron (now the 4th EW Squadron) in March 2020.
USAF PHOTO

up to between 500-600 personnel within the next year." Within Space Delta 3, there are currently four squadrons – the 4th, 5th, and 16th operational Electromagnetic Warfare Squadrons (EWS), and the 3rd Combat Training Squadron (CTS), which evolved out of the 721st Operations Support Squadron (OSS). It is also augmented by Air National Guard and Air Force Reserve units.

Space Delta 3 is commanded by Col Christopher Fernengel, who says their number one priority is to build a foundation of competency in spectrum awareness and in integrating and synchronizing space EW into all-domain operations and fires. "In the past, with space operators working within the Air Force, if you asked them what they did, they would say 'we operate a specific weapon system,' but what we realized is that, while being competent on a particular weapon system is absolutely critical, it's not enough."

As a result, for Space Force's EW Guardians, their focus is to develop EW professionals from the ground up. Says Fernengel, "After their initial Space Force training to become a Guardian, they jump right into spectrum awareness and EMS competency, and before they get into specific electromagnetic attack (EA), electromagnetic support (ES), or electromagnetic protection (ES) mission areas, we build them a solid foundation in overall spectrum awareness."

Fernengel says a complementary and co-equal focus area for space EW professionals is to develop mission-planning-cell chiefs and operators capable of integrating and synchronizing with different combatant commands and different command and control elements to bring EW fires into all-domain-operation solutions. "The days of the Space EW stovepipe acting alone are over. Unless we're able to effectively integrate and synchronize with all-domain fires, we will fail."

In addition, Fernengel says they also prioritize strengthening the EW enterprise. "Some of the ways we do that include what I just mentioned as far as integrating and synchronizing operational command and control. As such, it involves coordinating with Director of Staff Space Forces (who have begun transitioning to Commander Space Forces [COMSPACEFORs]), with the different combatant commands, partnering on total force solutions between the Air Force, Air National Guard, and Air Force Reserves, as well as partnering with some of our sister Services that focus on EW like the Army's 1st Space Brigade at Ft. Carson, CO."

Also, in this regard, Fernengel highlights that there is a new organization under USSF called the Space Warfighting Analysis Center (SWAC) in Colorado Springs, CO. The SWAC is charged with all of Space Force's future Force Design, including missile warning and tracking; wideband satellite communications (SATCOM); position, navigation, and timing (PNT) resilience; space domain awareness; intelligence surveillance and reconnaissance (ISR); and space superiority. Says Fernengel, "They're charged with conducting the Force Design for all of our systems and capabilities com-

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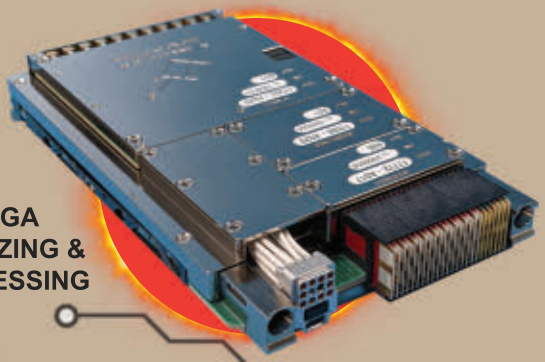

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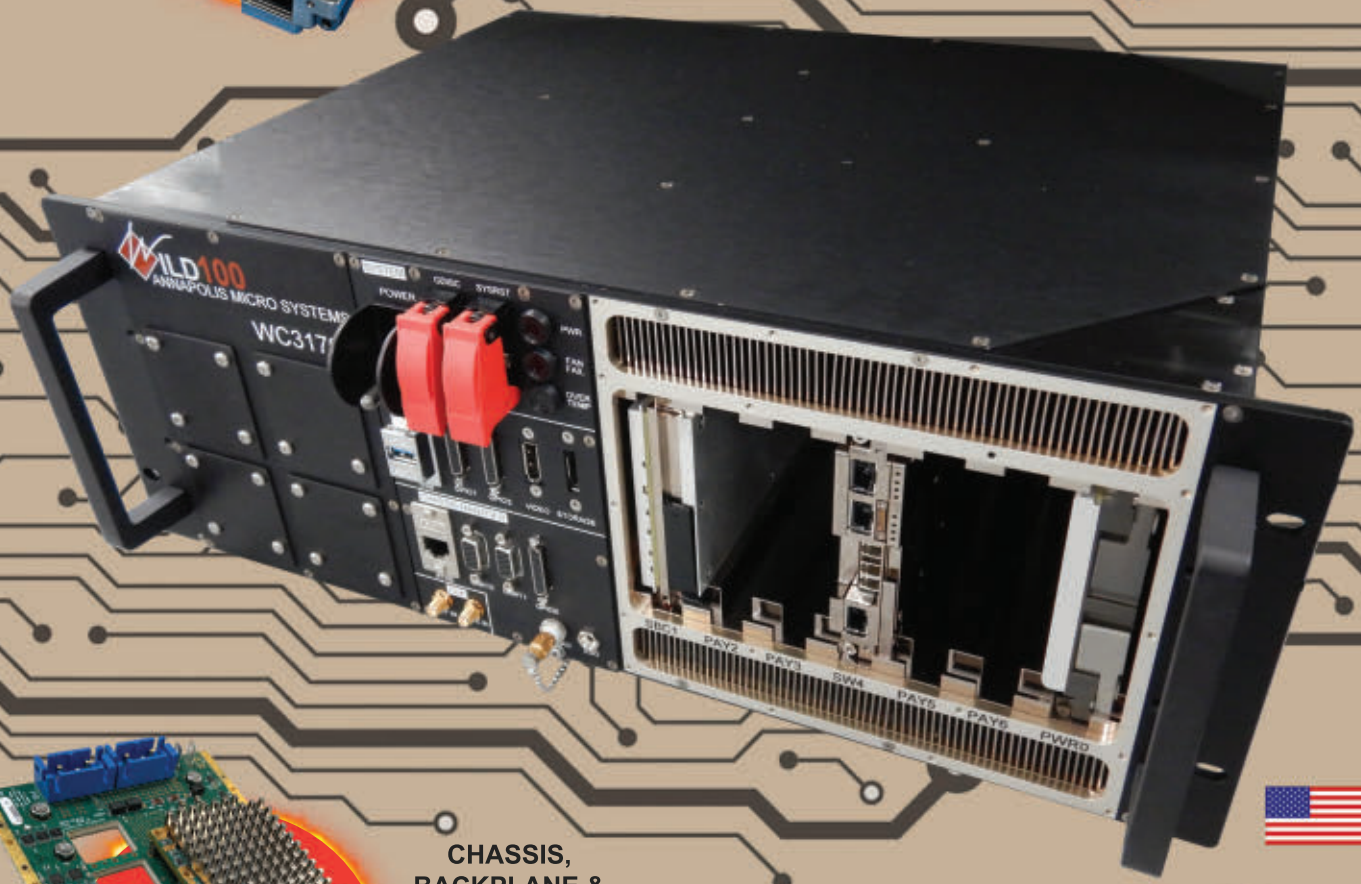

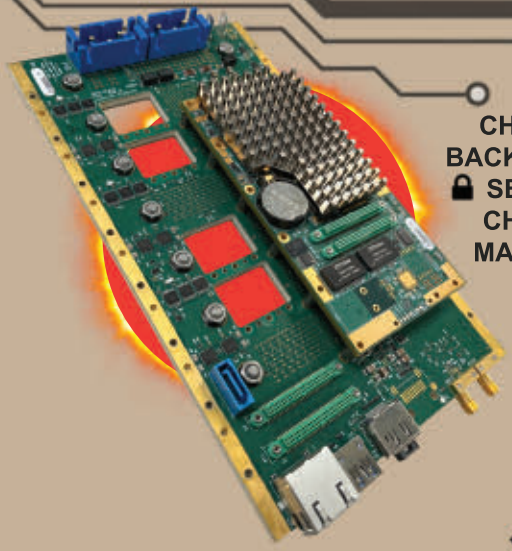

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The Multiband Assessment of Communications Environment (MACE) system, which performs electromagnetic interference geolocation, was developed with commercial technology and is "aperture agnostic." USSF PHOTO

ing out in the future. This includes not only the EMS but also the EW arsenal-of-the-future for the US." As stated by General Raymond, "The first step in building more resilient space capabilities is designing the force you need… How many satellites, which payloads, in what orbits, and what ground infrastructure, to balance performance, cost and resilience? The Space Warfighting and Analysis Center helps us answer that question."

SPACE DELTA 3 SQUADRONS

Each of the four squadrons within Space Delta 3 has a specific mission focus. Starting with the 4th EWS, its mission is to provide electromagnetic attack (EA) and electromagntic support (ES) operations. To achieve this, its primary weapon is currently the Counter Communication System (CCS). As described by Major Harris, the CCS provides "energy-on-energy brute-force jamming" of enemy satellite communications. 4th EWS is commanded by Lt Col Nicholas Shaw, the first officer to transfer from a Service (US Army) other than the Air Force to assume command of a Space Force unit.

According to Colonel Fernengel, prior to its re-designation in April, the 4th EWS was the Air Force's 4th Space Control Squadron (4th SPCS). Prior to that, in the 2015/2016 timeframe, the 4th SPCS had combined with the Air Force's 76th SPCS. "Both of those units had a long history with missions in EA and ES dating back to around the 2001 timeframe. So, over the course of about 21 years, they have been primarily expeditionary in nature and deployed all over the world."

As per Space Delta 3's overall mission priorities, Fernengel says the primary purpose of the 4th EWS is the integration and synchronization of its capabilities with all-domain fires. "This could include partnering with an airborne platform, such as the Air Force's Compass Call, an Army Terrestrial EW capability, or shipborne capabilities from the Navy, and then having an integrated and synchronized battle plan to meet commander's objectives."

In November 2021, L3Harris Technologies (Melbourne, FL) announced it had received a $125 million contract for the "CCS Meadowlands" production program to upgrade 16 CCS Block 10.2 systems. According to the news release the "CCS Block 10.2, also developed by L3Harris, reached initial operating capability in March 2020, making it the first offensive weapon system accepted by the US Space Force."

16th EWS

The 16th EWS, commanded by Lt Col Marshall Tillis provides ES operating its Bounty Hunter 2.0 system to provide electromagnetic interference (EMI) detection, characterization, and ultimately geolocation. Bounty Hunter 2.0 is a program of record (POR) for the 16th EWS and is continuously upgraded to improve its performance and capabilities. According to Fernengel, it is currently planned for upgrade to a Bounty Hunter 3.0 configuration over the next couple of years. "As recently as December, we did a major software upgrade to get benefits in terms of both effectiveness and efficiency."

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In addition to Bounty Hunter, the 16th EWS has also developed a commercial-off-the-shelf (COTS) version of the capability known as the Multiband Assessment of Communications Environment (MACE). As described by Major Harris, "It's an innovative grass-roots program by the mission-assurance personnel of the 16th using funding that SpOC had at the end of FY2019/2020 to acquire COTS systems and build a smaller form factor equivalent of Bounty Hunter for EMI geolocation."

Fernengel says the MACE system was developed in response to a perceived requirement and demand signal from users to be more agile and responsive. "While you lose some of the capacity and a little bit of the capability, the benefit is that, whereas it takes a C-5 or two C-17s to transport the Bounty Hunter system and supporting equipment, you can transport a MACE system in a pickup truck, or one aircraft pallet." Harris adds another benefit is that MACE setup time is on the order of 30 minutes as opposed to the time to change a feed on a Bounty Hunter system which is on the order of hours.

Over the last several years, Space Delta 3 has invested funding in concept development, testing and exercises to determine if, going forward, MACE should be pursued as an independent program of record, as well as if there are some intellectual and capability benefits that can be gained and put into the requirements and acquisition strategy for the next iteration of Bounty Hunter 3.0. "For example," notes Fernengel, "one of the benefits of the MACE system is that it is aperture agnostic, so you can actually take the system out and plug it into a user's already-available apertures."

In February 2021, the 16th EWS (then still 16th SPCS) participated in the Headquarters US Air Forces in Europe & Air Forces Africa joint, multi-national Combined Joint All Domain Command and Control (CJADC2) demonstration in the Baltic Sea region. Guardians from the 16th deployed with their MACE system during the demonstration and, as observed by the 16th commander at the time, Lt Col Angelo Fernandez, "It gave us a real-world opportunity to train and exercise with our coalition partners operating throughout various domains, gather lessons learned, and continue to improve our operations."

At the time, Maj Gen Kimberly Crider, Space Force Chief Technology and Innovation Officer, now retired, said the demonstration showed that "investments in space capabilities increase the effectiveness of operations in every other domain – the US military and our allies are better connected, more informed, faster, and precise because of space. With the rise of near-peer adversaries, it is essential we build on space capabilities to ensure we maintain the competitive advantage with our joint and allied partners."

380th SPCS

The Air Force Reserve 380th Space Control Squadron (SPCS), under Lt Col Andrew Buck (inbound October) is an associate unit to Space Delta 3's 16th EWS. The squadron also works with the Bounty Hunter system to monitor satellite communications links to detect, characterize and geolocate satellite communications jammers, sources of interference and other signals of interest. Since the unit currently still belongs to the Air Force, however, it retains its SPCS nomenclature, as opposed to EWS.

5th EWS

The specific mission of Space Delta 3's 5th EW Squadron, under Lt Col Alexander Courtney, is particularly sensitive, with Colonel Fernengel and Major Harris only willing to share that the unit "provides electromagnetic warfare capabilities and conducts EW missions."

3rd CTS

Rounding out Space Delta 3's complement of squadrons and capabilities is the 3rd Combat Training Squadron (CTS) under Lt Col Etan Funches. Formerly the 721st Operations Support Squadron (OSS), the 3rd CTS develops and trains combat relevant electromagnetic warfare professionals, providing the initial training for the Guardians who will eventually populate the operational squadrons, and continuation of advanced training during their tenure.

Joint Training and Quick Reaction Capabilities

Though each has a specific mission focus, all of the Space Delta 3 squadrons, other SpOC Deltas and the other

field commands under Space Force, continue to work closely and often with each other. For example, Fernengel says that after CTS training and assignment to their Space Delta 3 operational squadrons, the Guardians continue to train together, exercise together and participate in advanced training events, such as Space Flag, Red Flag, Austere Challenge, Space Challenge, Talisman Sabre and various other exercises. Fernengel says they also have a lot of interaction with the other Deltas within SpOC. This usually comes in the form of advanced training events, one of which was the Space Flag exercise recently held at Shriever AFB, CO, and which Fernengel was the senior leader. "I was very impressed as we integrated and synchronized capabilities across the Space Force for all-domain effects to meet the commander's intent."

Space Delta 3's squadrons also frequently interact and train with STARCOM's Space Delta 11. Says Fernengel, "They provide entities that perform as space aggressors, and provide a battlefield in the form of a space range where we can practice high-end fighting in contested domains. We also partner with them on testing to bring on systems such as CCS Meadowlands and Bounty Hunter 3.0. They're vital to the effective testing and checkout of those future systems." Space Delta 3 also partners with SSC and its program offices for the CCS, Bounty Hunter as well as some of the QRC capabilities brought along through the Rapid Reaction Branch of SSC.

As pointed out by Fernengel, "In our role of building EW professionals, we're in a unique position to provide quick reaction capabilities (QRC) and forces. When a component or combatant command requests an initial EW capability, we have the benefit of being able to reach across the four squadrons as well as the Space Delta 3 staff to posture and present professional EW forces. Although the squadrons traditionally deploy as a unit, for QRC missions, we have deployed personnel from across the different squadrons and Space Delta 3 staff in the form of a unified unit. It's all based on the premise that we build EW professionals first."

As observed by Major Harris, "It's important to emphasize that Space Delta 3 is one of the only Deltas that deploys members. It's truly the most expeditionary Delta within SpOC, and our individual teams are unique in that their capabilities service the Joint Force in not only a multitude of ways, but fit alongside the Joint Force, whereas a lot of the Deltas, while still providing effects, are separate from those effects and the users that are actually seeing them. Our operators are actually there with the Joint Force, and are having an impact all over the world."

Summing up, Fernengel says, "The overarching theme that cannot be understated is that the EMS is less of a domain and is more of a battlefield that transcends all domains. What we've seen in history and in the news is that the EMS is critical to the US's and our partners' national security across all the elements of national powers, not just military but civilian markets, and basically the worldwide economy. So, Space Delta 3's contribution is providing the EW fires for the US arsenal to protect and defend the EMS."

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A Forcing Function for US Army EW Staff Integration

By MAJ Luke Plante and LTC Matthew Haynes, US Army

Multi-Domain Operations (MDO) is the Army's concept for how it will fight in sustained large-scale combat operations. MDO relies on effects crossing the five recognized domains: air, land, maritime, space and cyberspace. The electromagnetic spectrum (EMS) is critical for synchronizing effects and simultaneously engaging in operations in all domains. One could even make a strong argument that the EMS should be its own domain.

Electromagnetic warfare (EW) in the United States (US) Army is not nearly as automated as it is in the other US military services. This means that electromagnetic attack (EA), electromagnetic support (ES), and electromagnetic protection (EP) will simply not happen automatically. All too often, Army EW officers are junior members of their staffs, they lack operational experience, they fit the stereotype of being technically-inclined but introverted, or they display a combination of these traits. While the Army is increasingly authorizing higher-ranking EW officers onto staffs, we need to recognize and address common hindrances to EW's integration into operations – particularly as MDO relies so heavily on the EMS.

EW officers often fail to integrate with signal officers. Signal officers often face immense pressure from commanders to have several fully-functional communications systems with all units and across all areas of the battlefield. This often leads to signal officers employing systems on high power levels, with directional antennas not pointing parallel to the forward line of troops (FLOT), and placing antennas where needed to maximize communication without regard for terrain masking. Signal officers are often senior to EW officers on staffs, and their performance often conflicts with emission control (EMCON) or EP in general, so EW officers rarely raise these concerns. This may also prevent EW sections from understanding key friendly emitters' locations, frequencies and other characteristics. It may even lead to fratricide in the EMS, as EW personnel may

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jam frequencies that friendly units are using. The complexity and abundance of communications systems that also vary among units in their contents and network architecture may thus elude EW officers. Exploitability and vulnerabilities with respect to geolocation and lethal targeting of specific frequencies need to become routing considerations for signal officers, but there is no broadly functional mechanism in place for this across our formations.

A failure to integrate with the intelligence community is another common weakness among EW personnel. Signals intelligence (SIGINT) personnel often fear the consequences of violating the strict authorities under which they operate. The National Security Agency (NSA) governs SIGINT and communications intelligence (COMINT) under US Code Title 50, whereas ES falls under US Code Title 10. SIGINT personnel understandably want to stay out of prison; however, this fear cannot stifle the Army's integration of ES into operations. The immediate threat warning that ES provides can certainly keep Soldiers alive and assets operational. EW and SIGINT personnel need to be completely integrated and

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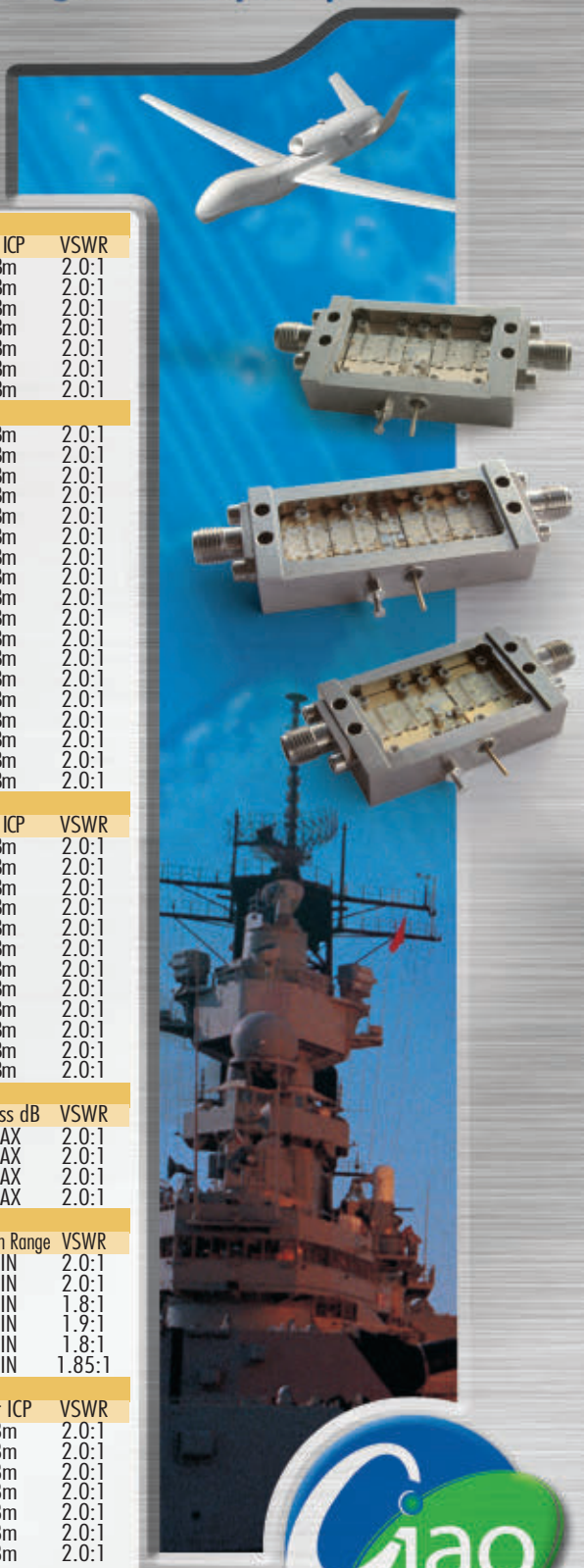

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Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA01-2110	0.5-1.0	28	1.0 MAX, 0.7 TYP	+10 MIN	+20 dBm	2.0:1
CA12-2110	1.0-2.0	30	1.0 MAX, 0.7 TYP	+10 MIN	+20 dBm	2.0:1
CA24-2111	2.0-4.0	29	1.1 MAX, 0.95 TYP	+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

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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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synchronized for units to operate to their full potential. The EW officer's understanding of the enemy's electromagnetic order of battle (EEOOB) and current running estimates of all key friendly and enemy sensors and emitters requires a close relationship with intelligence personnel. A lack of this shared understanding may lead to additional fratricide in the EMS if EW personnel jam frequencies on which intelligence personnel are collecting.

Perhaps the most common integration hurdle for EW officers is with the Operations Division (OD) of Army career fields. Field artillery, aviation and air defense artillery are all crucial for MDO, and their use of radars makes them particularly important for EW integration. OD officers, especially those in infantry, armor and field artillery, are also commonly the commanders, executive officers and operations officers who run staffs and units. A unit will never fully integrate EA, ES, and EP into its operations without purchase from these OD officers. Units may often broadcast lengthy meetings without any consideration of the ways that EP and EA may affect communications and collection efforts, ES could become SIGINT and slow down threat reporting, and radar cuing schedules will not necessarily align with enemy sensor employment. EW officers may never bring these concerns to unit leadership because they may have concerns about being lower in rank, not having a dominant or extraverted personality that they perceive OD officers may favor, or not having the operational experience to be as comfortable with operational and doctrinal vocabulary.

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EW officers may also fear looking incompetent if they do not know the exact capabilities and optimal employment techniques for every friendly and enemy emitter and receiver. EW personnel need to be very proactive and learn all they can about these systems and how enemies will use them, but they also need to be comfortable admitting in key planning sessions if they do not know exact specifications. They should have reference materials readily available, and they should conduct research personally and submit requests for information to intelligence personnel when needed. They should not, however, let the complex multitude of friendly and enemy systems hold them back from addressing concerns in EA, ES, and EP.

The Army has recognized the importance of EW, and it has mitigated these risks for MDO by authorizing higher-ranking EW officers on staffs. The

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Army is also addressing these concerns through increasing its EW personnel and providing them with materiel solutions. These mitigation solutions will take time, so in the interim we need to mitigate at the unit level. This includes training and education for staffs and commanders to understand EW and demand EA, ES, and EP from their staffs.

One way to systematically ensure that units integrate EW into their operations is through training exercises. Prior to combat training center (CTC) rotations, CTCs can review units' training objectives and strongly recommend that they include substantial EW integration into these objectives. Some commanders and staffs may believe that EW is a "Big Army" problem or that they need to figuratively crawl and then walk before they can handle the running that true EW integration would mean. If all units are starting from scratch every few years as key personnel changeover, then an unacceptable share of units will never make it to "running" phase.

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The Army should seriously consider being very demanding of units increasingly over time in terms of EW requirements in all training exercises. Allowing opposing forces to mass fires on and cause mass casualties in command posts using their EMS signatures – even if only once per exercise – may be a significant start. This may serve as a forcing mechanism for commanders and staffs to understand EA, ES and EP; plan for EW integration into all training events prior to culminating training exercises; and eventually *demand* considerable EW integration as a measure of success for training exercises in MDO.

Until commanders and staffs initiate significantly more demand signal for EW staff integration, there are actions that EW officers can and should take. Writing, publishing and following standard operating procedures (SOPs) is a key first step. These should include battle drills, specified reports and other specified products for use during the military decision making process (MDMP) and training exercises. The next step is to follow these SOPs at all times. This should entail routinely sharing information with and requesting information from the signal, intelligence, fire support, aviation, air defense and operations officers. This increased face-time with the staff is likely to increase integration to the point where EW officers can better understand the targeting process, what they need to bring to targeting events, what they need to get from others during targeting events, and also how they can plan and implement

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more effective and comprehensive EW for training exercises.

About the authors: ***MAJ Luke Plante*** *and* ***LTC Matthew Haynes*** *are assigned to the Operations Group in the Joint Readiness Training Center (Fort Polk, LA).*

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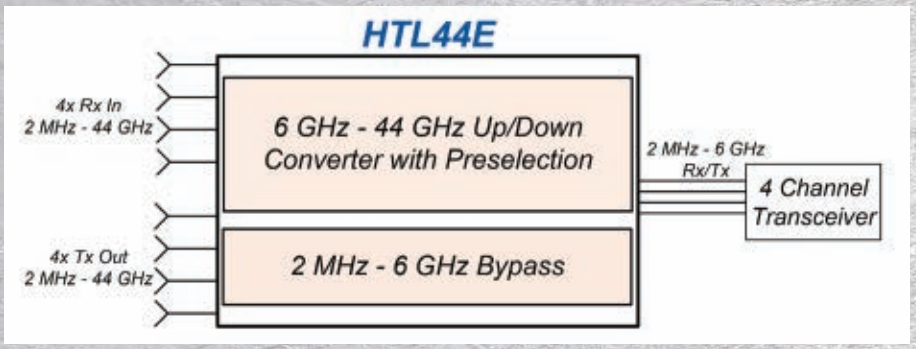

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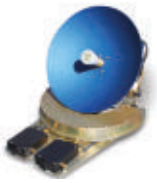

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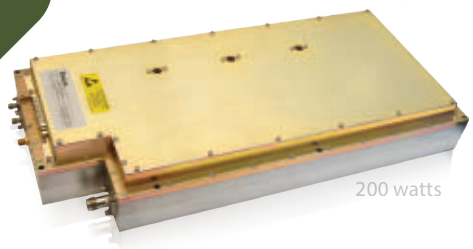

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Heber City, UT 84032
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Elettronica S.p.A
Booth 256
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Rome, 00131
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17000 Dallas Parkway, #200
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Rastatterstr 41, Pforzheim, 75179 Germany
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www.qmicrowave.com
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Planar Monolithics Industries (PMI), a Quantic Company designs & manufacturers a wide range of RF, Microwave & mmWave devices, components, & subsystems for mission critical applications in the military, aerospace, industrial and commercial markets.

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555 Bryant Street, #349
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www.radxtech.com
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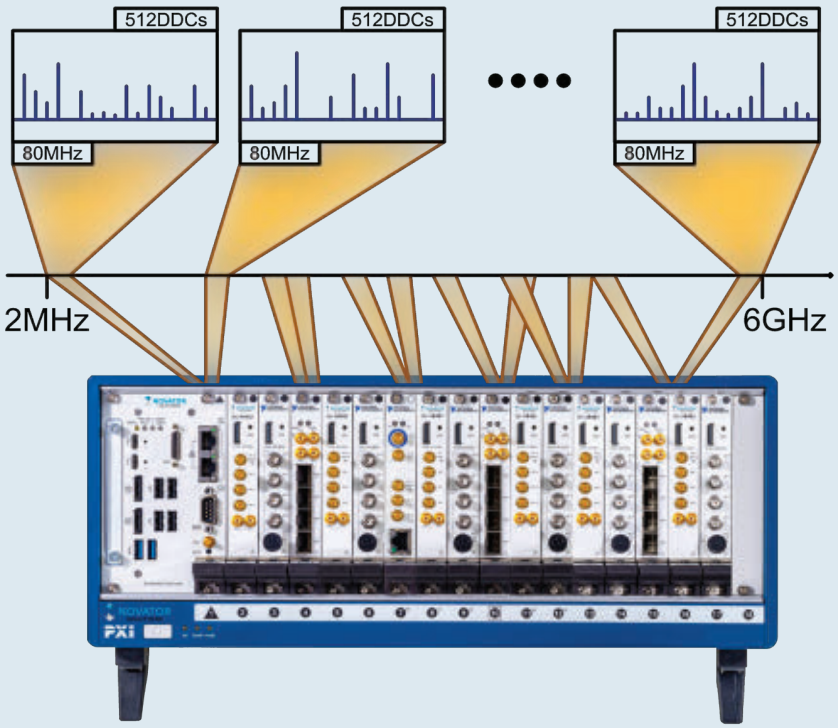

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Electromagnetic Protection (Part 6)

Counters to Side Lobe Jamming

By Dave Adamy

In last month's EW 101 column in the "What's Next" section at the end, the promise was made to cover coherent side lobe cancelling this month. On further consideration, it became clear that a couple of supporting subjects should be covered first. Thus, we will begin this subject area with a discussion of side lobe jamming and the approaches to countering it.

SIDE LOBE JAMMING

Any directional antenna has a main beam and side lobes. As shown in **Figure 1,** the side lobes fill all space outside of the main beam. In general, these beams vary with angle and have very narrow nulls between relatively wider side lobe beams. The radar's main beam and the first two side lobe beams are mathematically well behaved. Their amplitude and spacing follow the formula **sine(x)/x,** where *x* is the angle from the antenna's boresight. The other beams are impacted by reflections from structure and other considerations. The only way to accurately determine their gain vs. angle is to analyze the antenna's gain pattern from an anechoic chamber measurement or to consider the gain pattern of a similar antenna supplied by an antenna manufacturer.

As with any electromagnetic protection (EP) measure, the object is to reduce the jamming-to-signal ratio sufficiently to allow the radar to acquire or track a target in the presence of jamming.

Typically, threat databases give a side lobe estimate thatz is useful in planning countermeasures. As part of the radar definition, there is typically a statement like the following: **S/L = -20 dB.** This means that the average side lobe gain is 20 dB below the boresight gain of the antenna.

When a jammer is located away from the radar's target, as shown in **Figure 2,** it is usually proper to assume that the jamming signal is received by the radar in a side lobe. Unless you know the detailed gain pattern of the antenna and have well defined engagement geometry, it is common to assume the radar's side lobe gain to be as stated in the data base. The radar antenna boresight is assumed to be directed at the target without any tracking error.

Side lobe jamming is required any time that the jammer is not located on the target (i.e., self-protection jammer). This is usually the case for stand-off jamming, stand-in jamming or jamming by a maneuvering expendable jammer (i.e., MALD, ITALD, etc.).

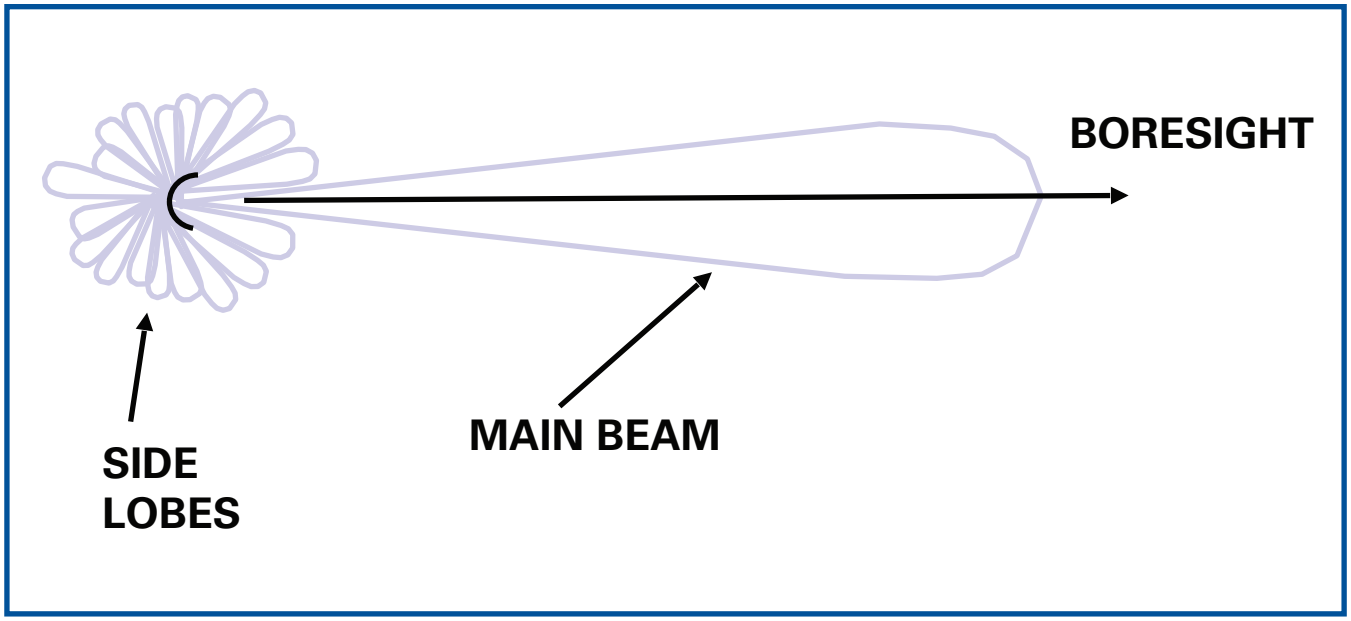

Fig. 1: *A directional antenna has a main beam that is centered on the boresight, and the rest of angular space is filled with side lobes. The boresight is usually the point of maximum gain of the main beam.*

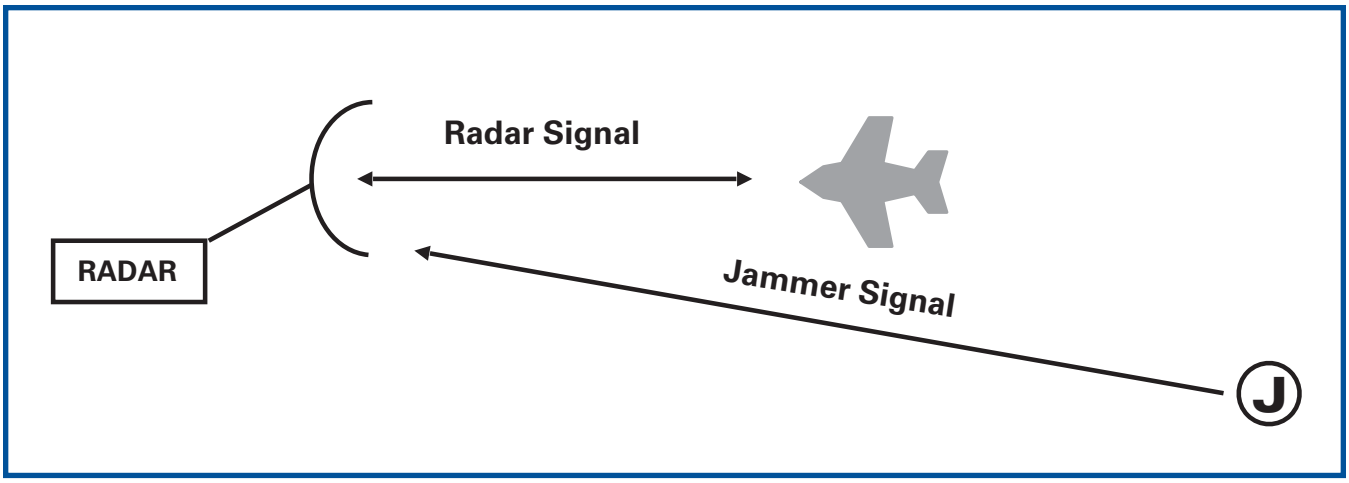

Fig. 2: When a jammer is remote from the radar's target, it must typically transmit into a side lobe of the radar's antenna.

EP AGAINST SIDE LOBE JAMMING

The jamming-to-signal ratio achieved is as calculated from the following formula:

J/S = ERPJ - ERPS + 71 + GS - GM - 20 Log RJ + 40 Log RT - 10 Log RCS

Where: *J/S* is the jamming to signal ratio in dB,
ERP_J is the effective radiated power of the jammer in the direction of the radar in dBm,
ERP_S is the effective radiated power of the radar in the direction of the target in dBm,

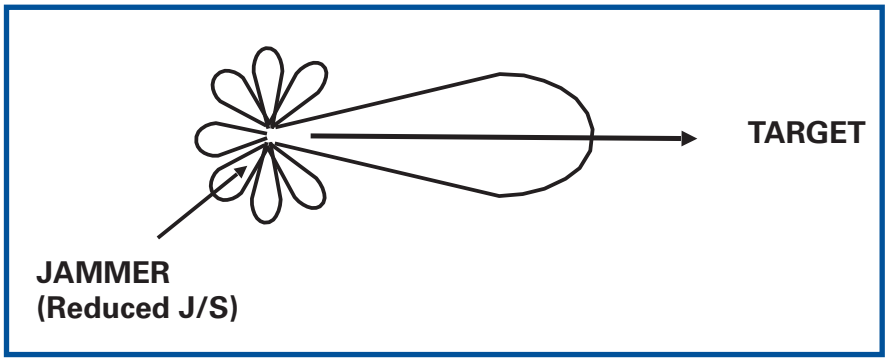

***Fig. 3:** In considering the jamming-to-signal ratio, the radar's antenna gain pattern is assumed to have its boresight aimed at the target. If the jammer is remote from the target, it is assumed to be aimed into a side lobe of the radar's antenna. If the side lobe level is reduced, the J/S is reduced proportionately.*

GS is the radar side lobe gain in the direction of the jammer in dBi,

G_M is the boresight gain of the radar antenna (assumed aimed at the target) in dBi,
R_J is the range from the radar to the jammer in km,
R_T is the range from the radar to the target in km, and
RCS is the radar cross section of the target in square meters

There are several approaches to reducing the jamming-to-signal ratio that can be achieved. The most obvious is to design the radar antenna to have very low side lobes.

***Table 1:** Levels of side lobes relative to antenna boresight*

Performance	Relative Level	Average Level
Ordinary	-13 to -30 dB	0 to -5 dBi
Low	-30 to -40 dB	-5 to -20 dBi
Ultralow	Below -40 dB	Below -20 dBi

Table 1 gives some common definitions of various levels of side lobe reduction relative to the antenna boresight gain for an antenna designed to minimize side lobes.

A review of threat databases will show that some radars can have very low antenna side lobes. Note that if the radar boresight gain is 30 dBi, an ultralow side lobe with a relative level of -45 dB would have a gain of -15 dBi. Plugging in some numbers for the J/S equation shown above:
If: the jammer ERP is 10 watts (40 dBm)
Then: the radar ERP is 10 Mw (100 dBm),
the radar antenna boresight gain is 30 dB,
the range to the jammer is 20 km,
the range to the target is 20 km,
the RCS of the target is 10 square meters, and
the side lobe gain is -15 dBi

The J/S achieved by the jammer is:

40 – 100 + 71 – 15 – 30 -26 +52 - 10 = -18 dB

This is well below the +10 dB J/S which would be desirable to those doing the jamming.

WHAT'S NEXT

Next month, we will continue our radar EP discussion by the consideration of other techniques against side lobe jamming. Dave Adamy can be reached at dave@lynxpub.com.

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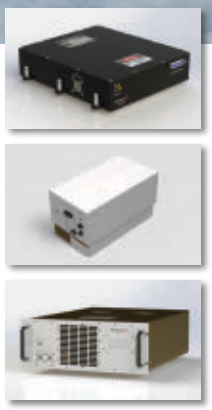

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Light/Tactical CEMA – rapid deployment 'Early-Entry' RF surveys

At the urgent request of a tropical friendly nation's overburdened Tactical CEMA Unit, a member of our Ops Team deployed to a location at the nation's border with a potentially hostile neighboring country to perform an 'Early-Entry' RF survey on behalf of the host Unit. The objective of the survey was to improve the host Unit's understanding of the local RF environment, and to inform their related planning and development of Tactics, Techniques & Procedures.

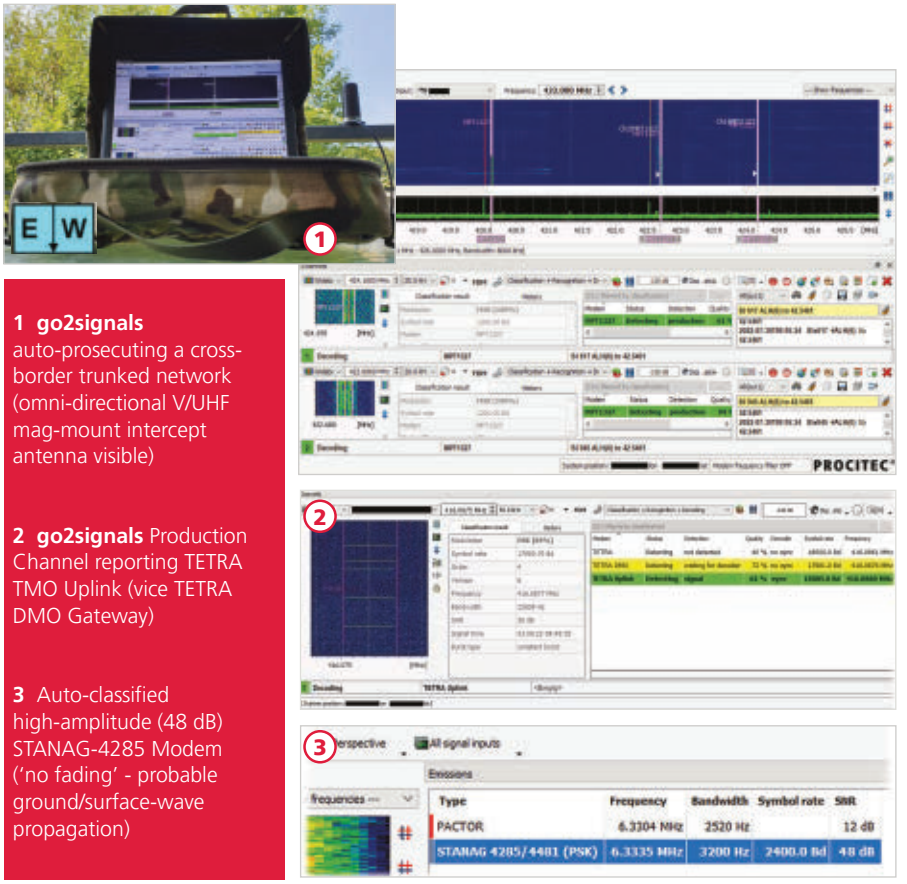
Paramilitary rebel factions across their border were thought to be using Professional Mobile Radios (PMRs) to coordinate their attacks and incursions into the friendly nation, but due to the ongoing heavy workload of the nation's Tactical CEMA Unit, no signals-exploitation assets were available in-country to deploy to this new Area Of Interest (AOI).

So, our Operator deployed in-country with a wideband receiver, directional and omni-directional intercept antennas, and a ruggedized mobile workstation PC running our go2signals radio-communications exploitation software suite.

The go2signals-derived Early-Entry survey results confirmed that the hostile rebel factions were indeed using UHF PMRs, specifically the Digital Mobile Radio (DMR) protocol. No DMR trunking networks were noted active; the rebel factions were found to be using their unencrypted DMR Handheld Transceivers (HTs) and Mobile Units (MUs) in simplex Point-to-Multipoint networking. However, cross-border MPT-1327 digital trunking broadcast downlinks were noted active and reported.

Meanwhile, Private Security Contractors (PSCs) were known to be undertaking mobile border-protection patrols for the friendly nation. Our Operator intercepted two such PSCs using unencrypted UHF Yaesu System Fusion Handheld Transceivers (HTs). The SOIs were automatically classified and decoded in real-time; our Operator's accompanying Interpreter realized that the PSCs were discussing details of their patrol locations, timings and weapons – a clear breach in COMSEC which our Operator immediately reported to the Tactical CEMA Unit for further action and mitigation.

Our Operator had been advised that the friendly nation's critical-communications trunked network infrastructure had been intentionally but temporarily disabled at their border to avoid exploitation and active effects being applied by a potential aggressor.



1 go2signals auto-prosecuting a cross-border trunked network (omni-directional V/UHF mag-mount intercept antenna visible)

2 go2signals Production Channel reporting TETRA TMO Uplink (vice TETRA DMO Gateway)

3 Auto-classified high-amplitude (48 dB) STANAG-4285 Modem ('no fading' - probable ground/surface-wave propagation)

The related portion of the UHF spectrum was indeed 'quiet'. However, the Operator noted a single, seemingly related emission transmitting apparent data-packets. Observing the emission on the go2signals wideband spectrogram display, the Operator initially believed the SOI to be a Tetra DMO Gateway which, erroneously, had not been deactivated.

However, the Operator 'dropped' the SOI from the go2signals wideband spectrogram into an available Production Channel, which, to the Operator's surprise, automatically classified and recognized the SOI as a Tetra Trunked Mode Operation (TMO) Uplink.

The Operator now realized that the SOI was a 'lonely' Tetra TMO Uplink which was sending data-packets to try to register with its 'parent' Tetra TMO cell, but could not register because, of course, the 'parent' Tetra cell had been intentionally deactivated!

The 'lonely' TMO Uplink could be prosecuted and geo-located by a potentially hostile 3rd-party; therefore, the Operator immediately reported these findings to the host Unit. Sometime later, the 'lonely' TMO Uplink's emissions went 'off-air'…

Even without our military (MIL) modem decoder sub-set the Operator was still able to detect and auto-classify signaling protocols of short-medium range HF military-standard modems in real-time by use of the go2signals automatic signals classification capabilities whilst these emissions' ground/surface-waves propagated through the canopy layers of the local primary tropical forest.

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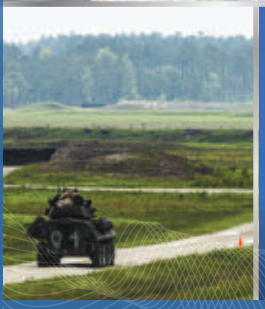

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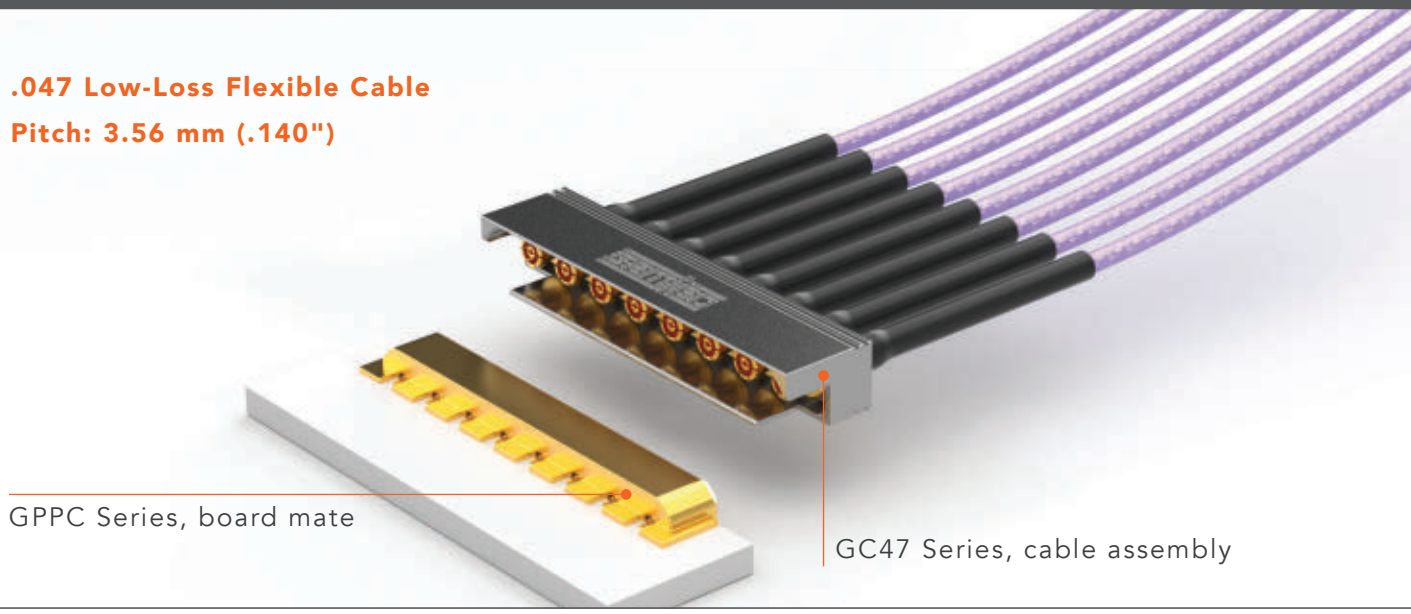

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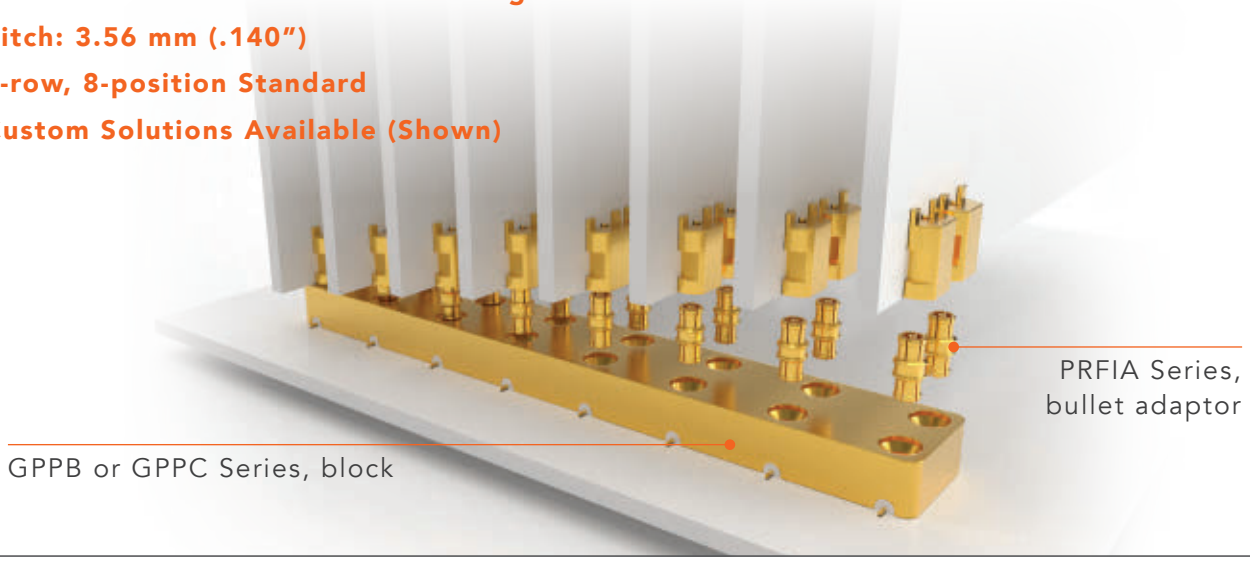

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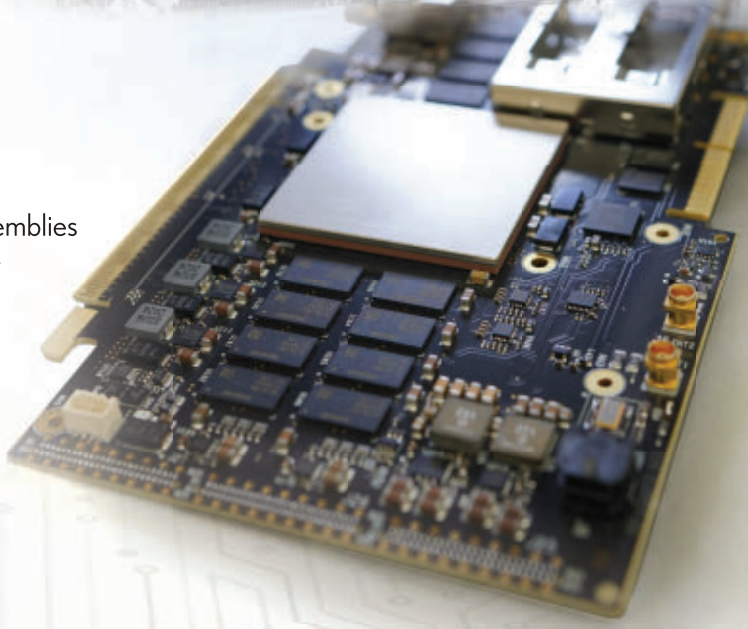

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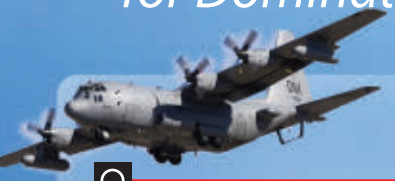

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