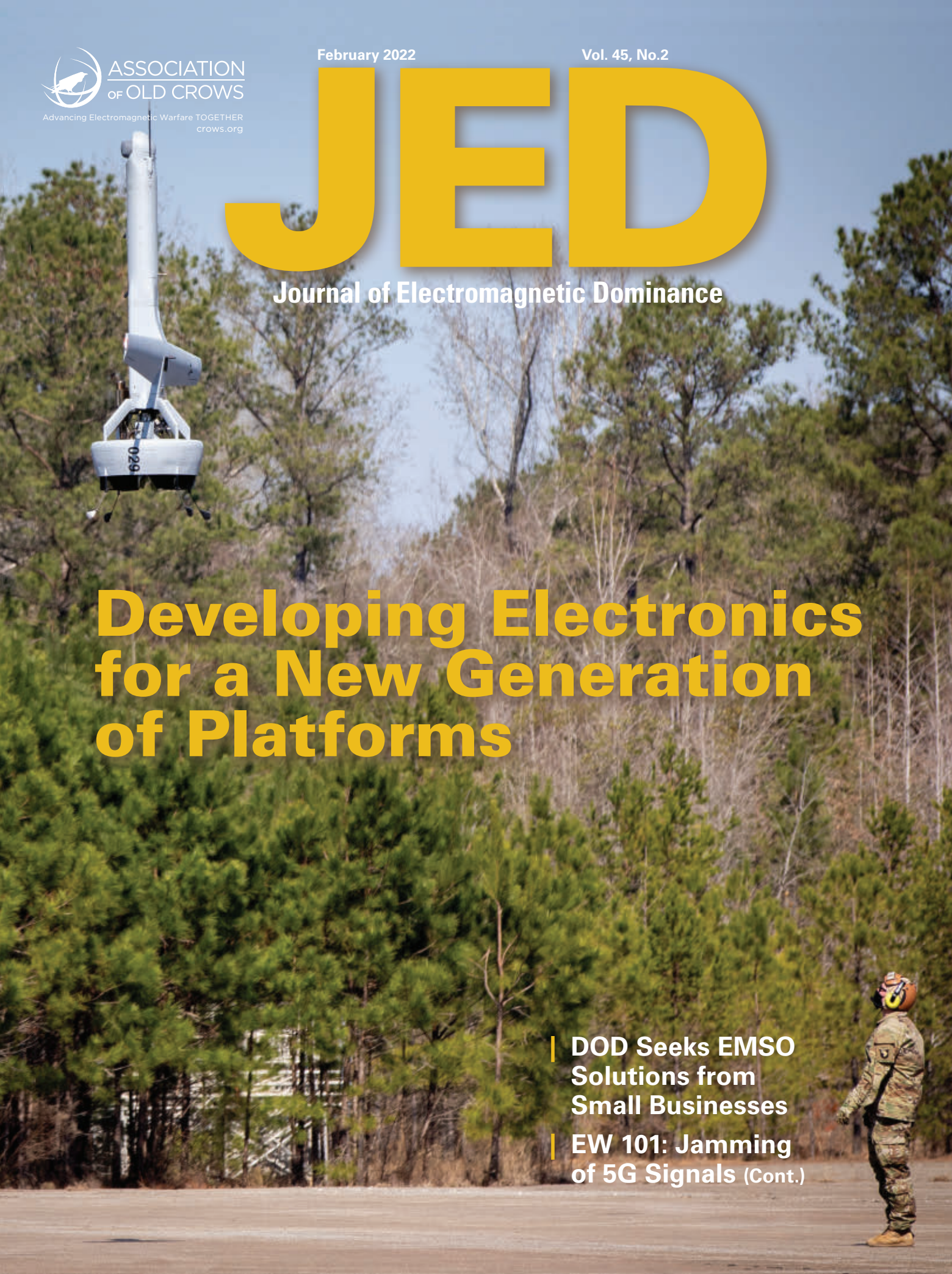
ASSOCIATION OF OLD CROWS
Advancing Electromagnetic Warfare TOGETHER
crows.org

February 2022 Vol. 45, No.2

JED

Journal of Electromagnetic Dominance



Developing Electronics for a New Generation of Platforms

- DOD Seeks EMSO Solutions from Small Businesses
- EW 101: Jamming of 5G Signals (Cont.)

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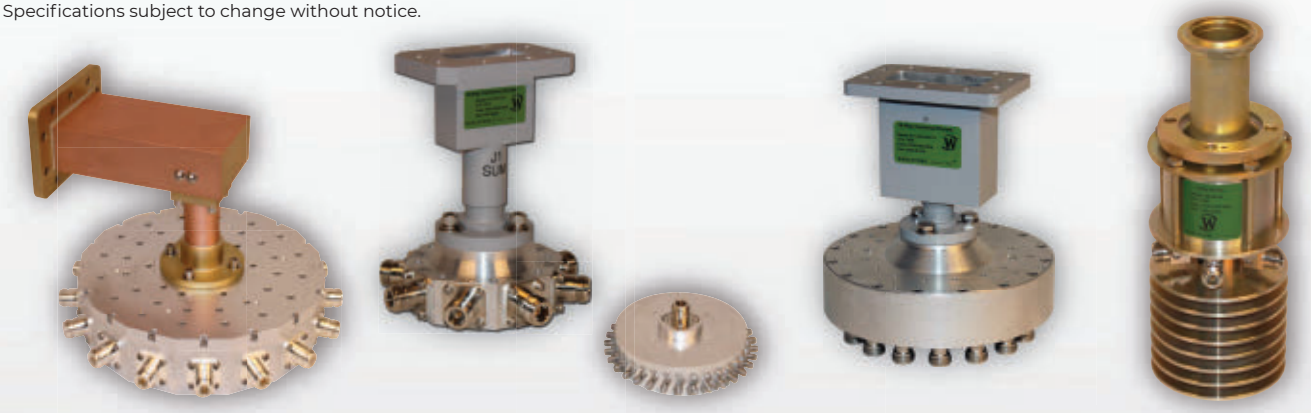
D9816	8-Way	330-530	10,000	50,000	0.25	1.30:1	3 1/8" EIA, N-Female
D8454	8-Way	370-450	10,000	50,000	0.25	1.30:1	3 1/8" EIA, N-Female
D5320	12-Way	470-860	500	5,000	0.30	1.30:1	All N-Female
D10119	4-Way	700-4200	2,000	15,000	0.30	1.35:1	13-30 DIN-Female, N-F
D10603	32-Way	900-925	50,000	150,000	0.15	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	50,000	0.25	1.40:1	WR430, 7/16-Female
D11828	8-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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ULTRA

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JED
Journal of Electromagnetic Dominance

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An EA-18G Growler, assigned to the "Gauntlets" VAQ-136, recovers on the flight deck of Nimitz-class aircraft carrier USS Carl Vinson *(CVN 70), on Jan. 2 in the Philippine Sea. Carl Vinson Carrier Strike Group is on a scheduled deployment in the US 7th Fleet area of operations.*

US NAVY PHOTO BY MASS COMMUNICATION SPECIALIST SEAMAN LARISSA T. DOUGHERTY

Departments

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OCTAVE BAND LOW NOISE AMPLIFIERS

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

NARROW BAND LOW NOISE AND MEDIUM POWER AMPLIFIERS

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

ULTRA-BROADBAND & MULTI-OCTAVE BAND AMPLIFIERS

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

LIMITING AMPLIFIERS

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

AMPLIFIERS WITH INTEGRATED GAIN ATTENUATION

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

LOW FREQUENCY AMPLIFIERS

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

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RESURGENCE?

This month's *JED* features a very insightful cover story by John Haystead about the US government's efforts to strengthen its position in the global electronics market and especially the fast-changing micro-chip market. In the first part of his article, he looks at the government's challenges of passing (and funding) the CHIPS for America Act – legislation that, during the Cold War, would have navigated the halls of Congress with far greater ease. In the second part, he addresses the broader set of defense technology programs that fall under DARPA's Electronics Resurgence Initiative (ERI). What is interesting is that for the first the first time in 30 years, there is broad agreement that the US Government needs to play a more central role in technology development, both for the defense sector (where performance is the dominant factor) *and* for the much larger commercial sector (where cost is the dominant factor).

Within the AOC Community, the CHIPS Act and the ERI will fund many of the technologies needed for the next-generation of EW, SIGINT, radar and communications systems. China, Russia and Iran (among others) are developing, fielding and continuously refining their sensor-to-shooter networks with ever-improving, long-range sensors and precision, long-range weapons. To counter this, the US needs better long-range ISR sensors for stand-off platforms that will operate outside the threat bubble; and it needs large numbers of small, unmanned, low-cost sensor platforms and weapons that can operate far inside the threat bubble. Meeting these new requirements depends in part on developing a new generation of electronics that can provide stand-off ISR platforms with the required sensitivity and performance at long range or that can feature small size, weight, power and cost footprints needed for autonomous attritable platforms to operate much closer to the threats.

Placed within the broader framework of geopolitics and grand strategy, initiatives such as the CHIPS Act and ERI are essential for maintaining the long-term military and economic power of the US and its partner nations. China has already embraced its approach to developing next-generation electronics as part of its Military-Civil Fusion Strategy, which is enabling Beijing to compete with US technology across a broad front, from quantum computing to high-energy lasers. While China marches on, the US continues to squander its electronics lead amid funding squabbles on Capitol Hill. Somewhere in our data-driven world perhaps there is a reliable statistic that can explain in dollar terms how much each month of delay now will cost the US in 2030 – both in terms of military power and economic benefit. – *J. Knowles*

JED
Journal of Electromagnetic Dominance

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Take a Listen to the AOC Podcasts

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From the Crows' Nest

This regularly scheduled podcast, hosted by Ken Miller, AOC's Director of Advocacy and Outreach, will feature interviews, analysis, and discussions covering leading issues of the day related to electromagnetic spectrum operations (EMSO). This will include current events and news from around the world, US Congress and the annual defense budget, and military news from the US and allied countries.

We will also bring you closer to AOC events and provide a forum to dive deeper into policy issues impacting our community.

crows.org/FromtheCrowsNest

The History of Crows

This podcast will take you on a journey throughout time and around the world to meet the inventors, the battles, and the technology that has not only shaped military operations - how we fight - but also how we live.

The History of Crows will cover some of the most important discoveries, battles, and events that shaped what we know today as electromagnetic spectrum operations. Episodes that take you deeper into our history will be added periodically.

crows.org/HistoryOfCrows

Interested In Being a Guest?

Send your ideas and recommendations to Ken Miller, Director of Advocacy and Outreach, at kmiller@crows.org. We look forward to hearing from you!

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For more information and to secure your sponsorship, please contact Sean Fitzgerald, AOC's Manager of Sales and Client Operations, at fitzgerald@crows.org.

Calendar *Conferences & Trade Shows*

FEBRUARY

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

European Microwave Week
February 15-17
London, UK
www.eumweek.com

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

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

MARCH

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

World Defense Show
March 6-9
Riyadh, Saudi Arabia
www.worlddefenseshow.com

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

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

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

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

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

AUSA Global Force Next Symposium
March 29-31
Huntsville, AL
www.ausa.org

APRIL

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

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

37th Space Symposium
April 4-7
Colorado Springs, CO
www.spacesymposium.org

SPIE Defense + Commercial Sensing
April 5-7
Orlando, FL
www.spie.org

FIDAE 2022
April 5-10
Santiago, Chile
www.fidae.cl/en

AOC Fiesta Crow
April 19-21
San Antonio, TX
www.crows.org

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

Calendar *Courses & Seminars*

FEBRUARY

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

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

Advanced RF Electronic Warfare Principles
February 28 – March 4
Atlanta, GA
www.pe.gatech.edu

MARCH

Fundamentals of Radar Signal Processing
March 7-10
Atlanta, GA
www.pe.gatech.edu

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

AOC Live Virtual Professional Development Course: Microwave Photonics
March 7-28
10 Sessions, 3hrs. each
www.crows.org

Principles of Millimeter Wave Radar EW
March 9-10
Atlanta, GA
www.pe.gatech.edu

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

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

SIGINT Fundamentals
March 15-16
Denver, CO
www.pe.gatech.edu

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

Infrared/Visible Signature Suppression
March 22-25
Atlanta, GA
www.pe.gatech.edu

APRIL

AOC Live Virtual Professional Development Course: Tactical ISR Principles, Systems, and Techniques
April 4-27
8 Sessions, 3hrs. each
www.crows.org

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

Basic RF Electromagnetic Warfare Concepts
April 12-14
Atlanta, GA
www.pe.gatech.edu

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ADAPTING TO AN EVER-CHANGING EM ENVIRONMENT

The need to continually adapt systems and tactics within the Electromagnetic Spectrum (EMS) never ceases to amaze me. Opportunities to operate and maneuver within the spectrum continue to evolve with more users and more systems utilizing this arena. As the wireless industry deploys and expands 5G systems, we are hearing concerns raised by major airline carriers about potential interference that could affect airports and commercial aircraft. AOC and other organizations had previously raised possible 5G interference concerns to government agencies and Congress. Users and systems will have to adapt in order to ensure access and safe operations of other systems across the other domains.

To deal and adapt with the ever-changing EMS, I think about my time as a B-52 EWO and how the B-52, which has now served the Air Force for more than six decades, was going to be retired at some point during my active-duty career (my last flight was in 2005). However, the B-52 and its aircrews continued to employ new weapons and tactics to remain relevant in today's operational environment. In those six decades, the B-52 mission has evolved from a high-altitude nuclear bomber, to a high-altitude conventional bomber, to a low-level penetrating bomber for both nuclear and conventional missions, to maritime interdiction and surveillance, and then back to a high-altitude precision strike platform for both stand-off and direct-attack missions. The B-52's onboard systems continue to be upgraded, building on its ability to carry a multitude of weapons on a single sortie. The EMS-related upgrades include radar and communications, as well as a broad-spectrum EW suite that will enable it to operate with legacy and fifth-generation aircraft, joint and coalition forces. The B-52 could reach 100 years of service with system upgrades, new engines, new weapons and aircrew tactics.

My question for my fellow Crows, spectrum warriors and users: are we designing, developing and producing EMS systems and infrastructure that can adapt and evolve like the B-52 has in the air domain? I'm not saying we must build EMS systems that will last 100 years – though we have – but we need systems that can endure and adapt to the ever-changing spectrum and digital environment that we live in today and tomorrow. Both defense and commercial industry must work more closely on EMS systems that can operate in various environments in a complimentary and non-interference basis. The spectrum continues to become more integrated across what used to be clear military and commercial lanes, and systems are becoming multi-functional.

Crows across all generations, industries, academia, governments and militaries must work together and mentor each other to succeed in the integrated spectrum. Our young Crows will be key participants, designers, developers and builders of EMS systems that will adapt across the air, land, maritime, space and cyber domains. Together, we can ensure access and usage across the EMS for all users. – *Glenn "Powder" Carlson*


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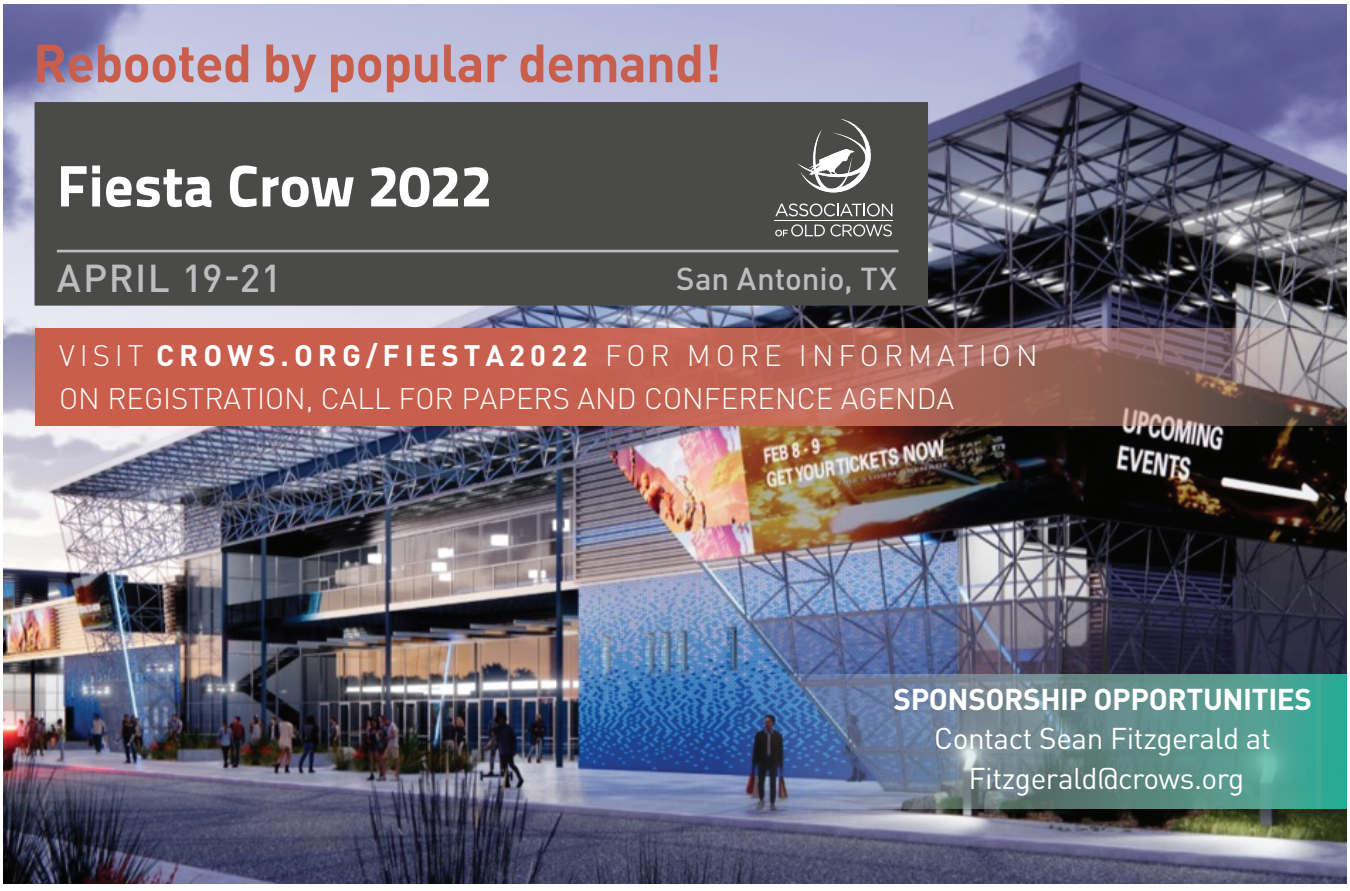
EW Capability Gaps &
Enabling Tech 2022
MAY 10-12
Crane, Indiana
CALL FOR PAPERS
Technical papers will be sought from United States Government, academia, industry, operational units, and subject matter experts on concepts, technologies and capabilities that will enable Force Level Electromagnetic Warfare.
There will be three sessions focused on Joint Long Range Fires, Joint All-Domain Command and Control, and Information Advantage.
SAVE THE DATE
REGISTRATION OPENS IN FEBRUARY!
VISIT CROWS.ORG/Crane2022 FOR MORE INFORMATION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DOD ISSUES EMSO-RELATED RESEARCH TOPICS FOR SMALL BUSINESSES

The DOD has released its first major Small Business Innovative Research (SBIR) solicitation of FY2022, with many topics focused on Electromagnetic Spectrum Operations (EMSO)-related capabilities. The SBIR 22.1 Program Broad Agency Announcement (BAA) lists hundreds of topics from the Army, Air Force, Navy and several other DOD agencies. Many of these opportunities begin with Phase 1 research contracts, typically around $150,000, although some topics are for "Direct to Phase 2" projects that often involve hardware development.

Army

A214-049 – Artificial Intelligence/ Machine Learning (AI/ML) for Radio Frequency (RF) Modulation Recognition: According to the topic description, "The purpose of this topic is to demonstrate the ability to interface to a modern Software Defined Radio (SDR) and the Photon digital signal processing framework in order to characterize large swaths of the RF spectrum in near-real-time (NRT) using AI/ML techniques for signal modulation recognition and sorting (Blue Force emitters; Red Force emitters; Civilian emitters); demonstrate the ability to 'learn' new or unique threat signals of interest so they can be rapidly identified when they transmit." Phase 1 work covers requirements definition, developing digital interfaces to SDR and Photon and demonstrating initial modulation recognition AI/ML capabilities for selected signals. During Phase 2, the contractor(s) will demonstrate advanced modulation recognition capabilities for multiple signals and "productize" the software.

Air Force

AF221-0022 – Explainable AI (XAI) for RF Applications of Deep Learning: Another AI-related effort, this topic aims to "...develop new approaches to explainable AI (XAI) applicable to advanced radio frequency (RF) applications such as radar, electronic warfare (EW), ELINT and SIGINT. This would allow for adequate testing and evaluation (T&E) of deep learning networks (DLNs)." As stated in the topic description, "The recent successes of deep learning applied to a variety of complex RF applications such as cognitive radar (CR) has prompted the need for new T&E methods to validate both performance and reliability, particularly for DoD applications. Explainable AI (XAI) is a branch of research focused on understanding "how and why" a DLN arrived at the response it did. However, for DOD applications, a very rigorous level of validation and reliability must be achieved in order to declare a system "operational". Thus, new XAI methods for DoD-specific applications are required that statistically: (1) quantify performance in an operationally relevant environment: and (2) quantify reliability (and thus availability). Methods are sought that do not require extensive (and expensive) field testing to obtain the relevant statistics." During Phase 1, contractor(s) will "...pursue new XAI methods specifically addressing the DOD's needs for rigorous T&E to declare a warfighting system operational. In particular, rigorous XAI approaches are sought that can result in accurate statistical characterizations of both performance and reliability. These approaches should also minimize reliance on costly field experiments or testing." Phase 2 will focus on one or more real-world focus applications to serve as the pathfinder for the new XAI approaches. The topic point of contact is Daniel Stevens, (315) 330-2416, daniel.stevens.7@us.af.mil.

AF221-0032 – Low-Cost Scalable Ultrawideband Receiver Personality for Attritable Platforms: The objective of this topic is "...to develop a multi-channel 2-18 GHz receive-only RF personality subsystem to interface with conformal antenna arrays and the Zynq UltraScale+ RFSoC analog-to-digital system-on-chip devices. The developed receiver personality will leverage a commercial off the shelf open architecture approach to reduce cost and be form factored to integrate inside the size, weight, and power (SWaP) limitations of platforms, such as the AgilePod and Valkyrie XQ58A nose cones."

According to the topic description, "...there is a critical need for distributed multi-function RF sensing capabilities on attritable platforms supporting integration into a dynamic battlefield environment within the sensing grid construct of the Air Battle Management System (ABMS)." To support this need, the DOD is "developing the next generation of conformal phased array technologies with highly flexible, scalable, and reconfigurable RF digital backends, also known as digital receiver/exciter (DREX). These DREX modules operate over wide frequency bands and support many channels in a small SWaP form factor." However, the description states, "Current multi-channel phased array receiver personalities, however, are still too expensive and have limited modularity for scaling capabilities in attritable-class platforms."

The goal of this topic area is to "develop a modular and scalable receive-only RF personality directly connected with structurally-integrated conformal antenna arrays and the Zynq UltraScale+ RFSoC for future SIGINT/ ELINT, radar warning receiver (RWR), bistatic synthetic aperture radar, and bistatic ground moving target indicator radar capability demonstrations...The Air Force seeks a scalable receive-only 32-channel and 128-channel RF person-

ality operating from 2-18 GHz (threshold requirement of 6-18 GHz) with a tunable bandwidth of 50-4000 MHz, spur free dynamic range of at least 90 dB, and Noise Figure better than 8 dB. The ADC sampling rate and effective number of bits (ENOB) will be defined by the Zynq UltraScale+ RFSoC, with further DREX subsystem and conformal antenna array interface details provided by the Air Force at the beginning of Phase 1. No other government materials, equipment, data, or facilities are required for successful program completion."

The description further states, "The developed RF personality should adhere to the 3U OpenVPX form factor, which defines maximum size, weight, power, and cooling per slot (see ANSI/VITA 65-2017). Likewise, the design must include at least 16 channels per VPX card to support standard phase array system architectures. The developed personality architecture needs to be readily scalable beyond 128-channels in order to support future sensing needs. Additionally, the RF personality must include functionality to enable a hybrid analog/digital subarray beamforming architecture. Each RF path must incorporate phase and amplitude control to support this RF system architecture."

Phase I efforts will focus on designing "…a high-fidelity RF systems model of the receive-only RF personality to meet the performance objectives outlined in the description." This includes "…modeling, simulation and analysis trade-studies to identify the optimal approach and demonstrate concept feasibility of expected performance, size, weight, power consumption, and cooling considerations." During Phase II, contractors will "…develop and deliver a prototype 32-channel and 128-channel receive-only RF personality meeting the topic performance requirements (TRL 4 demonstration criteria)." The point of contact is Jeff Massman, (937) 71-8047, jeffrey.massman.5@us.af.mil.

Navy

N221-019: Long-Range Passive Surveillance in Anti-Access/Area-Denial Environments

Under this topic, the Navy seeks to "Develop passive surveillance techniques that utilize the wideband signal processing and direction of arrival measurement capabilities of modern signals intelligence/electronic intelligence (SIGINT/ELINT) systems to act as a passive radar system leveraging opportunistic emitters in the operational area to develop and maintain the tactical surface picture in Anti-Access/Area-Denial (A2/AD) environments." The program description states, "Operations in high-threat environments drive both

DARPA SOLICITS INFO FOR NEXT-GENERATION PROCESSOR

The Defense Advanced Research Projects Agency (DARPA) has published a Request for Information (RFI) to gather data about Runtime Reconfigurable Array (RTRA) processors that will help it assess the state of technology development in this area. The RFI, which was released by DARPA's Microsystems Technology Office (MTO), also seeks information about potential DOD applications enabled by RTRAs.

As described in the RFI, "RTRAs combine the high performance and power efficiency of application specific integrated circuits (ASICs) with the flexibility and reprogrammability of field programmable gate arrays (FPGAs). These architectures potentially offer significant benefits for streaming signal processing and other applications, particularly when systems must operate in uncertain environments whose characteristics are difficult to specify at design time." The RFI goes on to list the technological advantages of RTRAs, such as their ability to "address a much broader set of applications and environments relative to ASICs at lower development costs and timelines; outperform the processing throughput of FPGAs by one or more orders of magnitude while retaining high input/output (I/O) bandwidth and low latency; deliver dramatically shortened compilation times relative to FPGA workflow; and achieve far faster reconfiguration times, moving from millisecond to microsecond or nanosecond timescales."

The RFI states, "Realizing these benefits requires overcoming multiple hardware and software challenges, including managing the flow of programming data throughout the processing array, programming models and tools that account for spatial and temporal dynamism, and data-driven run-time scheduling of highly parallelized compute resources."

According to the RFI, MTO's specific goal is "to understand the capabilities and limitations of today's RTRAs, the technical challenges that must be overcome with future research, and the defense and dual-use applications that could be enabled by continued development."

The office is seeking information about two specific topic areas. Topic 1 covers "Runtime Reconfigurable Architectures," specifically, "Processors and corresponding software architectures that support reconfiguration in fewer than 100 clock cycles are of interest. Architectures that enable real-time adaptation of streaming data processing in dynamic environments are of particular interest. Processing elements in these architectures may be heterogeneous or homogeneous and either coarse- or fine-grained." MTO is looking for responses that "…focus on unique capabilities of existing or in-development RTRA architectures, comparisons to state-of-the-art processors, and insights into unsolved technical challenges that present new research opportunities in this area. Applications may be defense only or dual-use."

Topic 2 addresses "Defense Applications." The RFI states, "RF, signal processing, and edge autonomy applications are of particular interest but any applications that would significantly benefit from runtime reconfigurable architectures are in scope."

The Notice ID is DARPA-SN-22-15. Responses are due by Feb. 23 and should be submitted to the technical point of contact, John Davies, DARPA MTO at DARPA-SN-22-15@darpa.mil. – J. Knowles

our own forces, as well as our adversaries, to effectively go dark by limiting detectable emissions. In such situations, long-range situational awareness provided by radar and SIGINT/ELINT systems is lost. However, in most of these environments, particularly those in littoral regions, many other electromagnetic emissions are present from other sources, including commercial ships, land-based emitters, and even satellites." While recognizing that Navy aircraft feature active radars, the description also notes that it may be difficult to utilize these active radars as passive radars due to narrow frequency coverage (usually X-band) that limits exploitation of opportunistic signals and limited system functionality, such as detection/tracking or imaging. It notes, however, that "...modern SIGINT/ELINT collection systems operate over a very wide-frequency range and have wide-instantaneous bandwidth processing capabilities, making them an excellent passive radar system in A2/AD environments where opportunistic emissions may be the only means to develop and maintain a long-range surface picture. The nature of the available emissions should be considered and their suitability for use in vessel detection, tracking, and inverse synthetic aperture imaging over frequency ranges typical of modern SIGINT/ELINT systems."

During Phase 1, the contractor(s) will "...develop passive radar concepts suitable for opportunistic emission exploitation by conceptual modern airborne SIGINT/ELINT systems. Supporting analyses should include the presence of potential opportunistic emissions in littoral and blue water oceanic regions... The concepts should consider the relatively modest antenna gain (0-3 dBi) of typical SIGINT/ELINT systems. Under Phase 2, "...candidate concept(s) will be matured through more detailed high-fidelity analyses with a focus on a particular SIGINT/ELINT system identified by the Navy sponsor." The contractor(s) will also develop and demonstrate prototype systems. The point of contact is Thomas Kreppel, Naval Air Systems Command, (301) 342-3482.

White Paper proposals for all SBIR 22.1 topics are due on Feb 10. – *J. Knowles*

ELBIT TO SUPPLY SELF-PROTECTION SUITE FOR UAE A330 MRTT AIRCRAFT

Israel's Elbit Systems has secured a milestone contract to supply air platform self-protection equipment for installation on military aircraft belonging to the United Arab Emirates (UAE).

The company's recently established UAE-based subsidiary Elbit Systems Emirates Limited has been awarded a contract valued at approximately US$53 million to supply directed infrared countermeasures (DIRCM) and threat warning systems for Airbus A330 Multi-Role Tanker Transport (MRTT) aircraft belonging to the UAE Air Force. The contract will be executed over a five-year period.

Under the terms of the sale, Elbit Systems Emirates will deliver a self-protection suite comprising a multi-turret J-MUSIC DIRCM system and the PAWS infrared missile warning system. The same combination of J-MUSIC and PAWS has previously been specified for the A330 MRTT aircraft being introduced under NATO's Multinational Multi-Role Tanker Transport Fleet program.

The UAE Air Force currently operates three A330 MRTTs. An order for a further two aircraft was confirmed to Airbus in Nov. 2021; this agreement also covers the upgrade of the existing A330MRTT fleet to the latest enhanced standard.

The sale of J-MUSIC and PAWS is believed to mark the first publicly announced sale of Israeli EW equipment to any Gulf Cooperation Council state. This follows the Aug. 2020 signing of the Abraham Accords, and the subsequent normalization of relations between the UAE and Israel. – *R. Scott*

IN BRIEF

The UK Defence Science and Technology Laboratory (Dstl) has awarded a US$445,000 task order to **QinetiQ** (Farnborough, UK) for Electronic Support (ES) visualization as part of the Understanding Unknowns challenge within the Future Electronic Surveillance research project. Part of Dstl's Future Sensing and Situational Awareness program, Understanding Unknowns addresses the challenge of characterizing, labelling and visualizing signals in a congested and contested electromagnetic environment which have either not been previously observed, or are difficult for traditional ES systems to understand.

Management Services Group, Inc. (Virginia Beach, VA) has won an $84.7 million contract from the Naval Air Warfare Center - Weapons Division (China Lake, CA) to supply ALQ-167 Pods, ULQ-24C enclosures and associated hardware for use by the Airborne Threat Simulation Organization (ATSO). The ALQ-167 pods and ULQ-24Cs are installed on various types of aircraft and are used to provide radar threat simulation for weapons development, test and evaluation, as well as for Fleet training against airborne radar targets. The contract includes $77.1 million for ALQ-167 Pods and ULQ-24C enclosures and associated hardware and $7.6 million for related hardware mods.

The **Air Force Research Lab's Directed Energy Directorate, High Power Electromagnetics Division (AFRL/RDH)** has announced a five-year Broad Agency Announcement (BAA) covering "High Power Electromagnetics (HPEM) Modeling and Effects." Under the closed BAA, the High Power Electromagnetics Division will issue various research "calls" that will address specific HPEM modeling and effects topics. During the BAA period, the Division expects to award multiple contracts totaling up to $80 million. The BAA covers 14 technical areas, including HPEM weapons effectiveness modelling; emerging technologies, including HPEM sources, diagnostics and sensors; and digital engineering of HPEM systems and components. Technical questions can be sent to afrl.rdh.acquisitionsmailbox@us.af.mil. The contract point of contact is Mr. Adan Dominguez, adan.dominguez.2@us.af.mil.

Naval Information Warfare Command - Pacific (San Diego, CA) has awarded a $369,950 contract to **CRFS Inc.** (Chantilly, VA) for two antenna array systems in support of the Electromagnetic Environment (EME) Sensing and Monitoring project. The direction-finding system will allow NIWC Pacific to provide necessary installation,

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spectrum monitoring support, and training for users at Shipboard Electronic Systems Evaluation Facility (SESEF) sites.

The **US Army Combat Capabilities Development Command Soldier Center** (Natick MA) has issued a Sources Sought Announcement for infrared-mitigating fabric that is woodland camouflage pattern on one side and solid white/white camouflage pattern on the other. The fabric should have performance throughout the electromagnetic spectrum, with improved performance in the higher wavebands, 3-12µm. Durability, launderability, weight and drying rate of the Army's current Snow Overwhites shall be met or improved. This fabric will be used in a science and technology efforts to develop reversible overwhite prototypes for protecting soldiers against detection by electro-optical sensors. The point of contact is Mary Prebensen, mary.k.prebensen.civ@army.mil. Responses are due by February 1.

DARPA's Microsystems Technology Office, which has teamed with **Semiconductor Research Corp.** (Durham, NC), has announced plans to release new research topics under the Joint University Microelectronics Program 2.0 (JUMP 2.0). The public-private partnership, which was established in 2018, funds annual research topics that "drive disruption" in microelectronics. DARPA and the industry consortium partners seek proposals that address one of the following complementary research themes: Cognition – next-generation AI systems and architectures; Communications and Connectivity – efficient communication technologies for ICT systems; Intelligent Sensing to Action – sensing capabilities and embedded intelligence to enable fast and efficient generation of actions; Systems and Architectures for Distributed Compute – distributed computing systems and architectures in an energy efficient compute and accelerator fabric; Intelligent Memory and Storage – emerging memory devices and storage arrays for intelligent memory systems; Advanced Monolithic and Heterogenous Integration – novel electric and photonic interconnect fabrics and advanced packaging; and High-Performance Energy Efficient Devices – novel materials, devices, and interconnect technologies to enable next-generation digital and analog applications. The SRC JUMP 2.0 solicitation is open to all US universities and is conducted on a competitive basis. The JUMP 2.0 Research Announcement is available on the SRC website at https://www.src.org/compete/.

DARPA has awarded two more contracts for its Generating RF with Photonic Oscillators for Low Noise (GRYPHON) program, which aims to develop photonics-based oscillators that feature low-noise characteristics. **Nexus Photonics, LLC** (Goleta, CA) was awarded $10.9 million to develop GRYPHON technologies, and **Honeywell International** (Broomfield, CO) won a $6.8 million contract. DARPA previously awarded GRYPHON contracts to BAE Systems and HQPhotonics.

Slingshot Aerospace (El Segundo, CA) won a $2 million contract for Data Exploitation and Enhanced Processing (DEEP) effort, which calls for monitoring telemetry between proliferated Low Earth Orbit satellites and ground stations to characterize the electromagnetic environment and detect sources of earth-based interference and jamming of GPS signals and other global navigation satellite systems. The DEEP contract, which was awarded through the National Security Technology Accelerator (NSTXL) consortium, will be managed by US Space Force's commercially augmented space inter-networked operations (CASINO) program office.

The **Indiana National Guard** announced in December that it will add approximately 200 new positions with the establishment of an intelligence and electronic warfare battalion. "During the emplacement of this unit in Indiana, the US Army will invest approximately $44 million across the first two years with an annual investment in manpower, training and equipment of $1.5 million," said COL Jeffrey S. Hackett, the Indiana National Guard's operations officer. In Oct. 2021, the Michigan Army National Guard announced that it would stand up a new 200-strong Intelligence and Electronic Warfare & Sensors Battalion by 2026. These two EW battalions are among four new EW battalions that Army National Guard plans to establish as part of the US Army's strategic shift to multi-domain operations.

Recognizing the Navy's growing interest in directed energy (DE) weapons, the **Naval Surface Warfare Center Dahlgren Division (NSWCDD)** announced last month that it has reorganized its DE technical capability into separate organizations for high energy lasers (HELs) and High-Power Microwave (HPM) weapons development. The move is part of a larger reorganization of NSWCDD's Integrated Engagement Systems Department. "HPM and lasers work in parallel in a lot of areas," said Kevin Cogley who leads the new HPM Weapon Systems Division.

The **US Army Combat Capabilities Development Command (DEVCOM) C5ISR Center,** Research & Technology Integration Directorate (RTI) (Aberdeen Proving Ground, MD) is conducting a Market Survey to identify potential sources for the procurement of cyber electronic warfare capabilities. Specifically, the RFI is related to Broad Agency Announcement W56KGU-19-R-9999: Cyber Electro-Magnetic Activities (CEMA) Cyber Operations/Offensive Cyber Operations, sub-topic #2 Electronic Warfare-Enabled Cyber. This sub-topic addresses a number of R&D areas, including: detecting, identifying, locating and mapping potential adversary C5ISR systems and nodes; development of capabilities to distinguish threat systems and nodes from non-threat systems and nodes that may be co-located, particularly those in an urban environment; surgically destroying, disrupting and deceiving threat information systems, networks and their components; performing surgical RF jamming; and exploiting C5ISR systems or networks to manipulate data, conduct ES functions, and/or conducting Denial of Service (DoS) attacks without direct intrusion into the threat system or network. The RFI's solicitation number is W56KGY-22-R-C190 7. Responses are due by Feb. 8.

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DARPA's ERI – Stre
US Defense Electro

By John Haystead

Although Congress chose to completely bypass the issue in the recently-signed FY2022 National Defense Authorization Act (NDAA), the Defense Advanced Research Projects Agency's (DARPA's) Electronics Resurgence Initiative (ERI) still shows the way forward to addressing the greatest vulnerability to the Nation's strength and security – loss of semiconductor technology dominance. The ERI had its genesis nearly five years ago with the recognition that continued US leadership in microelectronics was threatened in both the defense and commercial sectors.

The DARPA Microsystems Technology Office (MTO) held its fourth annual ERI Summit at the end of October last year. MTO's core mission is the "development of high-performance, intelligent microsystems and next-generation components to enable dominance in National security C4ISR, EW, and DE applications." Although the 2021 ERI Summit itself was held virtually, the importance of the subject matter discussed was very much real-world. This year's summit revolved around the launching of ERI 2.0, the latest iteration of the ERI umbrella program.

Hosting the Summit's opening technical session, Dr. Carl McCants, ERI Special Assistant to DARPA Director, provided an historical perspective of the event. The ERI officially began in 2018 with its first summit in San Francisco, California, where a number of factors were identified as driving the initiative. These included the offshore migration of advanced semiconductor manufacturing capability, the exploding complexity of microsystems across the board in state-of-the-art processors and system-on-chip system and package configurations, and the emergence and recognition of hardware security threats in both consumer and defense applications.

From these factors, six focus areas were identified: Increasing Information-processing density and efficiency, accelerating innovation in AI hardware to make decisions at the edge faster, overcoming the inherent throughput limits of 2D microelectronics, mitigating the skyrocketing costs of electronic design, overcoming security threats across the entire hardware lifecycle and revolutionizing communications 5G and beyond.

Said McCants, "Today these factors are even stronger drivers than they were when ERI was first initiated, with new trends emerging and a consensus in the need for action to address these trends." Among these, he pointed to the enormous offshore investments in commercial electronics by near-peer allies and adversaries "which have only grown since the start of ERI, particularly as manifested by the consolidation of leading-edge silicon manufacturing and an increasing footprint into state-of-the-art packaging by pure-play foundries." McCants also noted that the integrity of the microelectronics supply chain has also been of growing concern spurred by the disruptions of COVID-19 and the global nature of the supply network, as well as the formation of multinational alliances for 3D heterogeneous integration (3DHI) R&D and manufacturing.

ERI 2.0 LAUNCHES

A number of assumptions informed the planning for ERI 2.0. These were the recognition that maintaining US supremacy in semiconductor technologies over the long-term will demand a national investment in disruptive technologies; the fact that the scaling of transistors is unlikely to persist much further (and in any case will not drive future microelectronic innovation), meaning future microelectronics will instead be tied to the ability to design, fabricate, test and model the performance of complex 3D assemblies composed of heterogeneous microelectronic technologies; and that lab-to-fab capability represents an opportunity to accelerate and re-shore future manufacturing. Says McCants, "The result is that ERI must continue to strategically invest and seed new approaches to technology to maintain the US position in electronics systems and technology R&D."

Well before the creation of the ERI, the threat to the US lead in semiconductor technology was well recognized, or at least, it should have been. As referenced by McCants, the President's Council of Advisors on Science and Technology (PCAST) issued a Jan. 2017 report stating that "U.S. semiconductor innovation, competitiveness and integrity face major challenges. Semiconductor innovation is already slowing as industry faces fundamental technological limits and rapidly evolving markets. Now a concerted push by China to reshape the market in its favor, using industrial policies backed by over $100 billion in government-directed funds, threatens the competitiveness of U.S. industry and the national and global benefits it brings."

Reinforcing the point, Dr. Jason Boehm, Director, Program Coordination Office, National Institute of Standards and Technology (NIST), a physical sciences laboratory and non-regulatory agency of the United States Department of Commerce, observed during his presentation, that "over the past several decades, what we've seen is that our capacity for manufacturing advanced microelectronics and semiconductors has been on the decline. At one point we were about 37% of the global manufacturing capacity and now we're at about 12%. While global manufacturing capacity is projected to increase quite significantly because of huge demand, we find that we're in a very difficult competitive position and unless we take actions to incentivize construction of fabrication facilities here in US, it's projected that we will continue to drop in share of global manufacturing capacity."

ngthening nics Advantage

The PCAST report laid out a plan for strengthening US leadership in semiconductors: "Promoting US interests will ultimately require a strong focus on advancing semiconductor innovation. This demands a three-part strategy that pushes back against innovation-inhibiting Chinese industrial policy, improves the business environment for US-based semiconductor producers, and helps catalyze transformative semiconductor innovation over the next decade."

IF WE (CAN'T) BUILD IT, THEN WHAT?

The recognition of the importance of maintaining dominance in microelectronics technologies has been increasing dramatically within the DOD and other Government agencies with substantial investment in microelectronics identified as a key priority. Nevertheless, so far this recognition, and the actual spending of real money on the problem, have been pretty much two different things entirely.

To begin with, as pointed out by Boehm, "To make sure that we have a firm footing in domestic manufacturing and a robust R&D ecosystem, leaders in industry and Congress got together and worked on the programs called out in the CHIPS for America Act (CHIPS Act) as part of the FY2021 National Defense Authorization Act (NDAA)."

Said Boehm, "One key goal of the CHIPS Act was to make sure that we have, and are able to protect and extend, our US semiconductor technology leadership, and that we continue to have the investment in early stage R&D and the infrastructure to help translate and move that to development, prototyping and capturing the manufacturing course location. We want to ensure that we have a secure supply of chips for critical commercial economic sectors, as well as unique defense needs. This means ensuring that the US captures its share of projected growth in fabrication facilities across the globe so that we have a significant and stable chip manufacturing sector at the leading edge domestically to meet our critical needs, as well as to contribute to the global market. Right now, the great majority of this capability is located in Taiwan and South Korea, and over the past year, we've seen the challenges posed by the combined impacts of the pandemic, issues surrounding National disasters, and other factors creating microelectronics shortages and revealing the fragility of the global supply chain."

"Ultimately," says Boehm, "the goal is to promote a long-term, economically-viable domestic US semiconductor industry with a robust R&D infrastructure, manufacturing sector, and supply chain. At the end of the day, if we lose that manufacturing footprint and it all moves offshore, then we will lose key capabilities and work force that will further erode our leadership in research and innovation. The Chips Act programs collectively provide us all the tools we need to be able to address this challenge."

The 2021 NDAA authorized funding for the CHIPS Act, which included a number of sections. Section 9902 of the act authorized funding for the Commerce Department Financial Assistance Program, including grants for domestic semiconductor manufacturing and R&D. Section 9906 authorized the establishment of a National Semiconductor Technology Center (NSTC) (9906c) and section 9906d authorized funding for the National Advanced Packaging Manufacturing Program.

Says Boehm, "With regard to the National Advanced Packaging Manufacturing Program, this is really seen as a force multiplier. We realize that heterogeneous integration and advanced packaging will be a huge driver for innovation, and this is an area that the US absolutely must capture a leadership position."

Boehm also sees the NSTC as one of the core foundational pieces of the CHIPS Act. Envisioned to be an entity that can help, accelerate and drive research in advanced semiconductor manufacturing processes, design and packaging, the Center is expected to address Technology Readiness Levels (TRLs) 3-8, supporting access to design tools, robust prototyping and fabrication tools, advanced packaging, assembly and test capabilities and facilities, as well as providing for workforce development. Boehm says, they're "still in the process of talking with all the stakeholders and gathering input," but he expects it would be established through a competitive process. "As a piece of the National infrastructure, the NSTC must have a balance between operational independence and industry involvement."

Another area addressed in the CHIPS Act is the enhancement of metrology R&D. "This is critical for any manufacturing industry," says Boehm, "and we're looking at ways to expand our capabilities both in terms of the types of facilities that we can offer to the community and how we can align these efforts to work best with the NSTC, Manufacturing USA Institute and other programs to address both front- and back-end metrology challenges, as well as in assembly and packaging, test issues, and security and authentication along with automation and virtualization processes."

As an example of some of the things that NIST already does in the field of metrology, Boehm points to the unique facilities that they have available, including the Synchrotron Ultraviolet Radiation Facility (SURF). One of only two such facilities in the world, Boehm says it has "played a critical role in the development of advanced UV lithography technology since the 1990s." NIST is also always looking to contribute new reference materials and material test structures to enhance metrology capabilities.

As Boehm noted, all of these initiatives are designed to be interconnected and to "address a common set of challenges across the semiconductor/microelectronics technology ecosystem. We can't treat them as stovepipes working in isolation." Although today, Boehm points to existing innovative research programs in microelectronics from DARPA, NSF, DOE, as well as in university and national labs, "it's often difficult to transition those new innovations into manufacturing. We're lacking some of the necessary infrastructure, resulting in many of these would-be-successful achievements instead ending in the dreaded 'valley of death.' The CHIPS act is intended to fill this void and help avoid that result."

One example of how this interconnection could be achieved, says Boehm, is by tying together a broader set of R&D programs at the NTSC that will be focused on prototyping and scaling such capabilities. "And, since we'll need to be able to access fabrication facilities, recipients of these funds will be encouraged to allocate a certain number of wafer runs for NSTC-oriented projects."

SHOW ME THE MONEY!

The current status of the CHIPS Act provides a very clear illustration of the fact that authorization is not the same as the actual appropriation of funds.

In June 2021, the Senate passed an omnibus $250 billion US Innovation and Competition Act (USICA — S.1260) intended to be a part of the FY2022 NDAA. Included in this bill was a $52 billion appropriation to fund the CHIPS Act initiatives including $39 billion over five years for section 9902 ($19 billion in FY2022 and $5 billion per year for the following four years). It also included $2 billion in FY2022 for section 9906 for the NSTC plus $500,000 for other related R&D, and $5.5 billion shared with the Advanced Packaging and other programs ($2 billion in FY23, $1.3 billion in FY2024, and $1.1 billion in FY2025 and FY2026).

The omnibus nature of the appropriation, beyond just CHIPS programs, however, turned out to be a major problem. Although the CHIPS Act had passed easily with bi-partisan support and a common plan between the House and Senate, the much broader USICA legislation was a different story, with partisan political issues and the House having its own version of how, and how much, of this funding would be provided. As a result, in order to move forward with approval of the overall NDAA, the Senate withdrew the USICA portion. And, that is where things currently stand.

If, however, the CHIPS Act funding is indeed eventually provided, NIST expects to fund a number of additional activities in the space, such as development of a plan for increasing commercialization of IP developed by the DOD, the development of multiple models of public/private partnerships, and a national network for microelectronics R&D to enable the smooth laboratory-to-fabrication transition of microelectronics innovations. Says Boehm, "Each participating institute will follow a common model providing a common set of shared-use facilities, conduct applied research and also provide capabilities for workforce training."

Another program authorized under the CHIPS Act, that the Commerce Department would be responsible for, is the creation of a Manufacturing USA Institute or multiple institutions specifically focused on the unique manufacturing challenges of the semiconductor industry. The overall program has been around for many years, establishing core research hubs and industry-led consortia and public/private partnerships that are focused on different manufacturing industry sector R&D challenges. Right now, there is a network of 16 institutes across the country which NIST coordinates supported by a combination of NIST and DOE/DOD funding. Says Boehm, "It's definitely fitting to have one or more addressing the unique challenges of semiconductor manufacturing."

Even without having received CHIPS Act funding yet, NIST is nevertheless planning a CHIPS Act Program Office within NIST to provide the infrastructure to support these programs. "When these are funded," says Boehm, "there will be a lot of opportunity for jobs and where we will need the community's help, such as leadership for programs etc."

Congress is also in the early consideration phase of legislation called the Facilitating American-Built Semiconductors Act (FABS Act), which would establish a semiconductor investment tax credit. First introduced in June of 2021, it is endorsed by the Semiconductor Industry Association stating that "the FABS Act should be expanded to include expenditures for both manufacturing and design to help strengthen the entire semiconductor ecosystem."

DARPA ERI KEEPS US IN THE GAME

While the desperately needed, funding authorized but not yet appropriated in the CHIPS Act and the proposed FABS Act remain in limbo or planning stages. DARPA MTO and the ERI are nevertheless making important progress in keeping the US at least in a potentially competitive position in advanced microelectronics technology.

As pointed out by Dr. McCants at DARPA, one of the main purposes of holding an annual ERI summit is to present current work and note accomplishments. "The intent is to provide benchmarks for the progress we're collectively making and to encourage feedback on the technical emphasis and where we might be going in future." As part of this, McCants notes that ERI has increased participation of non-traditional partners from commercial industry in DARPA programs, fostering collaborative projects involving six of the top 10 semiconductor sales leaders, all five leading defense contractors and all of the top ten research universities (per *U.S. News & World Report* ranking). "We continue to strive to increase the base of those entities participating in our funded research."

Among the many specific successes over the past year, McCants points to the Hierarchical Identify Verify Exploit (HIVE) program, whose processor architectures deliver more than 100 times faster speeds than standard CPUs and GPUs; the development of programmable hardware architectures to increase processing efficiency under the Software Defined Hardware (SDH) program; the integration of machine learning into tools for end-to-end electronic design under the Intelligent Design of Electronic Assets (IDEA) program; data privacy research to process information while it remains encrypted such that the data is protected under the Data Protection

in Virtual Environments (DPRIVE) program; hardware security architectures to protect systems against whole classes of hardware vulnerabilities exploited through software, not just individual vulnerability instances, through the System Security Integration Through Hardware and Firmware (SSITH) program; integration of an FPGA core with a photonic transceiver in a multichip module in the Photonics in the Package for Extreme Scalability (PIPES) program; and early demonstrations of 22nm finFETs for specific defense industrial base applications. ERI has also provided open licensing with commercial technology vendors for DARPA research through the "DARPA Toolbox" Initiative.

In addition, McCants notes that over the past year DARPA has also created several new ERI programs in computing, algorithms, filters and heterogeneous integration. Among these is the Low Temperature Logic Technology (LTLT) program, which will develop low temperature (~77°K) device technology to achieve a factor of 25 improvement in performance and power compared to state-of-the-art room temperature CPUs; the Quantum-Inspired Classical Computing (QuICC) program to develop quantum- inspired solvers for a factor of 500 improvement over existing techniques in computational efficiency for a broad range of "hard optimization problems;" the Compact Front-end Filters at the Element level (COFFEE) program that will create an integral RF filter technology to mitigate the interference vulnerabilities of wideband Active Electronically Scanned Arrays (AESAs) operating in congested RF environments; and the Electronics for G-band Arrays (ELGAR) program to develop the integration technologies needed to create compact, high-performance G-band-array front ends to enable DOD communication and sensing phased array systems.

WHAT WILL ERI 2.0 BRING?

Looking at the future and specifically the future for ERI 2.0, McCants says, "We first have to look at what we've already learned. Among these is that it is possible to engage the academic, commercial, and US Government microelectronics communities in relevant, cutting-edge, dual-use research projects. We've also learned that it is possible to provide leap-ahead capabilities in computational efficiency, heterogeneous integration, hardware security, electronics design, AI components and secure communications through these collaborations that benefit both the US Government and private sector. However, we've also learned (or relearned) that maintaining technical advantage will require continuous innovation."

McCants says the next question is, "What are the trends today both in applications and technology and the industrial base that should shape our thinking about future R&D?" Pointing to application trends they've considered over the past year, such as passive sensing and adaptive electronic warfare (EW), McCants observes that other technology trends include novel computing and manufacturing and prototyping. Among industrial-base trends, he points to reshoring manufacturing, heterogeneous integration proliferating in products, and computing-at-the-edge AI growth rates in various commercial market sectors. "Again, the question is, what opportunities should we prioritize in planning for the future?"

To answer this question, McCants observes that DARPA's mission is to "prevent technological surprise as well as to create technological surprise when an opportunity is identified." This, says McCants, typically involves a longer time horizon than when focusing on translating commercial advances for DOD needs. So, for ERI going forward, this means asking questions like: What, as gains from transistor scaling continue well into the next decade, new manufacturing paradigms will appear? What fabrication techniques will be associated with disruption in performance? As we reach the classical quantum limit in transistor dimensions, and as the importance of microscale packaging increases, another question is, what packaging and assembly infrastructure and tool capabilities will be needed? What would support automating more of the manufacturing processes beyond the front-end foundry? How might an increase in the testing and validation activities for complex Systems on Chips (SOCs) provide feedback to the research more quickly, and what aspects of testing might be customized and automated through machine learning, taking advantage of predictive analysis?

McCants says all of these thoughts – combined with well-timed studies, analyses and a myriad of conversations – led to the assumptions described earlier in the planning of ERI 2.0. "Taking all of this into account, with ERI 2.0, we will continue innovating the next generation of microelectronics through the initial six areas of the initiative. But we will also be adding two new areas – R&D for Advanced Manufacturing and Electronics for Harsh or Extreme Environments."

R&D for Advanced Manufacturing will include the design, assembly, testing and digital emulation of 3DHI microsystems with an emphasis on the following: multichip/multi-technology assembly and packaging, tools for design, simulation and test, security, 3DHI interconnects, thermal management and power delivery. It will also pursue next-generation microelectronics prototyping. Says McCants, "We expect this will do the following: reduce cycle time for R&D and pilot manufacturing for 3D electronics assembly, ensure secure domestic supply chain with a domestic facility and provide the capabilities driven by future industry needs. Next, it will provide technology for advanced packaging and assembly with the potential for significant cost reduction in microsystems, and it will emphasize design innovations and enhance the use of manufacturing automation in the package, assembly and testing process."

The second new focus area for ERI 2.0 – Electronics for Harsh or Extreme Environments – will recognize and examine how high radiation, extreme temperature, high power (whether voltage or current) each present their own unique challenges and opportunities. Individual presentations at the 2021 ERI Summit specifically addressed both of these new ERI 2.0 focus areas.

The ERI program forms a critical piece of US strategy for semiconductor technology. McCants recognizes this when he says "As we prepare for the future, we definitely expect to have many new opportunities for coordination and collaboration with other Federal partners, academia, and industry."

5G Communication – Part 11

Communications Jamming of 5G Signals *cont.*

By Dave Adamy

JAMMING SCENARIOS

The following jamming situations are presented, showing the jamming-to-signal ratios that would be achieved with the parameters entered. In each case, the 5G transmitting antenna is assumed to be accurately aimed at the 5G target receiver.

MID BAND – 5G CELL PHONE NETWORK WITHIN THE ATMOSPHERE

The link and jamming geometry are as shown in **Figure 1:**

- Frequency is 3.5 GHz (mid band).
- 5G receiver has a circular array of antennas with 10-dB gain in all directions.
- The transmitter power is 10 watts.
- There is a clear transmission path over both the 5G and jamming links, so both links have line-of-sight propagation.
- The link transmitter and receiver each have 10-dB gain with 360^0 azimuthal coverage, and the link stations are 25 km apart.
- The 1 kW ERP jammer is 40 km from the target receiver.

Since the target receiver has a 360^0 antenna, the jamming-to-signal ratio formula is:

J/S = ERPJ – ERPS – LJ + LS

Where: *J/S* is the jamming-to-signal ratio in dB,
ERP_J is the effective radiated power of the jammer in dBm,
ERP_S is the effective radiated power of the desired signal transmitter in dBm,
L_J is the propagation loss between the jamming antenna and the target receiver antenna in dB, and
L_S is the propagation loss between the desired signal transmitter antenna and the target receiver antenna
in dB.

ERPJ = 60 dBm

ERPS = 40 dBm + 10 dB = 50 dBm

LJ = 32.4 + 20 log (40) + 20 log (3500) – 32.4 + 32 + 70.9 =135.3 dB

LS = 32.4 + 20 log (25) + 20 log (3500) = 32.4 + 28 + 70.9 = 131.3 dBj

J/S = ERPJ – ERPS – LJ + LS = 60 – 50 – 135.3 + 131.3 = 6 dB

This is effective jamming if the 5G link does not have an electromagnetic protection feature.

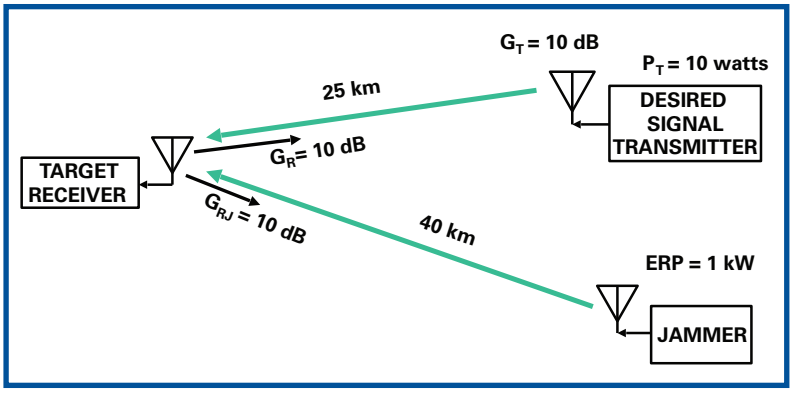

Fig. 1: *Both the desired signal transmitter and receiver are within the atmosphere. This is one link in a cell phone system. All system stations have non-directional antennas with 10-dB gain in all directions.*

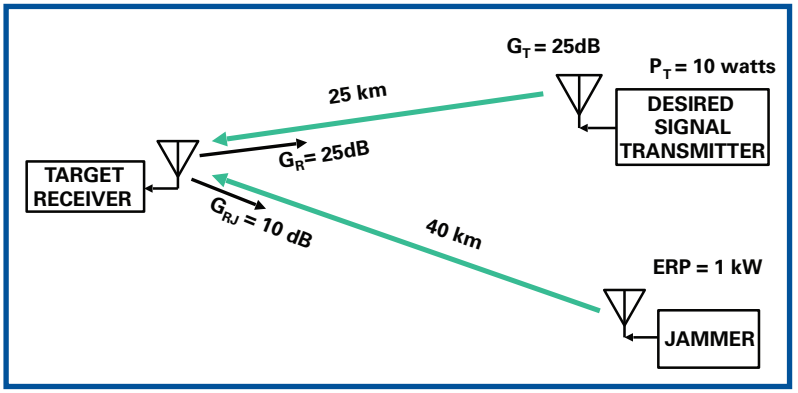

Fig. 2: *Both the desired signal transmitter and receiver are within the atmosphere, but the target receiver has a phased array antenna aimed at the desired signal transmitter, which has a phased array antenna aimed at the target receiver.*

MID-BAND – 5G DATA LINK WITH 25-dB PHASED ARRAY ANTENNAS ALL WITHIN THE ATMOSPHERE AND WITHIN LINE OF SIGHT WELL ABOVE THE GROUND

The link and jamming geometry is shown in **Figure 2.**

- The mid-band frequency is 3.5 GHz.
- The transmit and receiving antennas are phased arrays oriented toward each other.

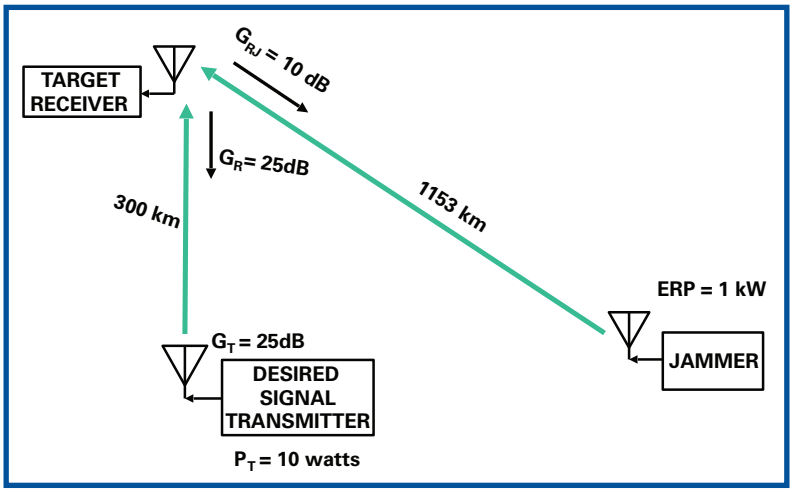

Fig. 3: The target receiver is in a low Earth satellite with 300 km altitude. A mid-band (3.5 GHz) G5 link is from a ground transmitter with an antenna elevation of 90°. The 1-kW jammer is on the Earth, with an elevation to the satellite of 10°.

- The gain of both the transmit and receive antennas is 25 dB.
- The jammer is in a 10-dBi side lobe of the receiving antenna.

ERP_J = 60 dBm

ERP_S = 40 dBm + 25 dB = 65 dBm

L_J = 32.4 + 20 log (40) + 20 log (3500) – 32.4 + 32 + 70.9 =135.3 dB

L_S = 32.4 + 20 log (25) + 20 log (3500) = 32.4 + 28 + 70.9 = 131.3 dBj

Because the target receiver antenna has directionality and is aimed at the desired signal transmitter, the J/S formula is:

J/S = ERPJ – ERPS – LJ + LS + GRJ - GR
= 60 – 65 - 135.3 + 131.3
+ 10 dB – 25 dB
= -24 dB

MID-BAND – 5G DATA LINK FROM THE GROUND TO A SATELLITE RECEIVER

The link and jamming geometry is shown in **Figure 3,** but we need to take a detour to **Figure 3** to determine the link distances. The receiver is on a satellite in a circular orbit 300 km above the Earth. The transmitter is on the ground directly below the satellite, but the jammer is on the ground at a distance that places the satellite 10^0 above the local horizon. The satellite, the jammer and the center of the Earth form a plane triangle. The sides of the triangle (lower case) and the angles (upper case) are shown in the same figure. Side a is the radius of the Earth + the satellite elevation (6671 km), side b is the radius of the Earth (6371 km) and Angle A is the elevation of the satellite above the center of the Earth as seen from the jammer (90^0 + 10^0 = 100^0). The sine of 100^0 is 0.985. From the law of sines, we can calculate angle C to be:

arcsin (6371 x .985 / 6671) = 70.2°

Angle B is: **180^0 - 100^0- 70.2^0 = 9.8^0**

The sine of 9.8 degrees is **0.170**

Then, from the law of sines, side b is:

6671 x 0.170 / 0.985 = 1,151 km

Now we can go back to **Figure 3**. The distance from the link transmitter to the target receiver is 300 km. The distance from the jammer to the target receiver is 1,151 km.

Now the rest of the givens for the problem are as shown in **Figure 3**:

- The link frequency is 3.5 GHz.
- The 5G transmitter power is 10 watts and the jammer ERP is 1 kW.
- The transmit and receiving gain of both the link transmit and receive antennas are 25 dB.
- The jammer is in a 10-dBi side lobe of the receiving antenna.

ERPJ = 60 dBm

ERPS = 40 dBm + 25 dB = 65 dBm

LJ = 32.4 + 20 log (1151) + 20 log (3500)
= 32.4 + 61.2 + 70.9 =164.5 dB

LS = 32.4 + 20 log (300) + 20 log (3500) = 32.4 + 49.5 + 70.9 = 152.8 dB

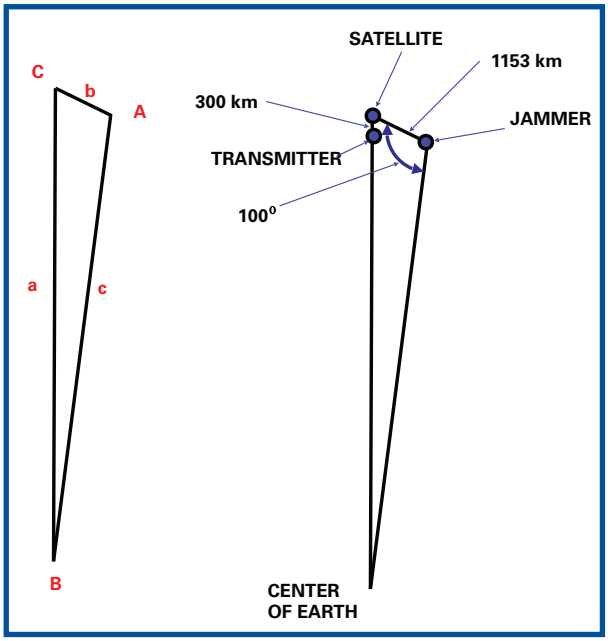

Fig. 4: This shows the link and jamming geometry for a satellite receiver on a 300-km high satellite, a ground transmitter right below it, and a jammer on the Earth with a 10° elevation angle to the satellite.

For both links, the attenuation through the atmosphere is negligible.

Because the target receiver antenna has directionality and is aimed at the desired signal transmitter, the J/S formula is:

J/S = ERPJ – ERPS – LJ + LS + GRJ – GR = 60 – 65 – 164.5 + 152.8 + 10dB – 25 dB = -31.7 dB

WHAT'S NEXT

Next month, we will continue our discussion of 5G signal jamming with the analysis of other jamming situations. For your comments and suggestions, Dave Adamy can be reached at dave@lynxpub.com.

AOC's Mentorship Program Is Seeking Mentors

The **AOC Crow Career Builder** was created to connect our network of professionals with the next generation of crows. Through step-by-step communications, our mentors and mentees are given a template for creating a valuable working relationship. Mentees will also have the opportunity to network and socialize among people just like yourselves and make essential connections.

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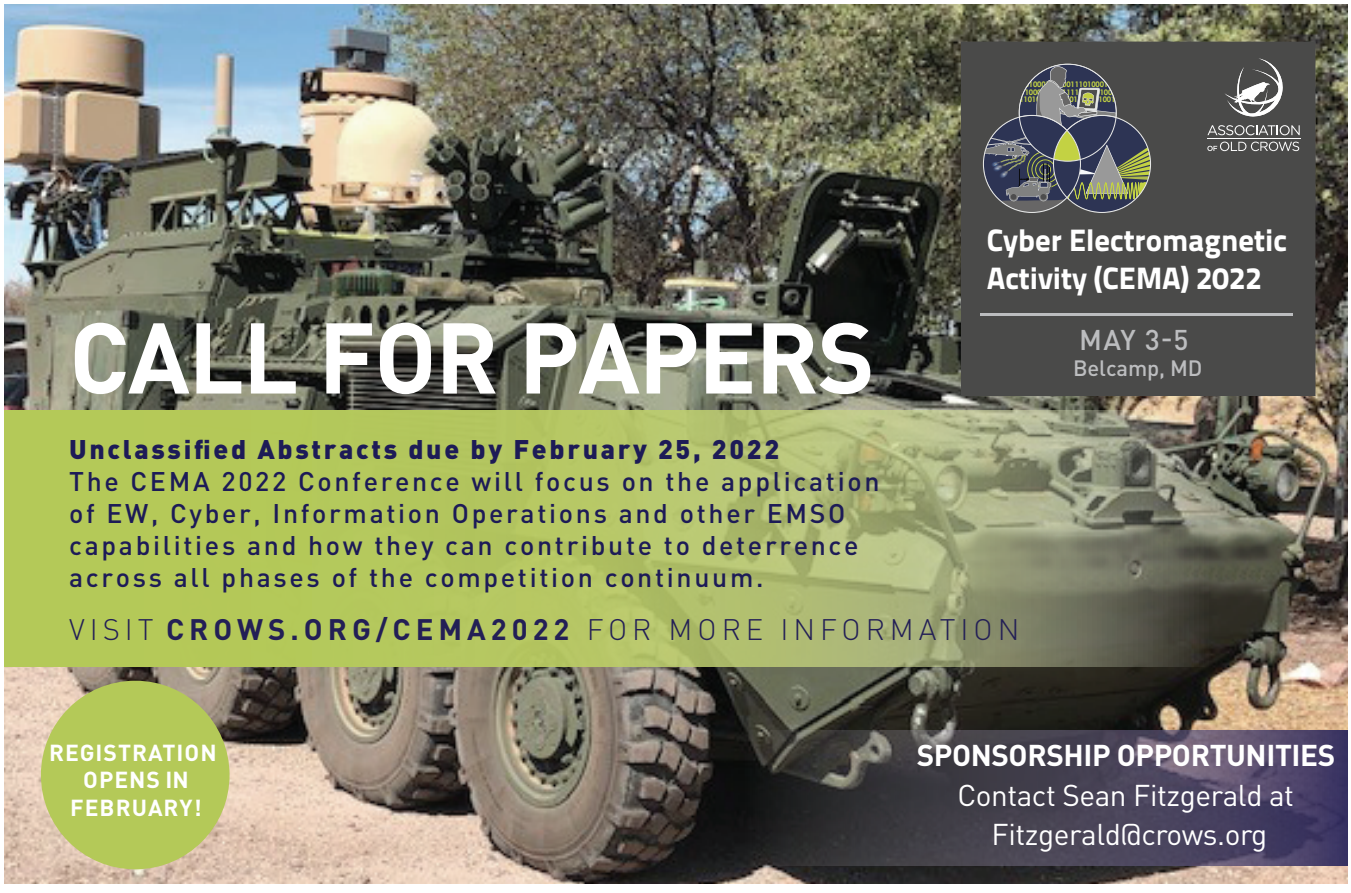
To become a mentor with AOC, visit crows.org/mentorship.



IMPORTANT DATES FOR AOC MEMBERS

2022 AOC AWARDS WILL OPEN MARCH 1 – APRIL 15

A central tenet of the AOC's mission is recognizing individuals, groups and military units for their outstanding performance in furthering the aims of the AOC and the Electromagnetic Warfare enterprise. The AOC has a number of awards that are available each year.

For more information, visit crows.org/awards.

NOMINATIONS FOR THE AOC 2022 ELECTIONS WILL OPEN ON MARCH 1

More information can be found at crows.org/elections.

AOC SCHOLARSHIP PROGRAM

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AOC currently provides two scholarships to students currently in their sophomore or junior year of college. Each year one male and one female student studying in engineering or engineering technology and interested in working in the aerospace and defense industry is awarded a scholarship. A generous donation from Raytheon Intelligence & Space funds these scholarships. We are seeking other industry partners to participate as well to grow our program further.

For more information, go to crows.org/scholarshipprogram.

Cyber Corps Warrant Officer Scholarship – Dates: April 1 – May 30

AOC is exceptionally proud of The Cyber Corps Warrant Officer Scholarship established by the Laurie Buckhout Foundation in August 2020 under the Association of Old Crows Education Foundation incorporated and registered as a Non-Profit status under 501(c)(3) of the Internal Revenue Code. The Cyber Corps Warrant Officers Scholarship Foundation is a non-profit organization dedicated to providing support to U.S. Army Cyber Corps (i.e., 170A, 170B, and 170D) warrant officers by allowing them to apply for financial assistance in gaining various levels of formal higher education.

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Already in progress: The Dixie Crow Chapter's approach to our 8th Annual Crows N.E.S.T. will be focused on providing monetary donations to surrounding schools to supplement the teacher's STEM classroom planning. (Unfortunately, there will be NO student STEM event during our Symposium as in years past.) However, we will still provide all participating schools' students with t-shirts displaying Industry logos and names of our Dixie Crow Chapter Education Foundation Donors! We greatly appreciate your support educating our "Leaders of Tomorrow!"

SCHEDULE OF EVENTS

SUNDAY, MARCH 20

Registration	Best Western Plus Executive Residency, Warner Robins, Georgia	5:00 PM-8:00 PM
Welcome Reception	Best Western Plus Executive Residency, Warner Robins, Georgia	5:00 PM-8:00 PM

MONDAY, MARCH 21

Registration/Lunch	Southern Landings Golf Course, Warner Robins, Georgia	11:30 AM-12:55 PM
Spring Golf Tourney	Southern Landings Golf Course, Warner Robins, Georgia	1:00 PM Tee Time

TUESDAY, MARCH 22

Registration	Century of Flight Hangar, Museum of Aviation	7:00 AM-6:00 PM
Exhibits Open	Century of Flight Hangar, Museum of Aviation	7:00 AM-7:00 PM
Exhibitor Reception	Century of Flight Hangar, Museum of Aviation	5:00 PM-7:00 PM

WEDNESDAY, MARCH 23

Registration	Century of Flight Hangar, Museum of Aviation	7:00 AM-2:00 PM
Exhibits Open	Century of Flight Hangar, Museum of Aviation	7:00 AM-3:00 PM
Crows N.E.S.T.	INDIVIDUAL SCHOOL EVENT	
Banquet	Nugteren Exhibit Hangar, Museum of Aviation	Cocktails – 5:30 PM-6:30 PM Dinner – 6:30 PM-8:30 PM

WELCOME TO DIXIE CROW SYMPOSIUM 46!

Our Symposium Committee, Dixie Crow Chapter President, Adam Delestowicz, and the Chapter Directors cordially invite you to join us for all the exciting events described here. Thank you in advance for your support of this important electromagnetic spectrum operations trade show.

Sincerely, Lisa Frugè-Cirilli, *Co-Chair* | lisa.fruge@baesystems.com
Tristan Caruso, *Co-Chair* | tcaruso33@gmail.com

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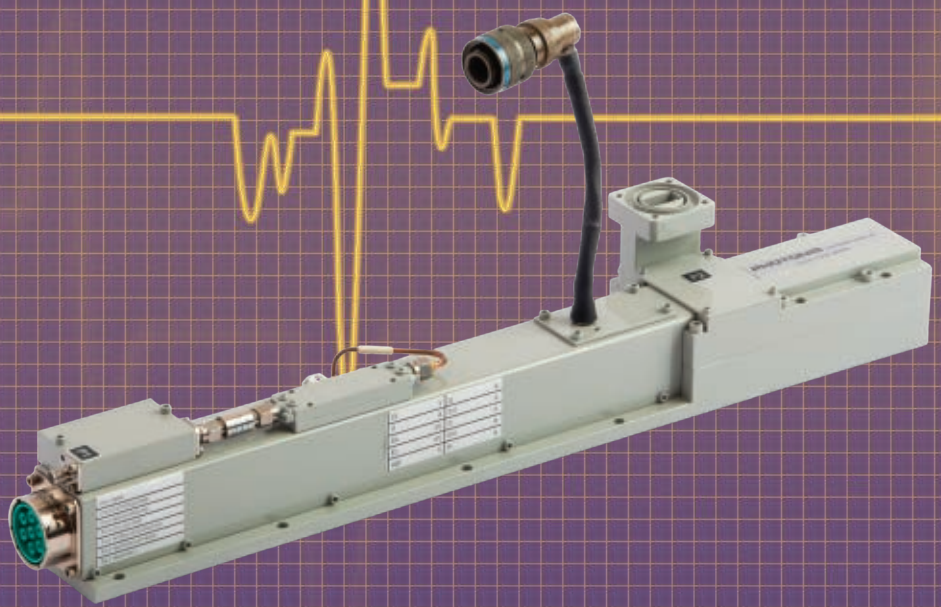

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