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# JED

*The Journal of Electronic Defense*

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## Maturing Multifunction



### Also in this Issue:

- Technology Survey: Portable Spectrum Analyzers
- EW101: Anti-Side-Lobe Jamming Techniques
- AOC Member Guide

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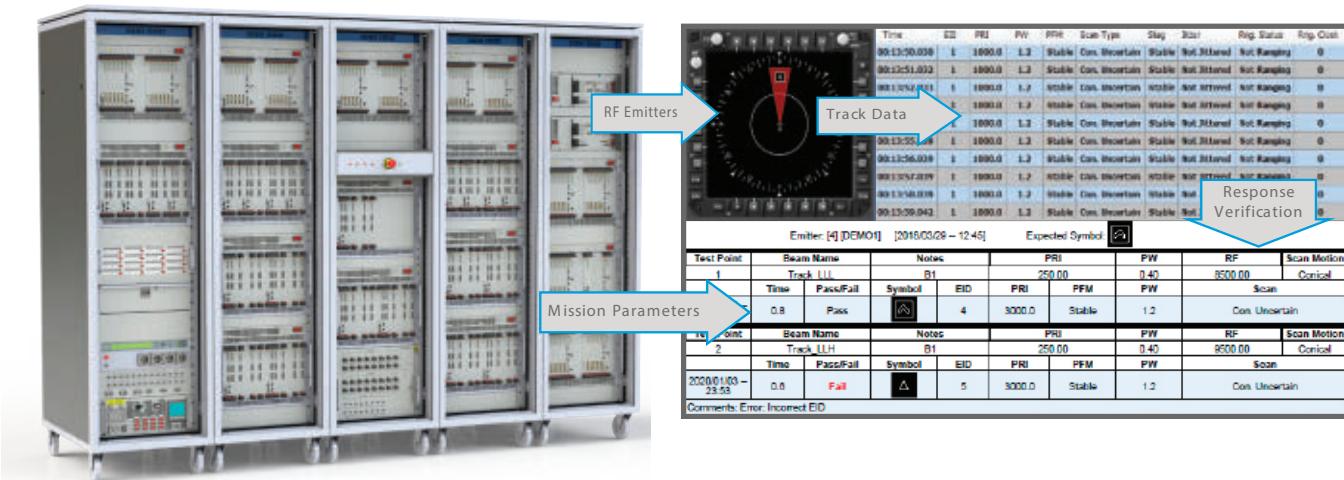
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Members of the 55th Electronic Combat Group (ECG) stand in formation during a ceremony for the final flight of the first EC-130H Compass Call aircraft, tail number 1587, at Davis-Monthan Air Force Base, AZ, on January 15. The aircraft, originally named "Kermit" and later renamed "Reaper," was the first Compass Call modified aircraft to arrive at Davis-Monthan in 1982. It participated in Operations Inherent Resolve, Iraqi Freedom and Desert Storm. The aircraft will be modified into a static aircraft, placed in front of the 55th ECG campus at Davis-Monthan.

US AIR FORCE PHOTO BY SENIOR AIRMAN CHRISTINA RIOS

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Barry Manz

Development of multifunction systems will depend on a matrix of enabling technologies. While many discussions have focused on the hardware aspects of multifunction, open software standards will be critical, as well.

### Technology Survey: Handheld and Portable Spectrum Analyzers 29

Barry Manz

The spread of spectrum analyzers from the laboratory to the field is not a new development. As the market for portable spectrum analyzers continues to grow, however, the offerings have become more diverse and more capable.

### 2020 Industry & Institute/University Member Guide 38

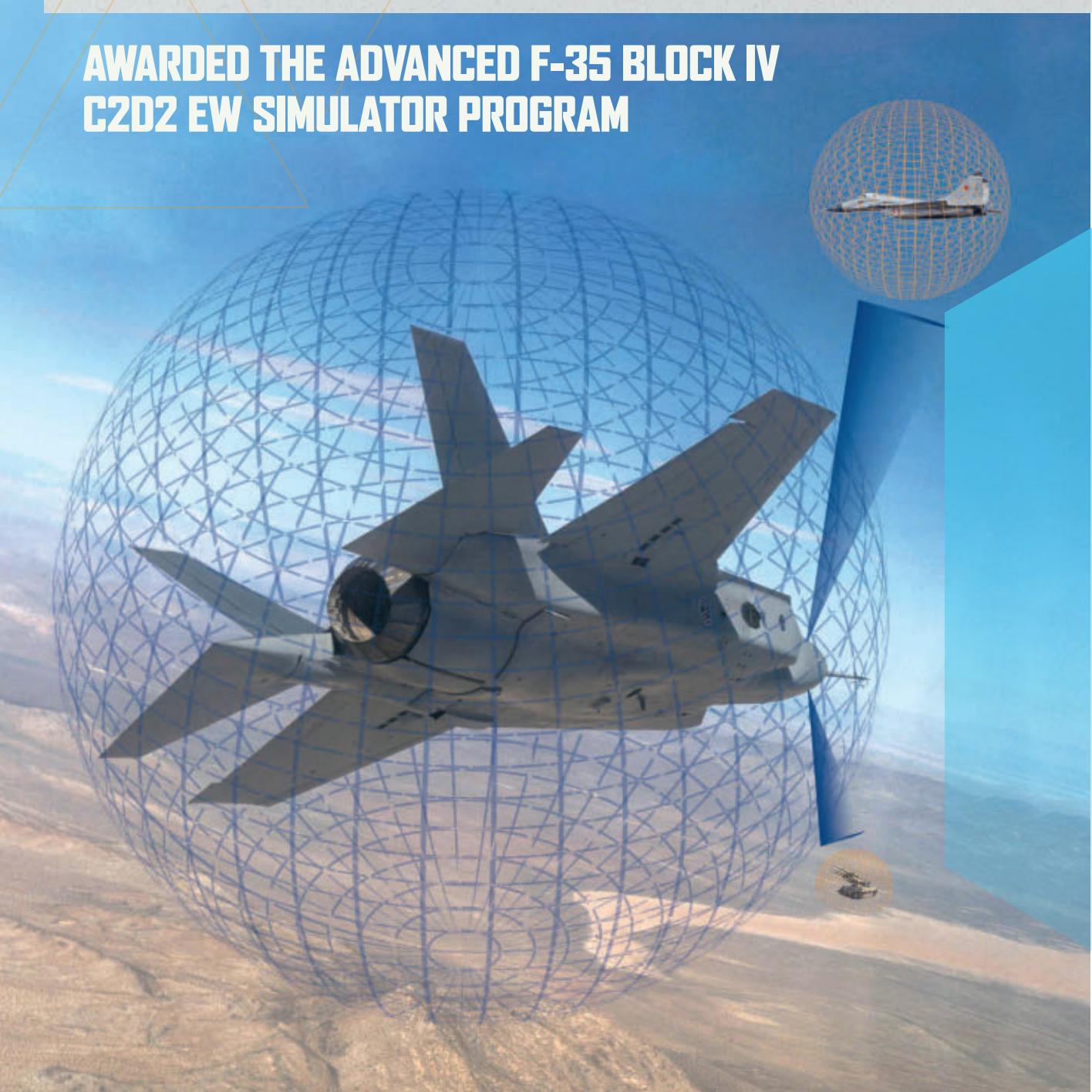
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# INTEL TO RF

AWARDED THE ADVANCED F-35 BLOCK IV  
C2D2 EW SIMULATOR PROGRAM



# M&S FOR MULTI-DOMAIN OPERATIONS

In January, Secretary of the Army Ryan McCarthy directed the Army Science Board to conduct a study “to assess the Army’s M&S capabilities in support of strategic decision making, acquisition, training, and test and evaluation (T&E). Specifically, the study should determine Army M&S needs, where the Army’s M&S capabilities are state-of-the-art (SOTA) and where they are not, then develop recommendations to close any shortfalls.” The driver for this initiative is the Army’s emerging focus on Multi-Domain Operations (MDO), and its recognition that it needs better decision making tools for space operations, cyber operations and electronic warfare.

The US Army isn’t the only Service facing this emerging MDO M&S challenge. To varying degrees, all of the Services, the COCOMs, and most US allies will need to invest in new M&S tools, personnel, etc. for MDO, whether they are aware of this yet or not. The last time the DOD resourced a major push in EW M&S – back in the 1990s – it was focused on relatively simple scenarios, such as 1 vs. 1 engagements against surface-to-air missile systems and streaming (rather than saturation) anti-ship missile attacks. In terms of today’s operations, we are entering an era where the force that can integrate and aggregate its stand-off, stand-in and stand-on sensors and effectors better than its opponent will win the electromagnetic contest. For the DOD, this not only requires a new set of models with a higher degree of fidelity, but also a new ability to manipulate, measure and assess the interaction of hundreds and possibly thousands of EM “players” across a vast MDO battlespace in real time. The DOD’s existing M&S tools and resources are not up to this challenge.

In some ways, the Army’s MDO M&S situation is at least easier to assess. For decades, it’s M&S strategy has focused primarily on kinetic weapons. The Army’s investment in non-kinetic M&S, in areas such as EW, directed energy and cyber effects, has been relatively small. In comparison, the Navy and the Air Force have historically invested more in their electromagnetic M&S tools because practically all of their weapons systems depend on radars, EW and communications systems. The potential challenge these two Services face is how to adapt their current M&S resources and strategy for MDO. (Sometimes a relatively clean slate shortens the decision-making process.) What is clear is that organizations across the DOD need to invest in M&S to grow the Department’s broad understanding of MDO.

In his 2006 essay, “Lean Dilemma,” economics professor H. Thomas Johnson wrote, “Perhaps what you measure is what you get. More likely, what you measure is all you get. What you don’t (or can’t) measure is lost.” As it shifts to its MDO concept, the DOD is in the early stages of identifying what it does and does not understand about the complexities of MDO. Only with new M&S tools and resources, however, can it mature its understanding of the problem. – J. Knowles

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## calendar conferences & tradeshows

### MARCH

**AFCEA West Conference and Exhibition**  
March 2-3  
San Diego, CA  
[www.westconference.org](http://www.westconference.org)

**Annual Directed Energy Science and Technology Symposium**  
March 9-13  
Destin, FL  
[www.deps.org](http://www.deps.org)

**2020 DoD Information Warfare Symposium**  
March 11-12  
Washington, DC  
[www.dsigroup.com](http://www.dsigroup.com)

**DIMDEX 2018**  
March 16-18  
Doha, Qatar  
[www.dimdex.com](http://www.dimdex.com)

**AUSA Global Force Symposium and Exposition**  
March 17-19  
Huntsville, AL  
[www.ausa.org](http://www.ausa.org)

### Dixie Crow Symposium 45

March 23-26  
Robins AFB, GA  
[www.dixiecrowsymposium.com](http://www.dixiecrowsymposium.com)

**Robins AFB and AIC Requirements Symposium**  
March 27  
Robins AFB, GA  
<https://chamber.robinsregion.com>

**Directed Energy to DC Exhibition (DE2DC)**  
March 30 – April 1  
Washington, DC  
[www.deps.org](http://www.deps.org)

**49th Annual Collaborative Electronic Warfare Symposium**  
March 31 – April 2  
Point Mugu, CA  
[www.crows.org](http://www.crows.org)

**Counter-UAS Winter Summit**  
March 31 – April 2  
Washington, DC  
[www.idga.org](http://www.idga.org)

**FIDAE 2020**  
March 31 – April 5  
Santiago, Chile  
<http://www.fidae.cl/en>

### APRIL

**Directed Energy Summit**  
April 1-2  
Washington, DC  
[www.boozallen.com/event/directed-energy-summit.html](http://www.boozallen.com/event/directed-energy-summit.html)

**Navy League Sea-Air-Space**  
April 6-8  
National Harbor, MD  
[www.seaairspace.org](http://www.seaairspace.org)

**LAAD Security 2020**  
April 14-16  
Rio de Janeiro, Brazil  
[www.laadsecurity.com.br](http://www.laadsecurity.com.br)

**Defense Services Asia**  
April 20-23  
Kuala Lumpur, Malaysia  
[www.dsaeexhibition.com](http://www.dsaeexhibition.com)

**2020 Army Aviation Mission Solutions Summit (AAAA)**  
April 22-24  
Nashville, TN  
[www.quad-a.org](http://www.quad-a.org)

**SPIE Defense + Commercial Sensing**  
April 28-30  
Anaheim, CA  
[www.spie.org](http://www.spie.org)

### MAY

**12th Annual EW Capability Gaps and Enabling Technologies Symposium**  
May 12-14  
Crane, IN  
[www.crows.org](http://www.crows.org)

AOC conferences are noted in red. For more info or to register, visit [crows.org](http://crows.org). Items in blue denote AOC Chapter events.

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## calendar courses & seminars

### MARCH

**Aircraft Survivability**  
March 9-13  
Swindon, UK  
[www.cranfield.ac.uk](http://www.cranfield.ac.uk)

**AOC Virtual Series Webinar:**  
**RF Challenges in the Modern EW Battlespace**  
March 12  
1400-1500 EST  
[www.crows.org](http://www.crows.org)

**Infrared/Visible Signature Suppression**  
March 24-27  
Atlanta, GA  
[www.pe.gatech.edu](http://www.pe.gatech.edu)

**AOC Virtual Series Webinar: How the West Is Losing the Navigation and Timing War – and Risking Everything**  
March 26  
1400-1500 EST  
[www.crows.org](http://www.crows.org)

### APRIL

**Radar Warning Receivers Fundamentals**  
April 1-2  
Atlanta, GA  
[www.pe.gatech.edu](http://www.pe.gatech.edu)

**Basic RF Electronic Warfare Concepts**  
April 7-9  
Atlanta, GA  
[www.pe.gatech.edu](http://www.pe.gatech.edu)

**AOC Virtual Series Webinar: Overview of Missile Design, Development, and System Engineering**  
April 9  
1400-1500 EST  
[www.crows.org](http://www.crows.org)

**AOC Live Professional Development Web Course: EW against a New Generation of Threats**  
April 13-29  
8 sessions, 1300-1600 EST  
[www.crows.org](http://www.crows.org)

**Radar Warning Receiver System Design and Analysis**  
April 14-16  
Shalimar, FL  
[www.pe.gatech.edu](http://www.pe.gatech.edu)

**Infrared Countermeasures**  
April 14-17  
Atlanta, GA  
[www.pe.gatech.edu](http://www.pe.gatech.edu)

**AOC Virtual Series Webinar: Pulse Compression Techniques inside LPI Radars: Basic Principles and Technology Trends**  
April 23  
1400-1500 EST  
[www.crows.org](http://www.crows.org)

### MAY

**AOC Virtual Series Webinar: The Basic Concepts of ELINT**  
May 7  
1400-1500 EST  
[www.crows.org](http://www.crows.org)

**Advanced Radar Signals Collection and Analysis**  
May 12-14  
Atlanta, GA  
[www.pe.gatech.edu](http://www.pe.gatech.edu)

**Military Electronic Warfare**  
May 18-22  
Swindon, UK  
[www.cranfield.ac.uk](http://www.cranfield.ac.uk)

**AOC Virtual Series Webinar: Leveraging Publicly Available Information to Map and Track GNSS Interference**  
May 21  
1400-1500 EST  
[www.crows.org](http://www.crows.org)

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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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# EMBM IS A MULTIFUNCTION ENABLER

**D**ecision-making within a complex operating environment spanning multiple domains necessitates enterprise-level operational agility. One of the prime focus areas for the AOC is multifunction systems that enable platforms to sense (detect, ID, locate), communicate (C3), and deliver non-kinetic effects using the same architecture and apertures. Multifunction platforms are a significant enabler for autonomous and collaborative operations in a highly contested and congested Electromagnetic Environment. DARPA's Mosaic effort (see the February JED) is a prime example, striving to maximize complexity on the battlefield and turn that into an asymmetric advantage in multiple domains. We must capitalize on what multifunction platforms and weapons bring to the fight. The challenge is two-fold – technology is one challenge, but Electromagnetic Battle Management (EMBM) is just as important.

On the multifunction technology front, we have been moving forward in a variety of areas, such as modeling and simulation, defining architectures, developing propagation tools, and improving mission planning systems. But we've been taking a stove-piped approach that hasn't delivered a real-time operational capability. If we build a multifunction system of systems architecture, where multiple, connected platforms and weapons are being employed, how do we integrate and compile the scene? Multiple platforms are sensing, detecting, identifying and engaging targets. But how are we fusing that data into a real-time picture of the EME in a way that informs the warfighter and helps him or her make fast decisions? If we can't do this, then defense reactions (i.e., maneuver in the EME) to prevent degradation, disruption or denial of critical information and data become very problematic.

On the offensive side, integrating kinetic and non-kinetic capabilities and, more importantly, de-confliction of electronic attack (including high-power microwave and high-energy lasers) becomes a major challenge. At which moments does a multifunction platform or weapon decide to sense, communicate or jam? Does the system have the duty cycle to be effective? How much time is delegated to each function in multiple frequency bands with multiple waveforms? That's the platform/weapon problem. Now, let's view this from a system-of-systems approach with multiple platforms and weapons contributing in a collaborative or autonomous environment. EMBM becomes the key to effective, optimized engagement and de-confliction.

A shift from the system level to the enterprise view is necessary at this point. When it comes to the EME, there is a lack of frameworks addressing how operational agility at the enterprise level can be obtained. This represents one of our main challenges moving forward with multifunction systems. Is this multifunction system-of-systems vision being mirrored by all the Services and US allies who can drive this concept to integrate/coordinate currently stove-piped technologies and functionality?

Strategy, prioritization and investment is required to achieve the vision and realize the full potential of what multifunction really means and bring that to the warfighter. We can't just advance technology without continually evaluating the requirements for and the impact to the EME. We have a long way to go. – *Muddy Watters*



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Dr. Clayton Stewart

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**June 19 – 20, 2020 | Liverpool, UK**

We will begin with a historical perspective and introduce use of radar, integrated air defense system, early EA functions and conclude with an overview of modern EA, ES, and EP.



## Machine Learning for EW

Kyle Davidson

**Mondays, Wednesdays, & Fridays**

13:00 – 16:00 EDT | September 14 – 30, 2020

This course introduces students to the fundamentals of machine learning and its application to modern Electronic Warfare (EW) and cyber solutions.



## RF Theory for ES Operations

Dr. Patrick Ford

**Sunday & Monday | 09:00 – 17:00 EST**

**Dec 6 – 7, 2020 | Washington, DC**

This course will include a thorough overview of key electromagnetic spectrum (EMS) concepts, with an emphasis on the RF spectrum and commensurate propagation mechanisms and environmental impacts.



## EW Modeling and Simulation

Dave Adamy

**Mondays & Wednesdays**

13:00 – 16:00 EDT | June 1 – 17, 2020

This is a practical course in which the basic concepts and techniques of Electronic Warfare modeling and simulation are presented and applied to practical problems.



## Missile Design, Development, and System Engineering

Eugene Fleeman

**Mondays, Wednesdays, & Fridays**

13:00 – 16:00 EDT | July 13 – 31, 2020

Missiles provide the essential accuracy and standoff range capabilities that are required in modern warfare. Technologies for missiles are rapidly emerging, resulting in the frequent introduction of new missile systems.



## Electro-Optical/Infrared Sensor Engineering

Dr. Phillip Pace

**Mondays & Wednesdays**

13:00 – 16:00 EDT | October 5 – 28, 2020

This course presents the fundamentals of electro-optical (EO) & infrared (IR) sensor technology, its analysis and its application to military search, track and imaging systems. Electronic warfare (electronic attack and electronic protection) are emphasized.



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# the monitor

## news

### NEW REPORT ON COMBAT AIR FORCE SURVIVABILITY CALLS FOR NEW ELECTRONIC ATTACK AIRCRAFT

A new report from the Center for Strategic and Budgetary Assessments (CSBA), (Washington DC) titled, "Five Priorities for the Air Force's Future Combat Air Force," provides recommendations to help the US Air Force align its combat air forces (CAF) with the 2018 National Defense Strategy (NDS). The report defines the CAF as including the Air Force's fighters; bombers; electronic warfare; strategic intelligence, surveillance, and reconnaissance (ISR); and battle management and command and control (BMC2) aircraft. The majority of its analysis is focused on the capabilities, mix and capacity of the Air Force's next-generation fighter and bomber fleets.

Of particular interest is Chapter 2 of the report, which addresses survivability of the CAF. Noting that the future CAF should be prepared to operate in highly-contested areas covered by advanced integrated air defense systems (IADS) that China, Russia and others are fielding to contest US air superiority and increase freedom of maneuver for their own air, land and maritime forces, the report stresses that the CAF should be prepared to continuously counter threats from multiple domains. "This will require the Air Force to modernize its CAF rather than continue to rely on legacy combat aircraft that were originally designed for far more benign threat environments. The current CAF predominately consists of aging, non-stealth aircraft that are not suitable for operations in contested and highly contested threat environments. Except for a small number of low-observable B-2s, F-22s, and a growing number of F-35As in the force, today's CAF cannot penetrate contested and highly-contested environments without risking significant attrition."

To address this, the report makes a number of observations and recommendations. First among these is that advances in stealth technologies will continue to provide a significant margin of survivability for future CAF capabilities. Noting that the decision to incorporate advanced outer-mold-line (OML-stealth) designs must be made during an aircraft's design phase, the report states that, "this is a key reason why the Air Force should develop and field a new generation of combat aircraft rather than attempt to further modify decades-old aircraft designs as it has been compelled to do for budgetary and other reasons since the end of the Cold War."

The report also points out that, "Although in certain instances low-observable aircraft designs and treatments alone may be sufficient to allow them to penetrate enemy air defenses, these features are most effective when combined with other countermeasures." For example, it notes that F-35 survivability is, in part, the product of its low-observable design combined with automated, multi-spectral sensors that generate highly accurate, real-time threat pictures. An ongoing upgrade to the B-2's Defensive Management System (DMS) provides that aircraft with similar capabilities. Another recommendation is to use multiple low-observable aircraft to conduct electronic attack against some threats, cycling active emissions between aircraft to reduce the probability they will be detected and engaged by the IADS.

In addition, the report states that next-generation platforms should have Low Probability of Intercept/Low Probability of Detection (LPI/LPD) communications systems that can be directionally focused and have

low-power and narrow beamwidths to reduce their risk of detection. Also, it notes that next-generation combat aircraft with multispectral, multi-phenomenology sensor suites with ranges greater than those available on current systems would help ensure they will be able to sense and counter threats before threats can target them. It also highlights the benefits of multidomain interoperability through a distributed, all-domain, self-healing network to improve shared situational awareness and battlespace management and command and control.

Perhaps the most significant recommendation of the report is that the Air Force develop and acquire a Penetrating Counter Air/Penetrating Electronic Attack (PCA/PEA) aircraft (also called a Next Generation Air Dominance or NGAD aircraft). The PCA/PEA aircraft "should be capable of a range of counter-air missions, including defeating airborne threats and conducting suppression of enemy air defenses/destruction of enemy air defenses (SEAD/DEAD) operations. In addition to the above attributes, the PCA/PEA aircraft should have sufficient payload capacity for offensive and defensive weapon systems. Future self-defense capabilities could include mission systems for multispectral electronic attack, the ability to carry multiple air-to-air Small Advanced Capabilities Missiles (SACMs), and on-board directed-energy weapons. The capability to sprint at supersonic speeds to help defeat airborne threats may also be important. Integrating more fuel-efficient adaptive engine technologies into a PCA/PEA design could help reduce tradeoffs between large weapons payloads, speed, long range and other performance attributes" – J. Haystead

## DARPA PURSUING WIDEBAND ADAPTIVE RF PROTECTION TECHNOLOGY

The Defense Advanced Research Projects Agency (DARPA) Microsystems Technology Office (MTO) is launching a new program to develop wideband adaptive RF circuit technology to address the challenges posed by increasingly congested and contested electromagnetic operating environments on the DOD's communications networks and radars.

The goal of the Wideband Adaptive RF Protection (WARP) program (Broad Agency Announcement HR001120S0027) is to develop filters and analog signal cancellers that selectively attenuate (or cancel) externally-generated RF interference (such

as jamming), as well as self-generated interference, to protect wideband digital radios from saturation. According to Program Manager, Dr. Timothy Hancock, current approaches to mitigating wideband receiver interference are sub-optimal and force compromises around signal sensitivity, bandwidth usage and system performance. "Unlike narrowband radios that rely on switching between pre-planned filtering and narrowband signal cancellation, today's wideband radios lack the RF front-ends that could help mitigate harmful signals before they reach the sensitive receiver electronics. This has prompted the exploration of wideband tunable circuit architectures to support cognitive radio technology."

## US NAVY SEEKS "ADVANCED ELECTRONIC WARFARE SUITE" FOR SUPER HORNET

Naval Air Systems Command (NAVAIR) (Patuxent River, MD) has issued a Request for Information (RFI) for a new RF EW suite for the F/A-18E/F Super Hornet, as well as next-generation aircraft. The new effort, dubbed the Advanced Electronic Warfare (ADVEW) Suite, is intended as a replacement for the Super Hornet's ALR-67(V)3 radar warning receiver (RWR) and ALQ-214(V) RF countermeasures (RFCM) subsystem, which were developed in the 1990s. ADVEW would represent the first major RF EW suite upgrade for the Super Hornet since it achieved Initial Operational Capability in 2001.

The US Navy is in the early stages of modernizing a large portion of its Super Hornet fleet with a combination of comprehensive upgrades from the Block II standard to Block III, as well as buying new Block III aircraft from Boeing... The Block III configuration adds more fuel capacity via conformal shoulder-mounted tanks; an advanced cockpit system; an improved IR search and track (IRST) system; and a new networking capability. The ADVEW suite is targeted for these upgraded and new Block III aircraft, the first of which will roll off Boeing's production line in 2021.

In terms of the ADVEW Suite performance, the RFI indicates NAVAIR will use the Super Hornet's current EW suite as a baseline. However, the RFI is quite clear about seeking improved performance and or lower cost systems in a compressed timeline. NAVAIR is also encouraging industry to identify existing systems or subsystems that can be used to minimize cost, schedule and technical risk in the program.

ADVEW could become a major EW program for the Navy. In order to complement its growing fleet of F-35Cs, the Navy is expected to acquire 480 Block III aircraft by 2030. This will comprise approximately 116 new-production Block III aircraft and 364 Block II aircraft upgraded to the Block III standard. The program is expected to draw interest from many of the major EW systems houses, including Raytheon (which manufactures the ALR-67(V)3), L3Harris (which makes the ALQ-214(V)); BAE Systems, and Northrop Grumman.

Responses to the ADVEW RFI are due on March 2. The point of contact is Shannon Buckalew, (301) 757-5552, e-mail [Shannon.buckalew@navy.mil](mailto:Shannon.buckalew@navy.mil). - J. Knowles

WARP will explore the development of wideband tunable filters that can continuously sense the EM environment and adapt to maintain the receiver's dynamic range without decreasing signal sensitivity or bandwidth. In particular, WARP aims to address self-generated inference through the development of adaptive, analog signal cancellers. As described by Dr. Hancock, although DOD communication systems can benefit significantly from same-frequency Simultaneous Transmit and Receive (STAR) capabilities (such as doubling spectrum efficiency and increasing network throughput), its usage has been limited due to few available means of ensuring that transmitter leakage does not interfere with the receiver. To combat this, WARP will explore analog cancellers that will reduce the transmit leakage before the wideband digital receiver, such that any residual leakage will be sampled and further cancelled in the digital domain. "If successful, these technologies will enable the use of Software-Defined Radios (SDRs) in congested and dynamic spectral environments – something that is limited today," says Dr. Hancock.

WARP research will examine innovative filter architectures supported by state-of-the-art components and packaging. Technical advancements are expected in three areas: wideband tunable filtering with both center frequency and bandwidth tuning to provide full-band coverage; wideband analog signal cancellation with sufficient analog cancellation to enable wideband same-frequency STAR over a large delay spread leakage channel; and embedded interference sensing and control of the electromagnetic environment or leakage path for autonomous closed-loop adaptation of the filtering and signal cancellation. Says Hancock, "With the WARP filters, the goal is to reduce the effect of large signals without attenuating smaller signals. When exposed to interference or jamming, the target WARP components will sense and adapt to the EM environment through the intelligent control of adaptive hardware."

The program is composed of three-phases over four years – the first two of which will run for 18 months with the final phase being a 12-month demon-

stration phase. Two Technical Areas (TAs) are being addressed. TA-1, "Wideband Adaptive Filtering," is focused on filtering architectures. As described by Hancock, "In today's digital world, the way we design RF transceivers is rapidly changing and we do more and more direct sampling. The challenge with this is that the A/D converters are actually quite fast and good now, but we still require some amount of analog processing in front of the A/D or the digital receiver, in general. Because the A/Ds today can sample so much bandwidth, it's basically outpaced our ability to tune RF circuits. And so, if we want a front end that can provide support over a very wide bandwidth, we're going to need some innovation, and it's not going to be as simple as just scaling some of the existing tunable filtering work done in the past. Usually, this type of work has only led to 2:1 improvements in tuning range or less. Covering a full 2- to 18-GHz range is going to be challenging, and will definitely require some innovation in the filter architectures." Target milestones for TA-1 include accomplishing a 2:1 tuning bandwidth by the end of Phase 1, a 3:1 tuning bandwidth at the end of Phase 2, and ultimately building to a 9:1 tuning bandwidth to cover the full 2-18 GHz range in the final demonstration phase.

With regard to TA-2, "Wideband Signal Cancellation," Dr. Hancock observes that this is a much less mature technology in general. "We know how to cancel signals, but we can't do it very well over very wide bandwidth. It's really based upon the instantaneous bandwidth coverage and the delay spread coverage, so we've specified a delay-spread of basically the multi-path environment between, for example, two antennas, and then requested program participants to work toward achieving wide bandwidth there." The overall objective of covering the 0.1-6 GHz band, is broken into two sub-bands – 0.1-1 GHz and 1-6 GHz. The target for the end of Phase 1 is to achieve 100 MHz of instantaneous bandwidth over a 25 nsec delay spread for the 0.1-1 GHz range and 400 MHz of instantaneous bandwidth over a 5 nsec delay spread for the 1-6 GHz range. Targets become 250 MHz and 1000 MHz of instantaneous bandwidth respectively in Phase 2, moving to full-band demonstration in Phase 3.

The WARP BAA was issued on January 30. Funding for the program is anticipated to be \$40 million in 6.2 funding with \$20 million for both Technical Areas 1 and 2. Multiple awards are expected. The technical point of contact is Dr. Timothy Hancock, email [HR001120S0027@darpa.mil](mailto:HR001120S0027@darpa.mil). – J. Haystead

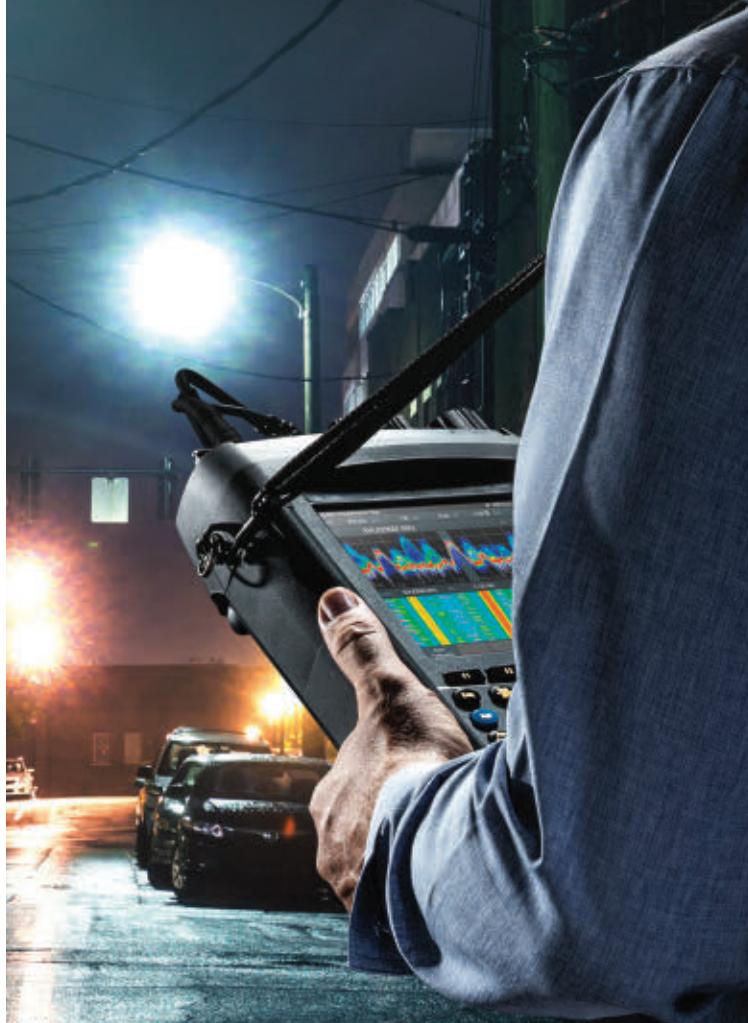
#### **US AIR FORCE TO ISSUE COUNTER-UAS RFP**

The Air Force Research Lab, Information Directorate (Rome, NY) is expected to receive proposals this month for development and initial procurement of a counter-small unmanned aircraft system (C-sUAS) system to protect air bases in the US and abroad. AFRL is seeking solutions that can provide "defensive depth" against Group 1 and 2 UASs and integrate into larger air base air defense systems.

In a December C-sUAS Industry Day, program officials described the threat, previous C-sUAS technology development, and an acquisition strategy that acknowledges there is "no one size fits all" solution. ARFL will pursue a two year re-

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search and development (R&D) phase that will leverage a mix of existing and enabling technologies to help fill gaps across the entire C-sUAS kill chain. According to the program's draft Statement of Work (SOW), the R&D phase will focus on "analysis of Electromagnetic Spectrum (EMS) signals and signatures; developing detection, location, and identification techniques; developing link access techniques; cyberspace Intelligence, Surveillance, and Reconnaissance (ISR); development of cyberspace and EMS-enabled cyberspace countermeasures; integration of C-sUAS components and technologies; Command and Control (C2) using open architecture solutions; automation of capabilities; autonomy; prototyping; and demonstration." The SOW adds that these efforts may employ blue-force sUAS in any part of the kill chain.

The RFP was scheduled for release in February, but it had not been issued before this issue of *JED* went to press. Proposals are due this month, with contract award(s) expected in September. The contract(s) will include a 24-month

R&D phase followed by a five-year Indefinite Delivery/Indefinite Quantity order period. The total program value is approximately \$490 million. The solicitation number is FA8750-20-R-1000, and the technical point of contact is Donna Toole, (315) 330-3972, e-mail donna.toole.1@us.af.mil. - J. Knowles

## IN BRIEF

Last month, **DARPA's Defense Sciences Office (DSO)** held a Proposers Day for its AtmoSense program, ahead of the planned release of a Broad Agency Announcement (BAA). According to a program description, "AtmoSense will attempt to understand the fundamentals of energy propagation from the ground to the ionosphere in order to determine if the atmosphere can be used as a sensor. This entails developing new modeling and simulation capabilities as well as new sensing modalities that can be combined to answer a set of fundamental questions that will help determine the feasibility of the AtmoSense concept." The program will investigate three questions: 1) What is the nature

of transmitted signals? 2) What mode structure (mechanical and electromagnetic) can the mesosphere and lower ionosphere support? 3) What dynamic variables are best measured, and at what altitude, to capture source disturbed information? The AtmoSense solicitation number is DARPA-SN-20-33, and the program point of contact is Maj Charlton David Lewis, II, Ph.D., Program Manager, e-mail AtmoSense@darpa.mil.



Also last month, **DARPA's Microsystems Technology Office (MTO)** held a Proposers Day for its Wideband Secure and Protected Emitter and Receiver (WiSPER) program. This effort aims to "...develop a fundamentally disruptive wireless air interface transceiver technology to enable and sustain secure and robust high-bandwidth RF communication links. The WiSPER wideband adaptive air interface will also mitigate impairment due to dynamic harsh and contested environments to maintain a stable communication link." The solicitation number is DARPA-SN-20-26. The



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**Industry News**

**INDUSTRY HOWL: Raven Claw Augments Battle Management for Electronic Warfare Operations**

Raven Claw has added a new electronic warfare management system to its suite of products. The system augments battle management for electronic warfare operations, including the ability to detect and identify threats and友军 (friendly) aircraft in real-time. The system also provides a common operating picture for electronic warfare operations, allowing users to quickly identify and respond to threats.

**INDUSTRY HOWL: Internet of Things to Provide Intelligence for Urban Warfare**

The Internet of Things (IoT) is revolutionizing the way we live and work. Now, it's being used to provide intelligence for urban warfare. The IoT allows for real-time monitoring and analysis of data from various sources, such as cameras, sensors, and drones, to detect and identify threats in urban environments. This technology is particularly useful for identifying and tracking enemy forces in dense urban areas, where traditional surveillance methods may be less effective.

**INDUSTRY HOWL: The U.S. Army Needs Micro Anti-Aircraft Missiles — And Fast**

The U.S. Army is looking for a new type of anti-aircraft missile system. The system must be able to detect and track multiple targets simultaneously, and must be able to engage them quickly and effectively. The Army is currently testing several different prototypes, and is hoping to have a final decision by the end of the year.

**INDUSTRY HOWL: The Marine Corps Wants to Make Cyber More Like Special Ops**

The Marine Corps is looking to increase its emphasis on cyber warfare. The Corps is currently working on a new strategy to better integrate cyber operations into its overall military operations. The goal is to make cyber warfare more like traditional military operations, such as ground combat or aerial warfare.

**SENTINEL**

program point of contact is Young-Kai Chen, DARPA MTO Program Manager, e-mail DARPA-SN-20-26@darpa.mil.



**The Boeing Company** (St. Louis, MO) and the US Navy recently flew two unmanned EA-18G Growlers, controlling both from a manned Growler, during demonstrations at Naval Air Station Patuxent River (Patuxent River, MD). According to a company news release, test pilots conducted 21 demonstrations over the course of four flights during the Navy Warfare Development Command's annual fleet experiment (FLEX) exercises. These exercises, according to the release, "proved the effectiveness of technology allowing F/A-18 Super Hornets and EA-18G Growlers to perform combat missions with unmanned systems." Such advancements in manned-unmanned network capabilities are critical to expanding the Navy's fighting range as well as keeping manned aircraft farther away from threats as often as possible. According to Tom Brandt, Boeing Manned-UnManned Teaming demonstration lead, "It's a force multiplier that enables a single aircrew to control multiple aircraft without greatly increasing workload. It has the potential to increase survivability as well as situational awareness."



**The Naval Air Systems Command (NAVAIR)**, PMA-290 (Program Office for P-8A aircraft), is soliciting information from industry contractors regarding the aeromechanical and software integration of the Long Range Anti-Ship Missile (LRASM) onto the P-8A aircraft. Additional weapons systems that could also be integrated include 500 lb to 2,000 lb class of Joint Direct Attack Munition (JDAM) variants, Mk62/63/65 mines, Small Diameter Bomb (SDB-II), Miniature Air Launched Decoy (MALD), Bomb Rack Unit BRU-55, and Universal Armament Interface (UAI). The Sources Sought Notice states the contract will include "upgrades to the Boeing Tactical Open Mission Systems (TOMS) and Stores Management Computer (SMC) software and interfaces, test planning, execution, data reduction, and

reporting on flight test efforts. Contract work will run from January 2021 through January 2026. Responses to the Sources Sought Notice are due March 4. The technical point of contact is Jessica Dean, (301) 757-0612, email Jessica.Dean1@navy.mil.



**The Department of Defense, United States Air Force (USAF)**, Air Force Test Center (AFTC), Specialized Contracting Branch (PZIE), Eglin AFB, is

seeking capabilities statements for potential sources for the 782 TS/ RNWP (JPRIMES), which requires the purchase of 33 RF generator "slices" to be used with the RFGEN sub-system of the NEWEG EW RF Simulator. Capabilities must be compatible with the NEWEG system architecture, as well as Amherst Systems, Inc.'s (Wilbraham, MA) RFGEN NEWEG emitter bay sub-system hardware. The technical point of contact is Tanya Warden, (850) 882-0174, email tanya.warden@us.af.mil. ↗

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# world report

## THALES, DASSAULT WIN CONTRACT FOR FRANCE'S NEW AIRBORNE SIGINT PROGRAM

Thales and Dassault Aviation have been jointly contracted to deliver France's ARCHANGE [Avion de Renseignement à CHArge utile de Nouvelle Génération] airborne strategic signals intelligence (SIGINT) program.

Awarded by the French Ministry of Defence's Direction générale de l'armement at the end of 2019, the contract covers the integration of the new CUGE [Capacité universelle de guerre électronique] SIGINT payload on board an initial two Dassault Falcon 8X aircraft to be operated by the French air force (Armée de l'Air). The information collected by the ARCHANGE system will be analyzed by monitoring and intel-

ligence specialists and fed into armed forces databases.

Under the ARCHANGE program, France intends to eventually replace its two Transall C-160 Gabriel SIGINT aircraft with three CUGE-equipped Falcon 8X business jets. A ground-training suite will be installed at Evreux air base.

Developed by Thales, the CUGE payload will be capable of detecting and analyzing both radar and communications signals simultaneously. Key features include multi-polarization antennas, and the use of artificial intelligence techniques to automate data processing.

The ARCHANGE system is planned to enter service from 2025. – *R. Scott*

## RUSI: RUSSIAN AND CHINESE IADS PROVE INCREASINGLY LETHAL

The Royal United Services Institute for Defence and Security Studies (RUSI) (London, UK) recently published a report titled "Modern Russian and Chinese Integrated Air Defence Systems: The Nature of the Threat, Growth Trajectory and Western Options," which addresses the challenges posed by the increasing lethality of Russian and Chinese Integrated Air Defense Systems (IADS), as well as potential strategies the United States and NATO might employ when preparing to counter anti-access/aerial denial (A2/AD) weapons networks.

According to the report, improved capabilities of long-range surface-to-air missile (SAM) systems, such as the SA-21 (Russian S-400), when networked with larger numbers of medium- and short-range threats, such as the SA-15 and SA-22 SAM systems, enable an IADS to operate more effectively on the battlefield. "Drawing on these external sources of target data allows systems like the SA-21 to fire their own long-range ac-

tive seeker missiles against targets far beyond their own radar-horizon."

The report continues: "Russia's IADS threatens to keep NATO airpower at arm's length and predominately occupied with the task of suppression of enemy air defences (SEAD) during the initial critical phases of any armed clash...The question is not whether the Russian IADS could eventually be degraded and rolled back, but whether NATO forces could do so quickly enough to avoid defeat on the ground while deprived of regular close air support in the meantime."

At the same time IADS and SAMs are becoming more advanced, Chinese and Russian electronic warfare systems and SAMs are proliferating on a global scale, which means, "A modern SEAD capability will soon be required in far more military situations than the peer-clash scenario of a conflict with Russia or China."

The Chinese IADS includes land-based, long-range HQ-9 and SA-21 systems, as well as several medium-range

## TERMA TO SUPPLY PIDSU PYLONS TO ANG

Terma (Lystrup, Denmark) has been awarded an \$84 million contract by the NATO Support and Procurement Agency (NSPA) to supply dispenser pylons for US Air National Guard (ANG) F-16 aircraft.

The contract comprises delivery of new-build Pylon Integrated Dispensing System Universal (PIDSU) EW core pylons with provisions for future missile warning system installation, Flare-Up kits and test adapters. The program will be executed through the Terma Aero-nautics business area in the US, as well as in Denmark, with deliveries due to start in late 2020.

According to Terma, the PIDSU core pylon configuration for the ANG is the most advanced variant of its kind with both the left- and right-hand pylons being equipped with three chaff/flare dispenser magazines each. This has been made possible by introducing a new compact variant of the Terma Digital Sequencer Switch which allows installation of the additional dispenser magazine.

Once implemented, all existing and new ANG Terma-pylons will feature flare dispense. The pylons will also have all hardware to enable smart dispense of expendable active decoys and multi-shot flares. – *R. Scott*

SAMs on the mainland and artificial reefs, and China is "pursuing multiple aerial and ground-based exotic radar and multi-spectral sensor technologies to support both its IADS and the People's Liberation Army Air Force."

Cooperation between NATO allies will be critical to combating IADS, according to the report. Stand-off cruise missile attacks, stand-off or stand-in jamming and other tactical techniques will not be enough; they must be combined with "the ability to detect, classify, track and pass target data to other coalition assets without being shot down in the process...If the Alliance wants to improve its ability to conduct effective SEAD operations and reduce the threat from modern IADS, it will need to cooperate and exercise collectively, as well as purchase new equipment." – *H. Swedeen*

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<sup>1</sup> - Nicol, E. F., Margus, B. J., Greblunas, J. R., Woolrich, K., & Schirmer, J. R. (2013). TWT versus SSPA: A Comparison Update of the Boeing Satellite Fleet On-Orbit Reliability (pp. 1-2, Tech.). Los Angeles, CA: Space & Intelligence Systems, Boeing Corporation.

# For Multifunction S the Future is Open

By Barry Manz

*"The Chinese love our acquisition system. They are the biggest fans of our acquisition process there possibly could be."*

— Michael D. Griffin, Under Secretary of Defense for Research and Engineering, OSD

For as long as anyone in the defense industry can remember, one of the most sought-after goals has been to achieve higher levels of functional integration, from components through subsystems and ultimately complete platforms. With this capability, the DOD would gain many benefits, from reducing the time required for new technology insertion, to lower acquisition costs initially and over time, and potentially the ability to produce truly "open" systems. It's been a long, bumpy road, fraught as much with stasis as technological challenges. But as necessity is the mother of invention, these capabilities are now being realized, and at a much faster pace than ever. The results could mark a paradigm shift equal to, or perhaps even more consequential than, other technological milestones in the last few decades.

The main factor driving the DOD's thrust into multifunction technology is the evolving sensor-to-shooter battle networks being fielded by Russia, China and others. New ISR capabilities, air defense radars, communications and precision-guided, long-range munitions are the foundations of their Anti-Access/Area Denial (A2/AD) strategies. Small, low-cost multifunction systems will enable US forces to integrate EW, cyber, radar, communications, PNT and other functions onto small autonomous vehicles that will operate in swarms against these sensor-to-shooter networks. Multifunction technologies are essential for

the DOD to create a new conventional deterrent, and they will form a key advantage in the electromagnetic competition between the US and its rivals over the next few decades. Now that multifunction systems are deemed crucial, wheels are turning faster to see how quickly DOD's goals can be met.

## INTEGRATION IN A NUTSHELL

The integration of functions begins at the device level, in which functions previously performed by discrete processor units are combined in a single device – a trend that the commercial world has been achieving for decades and continues to accelerate. Some examples include general-purpose GPUs, FPGAs that combine huge processing cores (including DSPs with high-end CPUs), and CPUs themselves that increasingly combine scalar and vector processing units to achieve performance once found only in supercomputers. RF technology integration, which presents an entirely different set of challenges, is producing entire subsystems on a single system-

on-a-chip (SoC), and achieving high levels of integration in the millimeter-wave region.

At the board level, multi-function devices are integrated within a specific form factor to produce still higher levels of integration relying on powerful host processors, FPGAs, GPUs, and massive amounts of I/O. These boards are then combined in a rack to produce nearly every function required to serve a specific application.

None of these levels of "multi-functionality" are easy to achieve even in highly-competitive, profit-driven commercial markets where new technology insertion is defined in months rather than years. That said, the aerospace and defense industry has achieved its own breakthroughs, although typically not as quickly, with notable exceptions, such as the rapid deployment of IED jammers in the CREW program during the mid-2000s. Some of the rapid advances in commercial products have actually been driven by the needs of the defense industry with longstanding support from DARPA. Examples include DARPA's MIMIC program (1987-1995) that accelerated the progress of gallium-arsenide (GaAs) monolithic microwave integrated circuits (MMICs), RF wafer-scale integration and development and deployment of gallium nitride (GaN).

**"As for latency, if you're doing radar, SIGINT, or communications, the latency from the antenna to your processing doesn't matter that much because you're just listening. But, with EW, every nanosecond matters."**

— David Jedynak

# systems,

## GETTING TO MULTIFUNCTIONALITY

The path to realizing systems that can serve more than one application (i.e., EW, radar, and communications) would ideally use one set of hardware that is reconfigured through software to serve the needs of the moment. A decade ago, this would have been impractical and too costly, but advances in processors and hardware accelerators, data converters, signal buses and other components now make it possible. But, it's still very difficult because EW, radar, and communications have different specifications. EW is inherently broadband, while radar and communications are not, and the acceptable amount of latency varies with each application, for example.

However, this isn't as great a deterrent as one might think. "Assume you have that tightly-coupled loop with a high-performance FPGA and RF front ends optimized for EW," says David Jedynak, chief technology officer at Curtiss-Wright. "After that you enter the world of VITA 49 with digitized RF data running over Ethernet moving through a cluster of processors on a network fabric.

"So, beyond that, it's all the same hardware programmed in a different way," he explained. "Once you get past that first stage of the board, not much really needs to be different, except possibly some replumbing based on the data rates required. As for latency, if you're doing radar, SIGINT, or communications, the latency from the antenna to your processing doesn't matter that much because you're just listening. But, with EW, every nanosecond matters."

Dr. Bill Conley, Mercury Systems' senior vice president and chief technology officer, cites just one of them. "Something that isn't often mentioned



*Even the US Navy's newest surface combatants, such as the USS Gerald R. Ford (seen above during a FOD walk), feature a large number of antennas for various radar, communications, EW, SIGINT, GPS and other systems. Multifunction systems would shrink this antenna footprint.*

US NAVY PHOTO BY MASS COMMUNICATION SPECIALIST 2ND CLASS RUBEN REED

when discussing reconfigurability is the length of time required for a weapons system to 'boot up' when being recon-

figured to perform a different function. When you change the function your system is running, you not only need to get

an FPGA reconfigured but also to change the data pipes required to achieve the level of command and control required to make good decisions.

"So, let's say a radar sees a threat and you want to convert from radar to EW," explains Conley. "If your system takes more than a very short time to do this, the latency is unacceptable. If a complete software overlay is required for each mission, the outcome will be poor, even though the signals are running through the same path and performing similar functions. On the other hand, longer reconfiguration time may be acceptable in other scenarios where latency is not a critical factor."

#### THE ROAD TO OPEN

In the last decade, some of the thornier issues surrounding open source and multi-functional integration have begun to be resolved, step by step, with participation from industry, academia and government. In each case, the goal has been to transition from the traditional stove-piped approach, to systems development and procurement, to an increasingly smaller set of requirements to which the DOD's many electronics systems buyers and sustainers would adhere.

The first of these was arguably the COTS initiative that was created to encourage greater use of commercial technology in defense systems so hardware could be commoditized and less expensive with shorter development time for technology insertion. It was also hailed as allowing the embedded systems community and prime contractors to have a greater choice of board-level products. COTS has experienced some success over the years. The problem, of course, is when most anything in an off-the-shelf product is changed, it's no longer COTS but a custom solution, which inherently limits its applicability. But it was a start.

Since then, many other initiatives have followed. For example, the Army's Vehicular Integration for C4ISR/EW Interoperability (VICTORY) initiative has focused on consolidating independent C4ISR and EW subsystems in military vehicles. Although conceived as an Army program it contains most of the

**"Something that isn't often mentioned when discussing reconfigurability is the length of time required for a weapons system to 'boot up' when being reconfigured to perform a different function."**

— Dr. Bill Conley

key ingredients required for open systems and modularity, with some specifications tailored for the Army's needs. It complements the C4ISR/EW Modular Open Suite of Standards (CMOSS) that allows communication components in military vehicles to share a common platform based on an open architecture and industry standards such as those within VITA. VICTORY builds on concepts that fall within an umbrella acronym called MOSA, or Modular Open System Architecture.

MOSA represents a great leap forward, as it integrates business and technical strategies for the implementation of open systems in the DOD, employs the concepts of modular design and uses widely-supported interfaces. Notably, it cited the need for validation, veri-



*The US Navy's Integrated Topside program aims to combine EW, Information Operations and communications functions in a single system. A prototype deployed at Chesapeake Beach, Maryland is serving as the test bed for Low-Level Resource Allocation Manager (LLRAM).*

NORTHROP GRUMMAN

fication and testing to ensure a given product was truly "open." However, neither MOSA nor any other previous open standards approach has been adopted throughout all three Services (that is, until SOSA came along – more on that below). One of the impediments to widespread DOD use of these and other approaches is agreement among the three Services required to implement them. Rodger Hosking, vice president at Pentek, depicts the scenario chronologically: "The open systems architecture has evolved through the three Services with many different standards each inspired by their view of what open systems meant to them," he explained. "But they ultimately realized that it's not desirable to have three standards, each unique to a Service, but rather to homogenize them to exploit the benefits of each one."

In addition to DOD's efforts, the embedded systems industry was itself taking steps to create a version of the VPX set of standards administered by VITA that could provide an open approach. The result was OpenVPX, championed first by Mercury Systems and released in 2009. It was later established as NSI/VITA 65-2017 as the OpenVPX system standard that includes specifications for ruggedization, RF and optical interconnects, and others.

OpenVPX has been widely accepted by both the embedded community and DOD. But, once again, without a mandate by DOD to provide complete (and verified) openness, the result has been a very large number of OpenVPX-compliant products that also contain proprietary bits (pins, for example) to differentiate one vendor's products from another. Consequently, even though OpenVPX has been a major step forward, it still leaves loopholes ripe for proprietary exploitation, and created a large number of "semi-open" products.

By this time, DOD, which through DARPA, NRL, AFRL, Southwest Research Institute, and others, had been creating a vast body of research programs and initiatives, resolved to fix the problem with a much more forceful approach. This led to an open system architecture mandate in the FY17 Defense Authorization Act that, along with more than

100 other changes to defense acquisition policy, included in Section 805 a "modular open system approach in the development of major weapon systems."

For the first time, all major defense acquisition programs receiving approval after January 1, 2019, would be designed and developed with MOSA "to the maximum extent practicable." It mandated the use of "a modular design with system interfaces between a major system platform (such as a ground vehicle, ship, or aircraft) and its major system components (such as sensors or communication equipment)."

In short, Congress was directing the DOD to make it very clear to its supplier base that, in the future, traditional procurement practices would be gone for good – at least with regard to embedded technology in its electronic systems.

## SOSA EMERGES

Following the Congressional push, the DOD's S&T and acquisition organizations got to work, incorporating the most important previous developments in open systems and multifunctional integration (including those from VITA) and forming them into a common open architecture standard across the Services. DOD was effectively formally mandating from the defense industry what it long had sought – consolidation of the best features accrued from previous programs in a single set of standards that all vendors would ultimately need to follow. Vendors not in compliance stood a good chance of being rejected.

The result was the creation of the Sensor Open Systems Architecture (SOSA) Consortium whose goal is to create a SOSA-delineated set of standards verified by an independent third party (The Open Group). SOSA creates an open-source framework using a common, multi-purpose architecture for EW, SIGINT, EO/IR, radar, and communications. Among other things, it provides interoperability between products from any manufacturer that are certified as compatible by The Open Group. The standards themselves are in the public domain and, once finalized, could theoretically be used by other industries beyond defense.

Within the SOSA Consortium, two working groups (technical and business)

were established. The technical working group is responsible for standardizing hardware, software, and protocols and governs the processes used to create them. It incorporates many aspects of current open standards from VITA, and can define others when needed. The business working group develops and documents business and acquisition strategies consistent with the initiative.

One of the foundations of SOSA is the "gray box" concept, which addresses one of the biggest problems for the ven-

dor community: IP protection. "What they are saying is that to maintain attractiveness for vendors, they must be incentivized to do so," says Hosking. "They want to protect the IP that vendors are putting into their products. So, what's being called a 'gray box' defines the inputs and outputs, form factor, and other metrics, but not what's inside the modules themselves. It doesn't matter what IP is inside a company's module, as that remains protected. The benefit is that vendors can compete on technical

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merit as well as price and other factors, as they do now."

Most of the products developed within SOSA are not likely to be ITAR restricted. But, in cases where there are export restrictions, the DOD entity proposing to use them has ways of managing them that are like those in place today. Other than the obvious benefits of creating a single standard, another advantage is that a manufacturer must prove that its products are SOSA-compliant through a rigorous process ultimately leading to certification by The Open Group. This is a major improvement over every other proposed approach, as it requires far more accountability, putting the responsibility of conformance not on DOD but the manufacturers themselves.

The Open Group is a formidable organization. It has more than 625 member organizations, is the certifying body for the UNIX trademark, and it manages and certifies dozens of open standards, including FACE (Future Airborne Capability Environment), which defines an open avionics environment for military airborne platforms.

**"They want to protect the IP that vendors are putting into their products. So, what's being called a 'gray box' defines the inputs and outputs, form factor, and other metrics, but not what's inside the modules themselves."**

**— Rodger Hosking**

The takeaway is that once SOSA becomes "law", DOD agencies will include this requirement in their solicitations, weeding out products that are non-compliant, except in the comparatively few cases where SOSA conformance could not be achieved. In fact, Hosking says Pentek is already seeing this requirement in DOD documents, even though the standard has not yet been finalized, making it obvious that DOD is very serious and heavily invested in SOSA's success.

For manufacturers, adoption of SOSA means that, at least initially, significant investments will be required to modify some products, such as moving RF connectors from the front to the back of

the board because SOSA considers front-mounted, RF screw-type connectors a reliability issue. This calls for connector manufacturers to find ways to accommodate these additional RF connectors using densely-packed, blind-mating types, which at least one company has already done.

"With SOSA" says Curtiss-Wright's Jedydynak, "you can yank blades and put in others of greater or lesser capability because you're using standard profiles. So, from an architecture standpoint, all the building blocks are arranged in a logical preplanned manner. Linking these cards and putting in others is not just a software switch because we're getting into the physics of the RF front end, but you



*Small unmanned platforms, such as the surveillance drone operated by these soldiers with 8th Infantry Regiment, Japan Ground Self-Defense Force (above), pose unique SWaP challenges that can be addressed with multifunction systems.*

USMC PHOTO

wouldn't necessarily have to change out the whole thing. We know we're going to make 10 pods with EW and 10 with radar, but the chassis, power supplies, backplanes, and network switches, and processing are the same, we're just changing out the tuners. Today everything is completely separate. Ultimately, what you're trying to do is benefit the warfighter so you can get technology in the field faster."

#### BUY-IN

For evidence of the interest in SOSA, consider the recent Embedded Tech Trends forum sponsored by VITA, which was held in January at Georgia Tech. The event, formerly known as Bus & Board, is held every year to connect vendors involved in the embedded community with members of the media. It's typically a small event when compared with others serving broader markets, but this year was different. There was a larger presence from DOD and noticeably more attendees, according to those who were there – and a big draw was SOSA. After the event, vendors demonstrated examples of what an open-source world will look like once the standard is finalized, with products from different vendors in the same enclosure. The room was allowed to accommodate 250 people but more than 400 showed up. "I was amazed that there is so much participation," says Hosking. "We've been talking about this for two or three years, but this show was really a milestone in intense activity and interest."

#### SOSA AND MULTIFUNCTIONALITY

SOSA's contribution to enabling multifunctional systems may be obscured by its importance in other areas, but it nevertheless plays an important role, as it potentially allows a greater choice of functional modules from different vendors to be used. As stated earlier, the same hardware used for EW in a subsystem will also be used by at least one other application. Once these basic elements and their interconnection paths are established by SOSA, it should be easier and faster to use a building-block approach at the board level. With critical functions defined in SOSA's small number of formats, the types of interfaces will be reduced as well. Although this has been possible before, the proliferation of OpenVPX boards made it likely that modules from different vendors would be used to build a subsystem.

For anyone following the defense industry over time, it might seem almost inconceivable that DOD would be taking such impressive steps toward what could ultimately become a near-wholesale revision of its procurement processes. It's taken many years to arrive at SOSA, but as employing this

group of standards will be essential to be considered for program participation, it will have dramatic effects at every level, from components through entire systems – and it will affect procurement by prime contractors as well. And, while SOSA's positive effects on achieving multifunctionality remain to be seen, there are clear reasons why there should be. SOSA makes it possible to create a system by choosing from a greater number of candidate modules, all compatible by decree. 



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# TECHNOLOGY SURVEY

## A SAMPLING OF PORTABLE AND HANDHELD SPECTRUM ANALYZERS

By Barry Manz

The field of portable and handheld test equipment has come a long way since Anritsu introduced the first "SiteMaster" back in the 1990s. It was the first truly portable instrument that could make the measurements required to evaluate the RF performance of the macro base stations that were sprouting everywhere. Today, more than a dozen manufacturers offer handheld and portable instruments, a few of which even combine spectrum analysis with vector analysis well into the millimeter-wave region.

What's more, some handheld instruments fit in a shirt pocket, with only a tablet or laptop computer required to complete the package, connected via USB. As is usually the case today, the remarkable performance achievable in such a small form factor is the result of advances in both analog and digital technology, as well as the ability to transfer data to and from the instrument at high speeds.

There are three types of portable spectrum analyzers available, ranging from extremely small to the size of a breakfast cereal box – each one designed to serve specific applications. The smallest instruments are powered by USB and require an external monitor and laptop for the user interface, processing, and storage. In the middle, are instruments that have performance equivalent to much larger benchtop instruments but don't have a display. Finally, there are complete instruments that contain a high-resolution color display along with the same signal processing and computing capabilities as the "non-display" type. The latter two also can perform signal analysis functions, and often many other functions.

So, it's possible to choose portable and handheld instruments that provide capabilities ranging from basic functionality to performance near that of many mainstream benchtop spectrum analyzers. In fact, measurements that now can be made in a small, portable form factor can deliver performance better than what was attainable in high-end systems less than a decade ago.

Although portable and handheld spectrum analyzers were initially developed to serve the wireless industry (where they still reign supreme), this industry isn't the only beneficiary of their capabilities. They have been used in large numbers for many years in defense applications for flight-line testing, interference monitoring, spectrum monitoring, and evaluating systems on the battlefield – anywhere RF measurements must be made, no matter how hostile the conditions.

Many of these instruments also have the benefit of real-time spectrum analysis (RTSA) enabled by wideband analog-to-digital converters, wide-bandwidth memory, high-speed processors and the use of overlapping FFTs. RTSA allows the instrument to capture and process complex waveforms in extremely dense signal environments and reveal weak signals

buried within stronger ones as well as nonrecurring and pulsed waveforms with a probability of intercept of nearly 100%. Traditional swept-tuned spectrum analyzers cannot capture signals in these situations.

In the more comprehensive instruments, the secret sauce is the vector signal analysis capability performed by Windows or Linux software running on a connected laptop. The software provides comprehensive signal analysis, producing detailed information about the electromagnetic environment and the signals within it, as well signal demodulation and other metrics required for characterization.

For SIGINT applications, VSA software allows handheld spectrum analyzers to serve long-term signal recording applications that were previously possible only with larger instruments. Although recording time and other metrics are not as extensive as systems designed specifically for this purpose, they're often more than adequate for short-term signal recording in the field – where large instruments can't go.

In summary, the trend over the years has been to incorporate more capabilities while increasing performance in a form factor that has never grown in size. The most comprehensive instruments aren't inexpensive, but for less than about \$50,000, these measurement systems offer all the essentials, and much more.

For example, checking all the boxes on the options sheet will create an instrument with spectrum analysis with 1-Hz resolution and the same RTSA capability found in benchtop instruments, frequency coverage from HF through 50 GHz, vector network analysis with multiple calibration methods, distance-to fault, passive intermodulation distortion, noise figure, and RF power measurements.

In addition, the system will provide vector signal analysis, demodulation, I/Q and interference analysis, advanced pulse signal measurement, channel scanning, GPS-based indoor and outdoor mapping, geo-tagging and control by Wi-Fi or Ethernet, and apps for Android and iOS, all while meeting military standards for operating temperature and humidity, vibration, and shock.

### THE SURVEY

This month's survey includes 26 products from 11 manufacturers. While there are more portable spectrum analyzers on the market, we focused on systems that appear to meet military applications based on their frequency coverage and other performance specs.

### NEXT TECHNOLOGY SURVEY

In May, our Technology Survey will focus on communications jammers and remotely controlled improvised explosive device (RCIED) jammers.

## PORTABLE AND HANDHELD SPECTRUM ANALYZERS

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<b>Anritsu; Allen, TX, USA; +1 800-ANRITSU (267-4878); <a href="http://www.anritsu.com/en-US/test-measurement">www.anritsu.com/en-US/test-measurement</a></b>					
Anritsu Field Master Pro™ MS2090A	Real-Time Spectrum Analyzer	9 kHz - 9/14/20/26.5/32/43.5/54 GHz	Zero span with 60 nsec minimum sweep time	1 Hz - 10 MHz (up to 40 MHz in RTSA)	Avg/RMS, peak, negative
Spectrum Master™ MS2720T	Swept-tuned, FFT, Hybrid, Other	9 kHz - 9/13/20/32/43 GHz	Span, span up/down (1-2-5), full span, zero span, last span	1 Hz - 10 MHz in 1-3 sequence ± 10% (-3 dB bandwidth)	RBW with quasi-peak detection 200 Hz, 9 kHz, 120 kHz (-6 dB bandwidth) VBW with quasi-peak detection auto VBW is on, RBW/VBW = 1
Spectrum Master™ MS2711E	Interference Analyzer	9 kHz - 3 GHz	Frequency center/start/stop, span, frequency step, signal standard, channel #, channel increment; span, span up/down (1-2-5), full span, zero span, last span	100 Hz - 3 MHz in 1-3 sequence ± 10% (1 MHz max in zero-span) (-3 dB bandwidth)	Peak, RMS, negative, sample, quasi-peak
<b>B&amp;K Precision; Yorba Linda, CA, USA; +1 714-921-9095; <a href="http://www.bkprecision.com">www.bkprecision.com</a></b>					
2650A	PLL synthesizer	50 kHz - 3.3 GHz	200 kHz - 2GHz, zero span or full span (3.3 GHz)	Within ±4 kHz @ 3 kHz, 10 kHz, 30 kHz within 20% of RBW @ RBW: 100 kHz, 300 kHz within 10% of RBW @ RBW: 1 MHz, 3 MHz	Positive peak, negative peak, sample
2652A	PLL synthesizer	50 kHz - 3.3 GHz	200 kHz - 2GHz, zero span or full span (3.3 GHz)	Within ±4 kHz @ 3 kHz, 10 kHz, 30 kHz within 20% of RBW @ RBW: 100 kHz, 300 kHz within 10% of RBW @ RBW: 1 MHz, 3 MHz	Positive peak, negative peak, sample
2658A	PLL synthesizer	50 kHz - 8.5 GHz	200 kHz to 5GHz, zero span or full span (8.5GHz)	Within ±4 kHz @ 3 kHz, 10 kHz, 30 kHz within 20% of RBW @ RBW: 100 kHz, 300 kHz within 10% of RBW @ RBW: 1 MHz, 3 MHz	Positive peak, negative peak, sample
<b>Bird RF; Solon, OH, USA; +1-866-695-4569; <a href="http://www.birdrf.com">www.birdrf.com</a></b>					
SignalHawk SH-60S-AOA	*	9 kHz - 6 GHz	*	10 Hz to 5 MHz in 1, 2, 3, 5, 10 Steps	*
<b>Keysight Technologies; Santa Rosa, CA, USA; +1 800-829-4444; <a href="http://www.keysight.com">www.keysight.com</a></b>					
FieldFox Microwave Analyzer N99xxA/N99xxB	Swept-tuned, FFT and real-time spectrum analyzer	5 kHz - 50 GHz	Zero span, 10 Hz to maximum frequency of instrument	10 Hz - 5 MHz (100 MHz real-time bandwidth)	Normal, positive peak, negative peak, sample, average

Min. Event Duration	Trigger Types	Form Factor	Size	Weight	Features
2.05 µsec	Zero Span Only: Free Run, Video, External, Periodic	Handheld	314 x 235 x 95 mm (12.4 x 9.25 x 3.74 in.)	MS2090A-0709, -0714, -0720: 5.06 kg (11.15 lbs) MS2090A-0726, -0732, -0743, -0754: 5.4 kg (11.9 lbs)	All versions include a spectrogram display that helps monitor the RF spectrum for intermittent or interfering signals.
*	Hysteresis, hold-off, and delay	Handheld	315 x 211 x 77 mm (12.4 x 8.3 x 3.0 in.)	4.4 kg (9.8 lbs) fully loaded	Battery Powered long-life Li-Ion batteries (3 hours typ.); built-in worldwide signal standards and channels for cellular formats, WiFi and others.
*	Free Run, External, Video, Change Position, Manual	Handheld	273 x 199 x 91 mm (10.7 x 7.8 x 3.6 in.)	< 3.45 kg	Store 2000 traces internally; internal preamplifier optional; internal power meter optional; high-accuracy power meter optional.
10msec to 30 sec or auto	Auto, Internal, External	Handheld	162(W)×71(H)×265(D)mm	Approx. 1.8 kg, 4 lbs (including battery)	-127 dBm DANL; 4-hour battery life; easy-to-replace rechargeable Li-ion battery; auto tune function.
10msec to 30 sec or auto	Auto, Internal, External	Handheld	162(W)×71(H)×265(D)mm	Approx. 1.8 kg, 4 lbs (including battery)	Measurement functions: channel/adjacent channel power, occupied bandwidth, electric and magnetic field strength.
10msec to 30 sec or auto	Auto, Internal, External	Handheld	162(W)×71(H)×265(D)mm	Approx. 1.8 kg, 4 lbs (including battery)	Measurement functions: channel/adjacent channel power, occupied bandwidth, electric and magnetic field strength.
1.1msec	*	Handheld	7.8 x 3.7 x 2.4 in.	1.98 lb (0.9 kg)	Li-ion battery provides 5 hrs of continuous operation; Android OS; map display mode for geolocating emitters.
5.52 µsec	Free run, External, Video, RF Burst, Periodic Frame	Handheld	11.5 x 7.4 x 3.2 in.	7.35 lbs	Spectrum analyzer, VNA, CAT, real-time spectrum analyzer, independent source, pulse analysis, 5G NR over-the-air, noise figure, GPS receiver and more.

## PORTABLE AND HANDHELD SPECTRUM ANALYZERS

Model	Spectrum Analyzer Type	Operating Freq. Range	Center Freq. and Span Options	Resolution Bandwidth	Detector
<b>Narda Safety Test Solutions GmbH; Pfullingen, Germany; +49 (0) 7121-9732-0; <a href="http://www.narda-sts.com">www.narda-sts.com</a></b>					
IDA 2 Interference and Direction Analyzer	Hybrid	9 kHz - 6 GHz	Set with CF & span or with start & stop; CF: 9.5 kHz-6 GHz; span: 1 kHz-6 GHz	10Hz - 20 MHz; zero span 100Hz - 32 MHz; IQ mode 94 mHz - 239 kHz	Act, max, avg, min, +peak, RMS, -peak
SignalShark Handheld 3310	Preselected superhet/real-time	8 kHz - 8 GHz	Up to 40 MHz span real time, > 40 MHz - 8 GHz span stitched spectrum	RBW (real-time spectrum) 1 Hz - 800 kHz; RBW (scan spectrum) 1 Hz - 6.25 MHz	+Pk, RMS, -Pk, avg and sample, Cpeak (quasi-peak), CRMS & Cavg
SignalShark Remote 3320	Preselected superhet/real-time	8 kHz - 8 GHz	Up to 40 MHz span real time, > 40 MHz - 8 GHz span stitched spectrum	RBW (real-time spectrum) 1 Hz - 800 kHz; RBW (scan spectrum) 1 Hz - 6.25 MHz	+Pk, RMS, -Pk, Avg and Sample, Cpeak (quasi-peak), CRMS & Cavg
<b>Research Electronics International (REI); Cookeville, TN, USA; (931) 537-6032, <a href="http://www.reiusa.net">www.reiusa.net</a></b>					
OSCOR Green 24 GHz	Swept-tuned	10 kHz - 24 GHz	Both are adjustable; center: 9.155 kHz - 24.024 GHz; span: 267.029 kHz - 24.025 GHz	Sweep mode: 25 kHz; analyze mode: automatically varies depending on span	Sample detection, peak detection, avg detection
OSCOR Blue 24 GHz	Swept-tuned	10 kHz - 24 GHz	Both are adjustable; center: 9.155 kHz - 24.024 GHz; span: 267.029 kHz - 24.025 GHz	Sweep mode: 25 kHz; analyze mode: automatically varies depending on span	Sample detection, peak detection, avg detection
MESA	Swept-tuned	10 kHz - 6 GHz	Both are adjustable; center: 22.5 kHz-5.998 GHz; span: 25 kHz-6 GHz	Variable depending on span: 0.0380-312.5 kHz	Peak detection, avg detection
<b>Rohde &amp; Schwarz GmbH &amp; Co. KG; Muenchen, Germany; +49 89-4129-0; <a href="http://www.rohde-schwarz.com">www.rohde-schwarz.com</a></b>					
R&S®PR200, Portable Monitoring Receiver	FFT	8 kHz - 8 GHz (base unit), extension up to 18 GHz	40 MHz real-time bandwidth	0.625 Hz - 2 MHz	Level: peak, RMS, average, fast; FFT: auto peak, positive peak, negative peak, average, sample
FPH	Hybrid	5kHz - 31 GHz	Manual/full span, zero span	1 Hz - 3 MHz	Max. peak, average, RMS, quasi-peak
FSH	Hybrid	9kHz - 20 GHz	Manual/full span, zero span	1 Hz - 3 MHz	Max. peak, average, RMS, quasi-peak
<b>SAF North America, LLC.; Aurora, CO, USA; +1 720-502-0728; <a href="http://www.saftehnika.com">www.saftehnika.com</a></b>					
JOSSAP33	Swept-tuned	0.3-3 GHz	Span: 500 kHz - 2700 MHz	10-300 kHz	Selectable - min/max/avg
JOSSAP55	Swept-tuned	2-8 GHz	Span: 1.5-6000 MHz	30 kHz - 1 MHz	Selectable - min/max/avg
JOSSAP54	Swept-tuned	24-43 GHz	Span: 10-19000 MHz	100 kHz - 1 MHz	Selectable - min/max/avg

Min. Event Duration	Trigger Types	Form Factor	Size	Weight	Features
TP0I=9 $\mu$ sec @ IQ mode RBW=239.43 kHz; TP0I≤64 nsec @ zero span CBW=32 MHz	Free run, single, multiple, time controlled	Handheld	213 x 297 x 77 mm, 8.4 x 11.7 x 3 in.	2.8 kg, 6 lbs	Sweep rate of 12 GHz/sec; embedded GPS receiver and electronic compass; interference search with smartDF®.
> 3.125 $\mu$ sec without attenuation and spectral growth > 2 nsec with attenuation proportional to the spectral growth	*	Handheld	230 x 335 x 85 mm, 9.06 x 13.19 x 3.35 in.	Approx. 4.1 kg, 9.04 lbs (with one battery)	Win10 open platform for 3rd party applications, integrated heat map, 4 inputs, up to 50 GHz/s, ITU compliant dynamic range.
> 3.125 $\mu$ sec without attenuation and spectral growth > 2 nsec with attenuation proportional to the spectral growth	*	Stand-alone / brick unit and 19" rack, 1HU single / dual devices available	43.5 x 220 x 204 mm, 1.71 x 8.66 x 8.03 in.	Approx. 2.1 kg, 4.63 lbs (stand-alone unit)	Win10 open platform for 3rd party applications, integrated heat map, SCPI remote control, VITA 49 streaming.
1.25msec	Triggers on RF level to add signals to signal list; available scope triggers: rising edge, falling edge	Portable	11.5 x 13.2 x 3.0 in. (29.2 x 33.5 x 7.6 cm)	9.6 lbs (4.4 kg)	Resistive touch-screen, waterfall display, audio demodulation (AM, FM), video demodulation (NTSC, PAL, SECAM), Subcarrier Demodulation.
1.25msec	Triggers on RF level to add signals to signal list; available scope triggers: rising edge, falling edge	Portable	11.5 x 13.2 x 3.0 in. (29.2 x 33.5 x 7.6 cm)	9.6 lbs (4.4 kg)	Correlation, ranging, VNC remote operation, trace record waterfall, persistence trace, built-in battery charger, math trace, signal lists, baseband output, IF output.
1.25msec	Triggers on RF level to enable haptic alerts, audible alerts, visible alerts and to add signals to signal list	Handheld	5 x 8 x 2 in. (12.7 x 20.3 x 5.08 cm)	2.4 lbs (1.08 kg)	Capacitive touch-screen, bar graph view of RF spectrum, patented expanded detail graphical display of RF spectrum, WiFi/Bluetooth Scanner.
Probability of intercept (100 % P0I): 1.5 $\mu$ sec nom.	Trigger In: serial RS-232 and LVTTL Zero Span: Free run, external, video	Portable/ Handheld, Portrait format	Approx. 192 x 320 x 62 mm (7.56 x 12.60 x 2.44 in.)	Approx. 3.5 kg (7.72 lbs), including battery	Extention up to 18 GHz w/ external R&S®HF907DC SHF directional antenna with downconverter; tracking and suboctave preselection as standard.
*	Free run, video, external, gated trigger	Handheld	202 x 294 x 76 mm (8.0 x 11.6 x 3 in.)	2.5 kg (5.5 lbs)	Full-capacitive touchscreen, lightweight (only 2.5 kg), fast boot time, 999 hours spectrogram recording.
*	Free run, video, external, gated trigger	Handheld	194 x 300 x 69 mm (7.6 x 11.8 x 2.7 in.)	< 3 kg (< 6.6 lbs)	Excellent RF specification, multi-purpose analyzer, rugged, splash-proof housing.
200 msec	Manual, Continuous Sweep	Handheld	5.3 x 3.3 x 1.4 in.	1.25 lbs	Time record plot, min/max/hold, Power-in-Band, standalone or remote operation (over LAN or USB), API, IP54.
200 msec	Manual, Continuous Sweep	Handheld	5.3 x 3.3 x 1.4 in.	1.25 lbs	Time record plot, min/max/hold, Power-in-Band, standalone or remote operation (over LAN or USB), API, IP54.
200 msec	Manual, Continuous Sweep	Handheld	5.3 x 3.3 x 1.4 in.	1.25 lbs	Min/max/hold, Power-in-Band, standalone or remote operation (over LAN or USB), API, IP54.

## PORTABLE AND HANDHELD SPECTRUM ANALYZERS

Model	Spectrum Analyzer Type	Operating Freq. Range	Center Freq. and Span Options	Resolution Bandwidth	Detector
<b>Signal Hound; Battle Ground, WA, USA; +1 360-313-7997; www.signalhound.com</b>					
SM200B	FFT	100 kHz - 20 GHz	Any span	0.1Hz (<200kHz span) to 3MHz (any span) using 40 MHz IBW; 30 kHz - 10 MHz using 160 MHz IBW	Min/max/avg
SM200C	FFT	100 kHz - 20 GHz	Any span	0.1Hz (<200kHz span) to 3MHz (any span) using 40 MHz IBW; 30 kHz - 10 MHz using 160 MHz IBW	Min/max/avg
<b>Tektronix; Beaverton, OR, USA; +1 800-833-9200; www.tektronix.com</b>					
RSA306B	Real-time spectrum (signal) analyzer	9 kHz - 6.2 GHz	Settable and adjustable to the full frequency range of the instrument. Real-time (instantaneous) bandwidth of up to 40 MHz	1.18 Hz - 8 MHz	Supports: avg (VRMS), avg (of logs), CISPR peak, +peak, -peak, sample, CISPR quasi peak, CISPR avg
RSA500 Series	Real-time spectrum (signal) analyzer	9 kHz - 3/7.5/13.6/18.0 GHz	Settable and adjustable to the full frequency range of the instrument. Real-time (instantaneous) bandwidth of up to 40 MHz	1.18 Hz - 8 MHz	Supports: avg (VRMS), avg (of logs), CISPR peak, +peak, -peak, sample, CISPR quasi peak, CISPR avg
RSA600 Series	Real-time spectrum (signal) analyzer	9 kHz - 3/7.5 GHz	Settable and adjustable to the full frequency range of the instrument. Real-time (instantaneous) bandwidth of up to 40 MHz	1.18 Hz - 8 MHz	Supports: avg (VRMS), avg (of logs), CISPR peak, +peak, -peak, sample, CISPR quasi peak, CISPR avg
<b>ThinkRF Corp.; Kanata, Ontario, Canada; +1 613-369-5104; www.thinkrf.com</b>					
R5750-427	Real-time pectrum analyzer	9 kHz - 27 GHz	Real-time bandwidth or span of 100 MHz; span 50 kHz - 27 GHz	1 Hz - 488 kHz	Peak

## SURVEY KEY – SPECTRUM ANALYZERS

### MODEL

Product name or model number

### SPECTRUM ANALYZER TYPE

- FFT = fast Fourier transform

### OPERATING FREQUENCY RANGE

Operating frequency or center frequency

### CENTER FREQUENCY AND SPAN OPTIONS

The center frequency and span of the spectrum analyzer unit

- CF = center frequency

### RESOLUTION BANDWIDTH (RBW)

Bandwidth of the filter (swept or digital) used for signal processing

### DETECTOR

The technique used to determine the signal amplitude

- avg. = average
- CISPR = International Special Committee on Radio Interference
- EMI = electromagnetic interference
- RMS = root mean square (power averaging)
- VRMS = root mean square voltage

### MIN. EVENT DURATION

Minimum event duration for 100% probability of intercept

- IBW = instantaneous bandwidth
- POI = probability of intercept

Min. Event Duration	Trigger Types	Form Factor	Size	Weight	Features
12 $\mu$ sec @ 300 kHz RBW	Video, external	Portable	10.2 x 7.2 x 2.15 in.	7.77 lbs	160 MHz instantaneous bandwidth (IBW) calibrated I/Q capture, available through block transfer of a 2-second I/Q buffer over USB 3.0 to the PC.
12 $\mu$ sec @ 300 kHz RBW	Video, external	Portable	10.2 x 7.2 x 2.15 in.	7.77 lbs	10 GbE SFP+ interface for continuous streaming of up to 160 MHz bandwidth, with commands and data sent over the 10 GbE link.
27 $\mu$ sec	RF Input Power, External TTL Internal Time Also: Mask Search	Portable, USB3.0 powered, for field, lab, or production use	31.9 x 190.5 x 139.7 mm (1.25 x 7.5 x 5.5 in.)	0.73 kg (1.6 lbs)	Full-featured spectrum analysis capability with Tektronix SignalVu-PCTM software; 17 spectrum and signal analysis measurement displays enable dozens of measurement types.
15 $\mu$ sec	RF Input Power, External TTL Internal Time Also: Mask Search	Portable, battery or line powered for field, lab, and production use	67.3 x 299.1 x 271.3 mm (2.65 x 11.78 x 10.68 in.)	3.17 kg (7.0 lbs) with battery	Options for mapping, modulation analysis, WLAN, LTE, and Bluetooth standards support, pulse measurements, playback of recorded files, signal survey, and frequency/phase settling.
27 $\mu$ sec	RF Input Power, External TTL Internal Time Also: Mask Search	Line powered for lab or production use	75.0 x 222.3 x 358.6 mm (2.95 x 8.75 x 14.12 in.)	2.88 kg (6.35 lbs)	EMC/EMI pre-compliance and troubleshooting - CISPR detectors, predefined standards, limit lines, easy accessory setup, ambient capture, failure analysis, and report generation.
17 $\mu$ sec	Amplitude threshold and Frequency limits; External pulse trigger	Small, Rugged	257.3 x 193.7 x 60 mm (10.13 x 7.63 x 2.36 in.)	< 6 lbs	27 GHz frequency range can be extended to 40 GHz; networkable with built-in Gig-E capability; built-in GNSS for geo-location and transmitter location.

**TRIGGER TYPES**

Options for starting measurement of a specific signal

**WEIGHT**

Unit weight in pounds or kilograms

**FORM FACTOR**

Suitable operating environments (lab or field) for the spectrum analyzer

**OTHER ABBREVIATIONS**

- BW = bandwidth
- freq. = frequency
- IF = intermediate frequency

\* Indicates answer is classified, not releasable or no answer was given.

**SIZE**

Length, width and depth in inches or millimeters.

**MAY 2020 PRODUCT SURVEY: COMMUNICATIONS JAMMERS AND RCIED JAMMERS**

This survey will cover communications jammers and remotely-controlled improvised explosive device (RCIED) jammers. Please e-mail [JEDEditor@naylor.com](mailto:JEDEditor@naylor.com) to request a survey questionnaire.

**EXHIBIT AND  
SPONSORSHIP  
OPPORTUNITIES  
AVAILABLE!**



DIXIE CROW  
SYMPOSIUM  
**XLV**

MARCH 22-25, 2020 // MUSEUM OF AVIATION, ROBINS AFB, GA



**KEYNOTE SPEAKER**  
**Brig Gen David Gaedecke,  
HQAF/A5L**



**BANQUET SPEAKER**  
**Maj Gen Cameron Holt,  
SAF/AQC**

7<sup>TH</sup> ANNUAL THE CROW'S

**N.E.S.T.**  
(Novel Experiments with Science & Technology)

The Dixie Crow Chapter of the Association of Old Crows Science, Technology, Engineering, and Mathematics (STEM) Robotics displays and technology demonstrations, are an interactive experience that will capture the minds and hearts of students, parents and teachers. The displays are a collaborative effort between local military, government civil service, academia, defense industry and volunteers designed to inspire students to pursue STEM careers. Interacting with the robotics displays and technology demonstrations will demonstrate to students that STEM can be both fun and engaging. Enthusiastic workers in STEM fields will also be on hand to answer questions and help students learn how they can prepare to enter the exciting world of STEM. Make time to visit and participate in our Crows N.E.S.T. displays and technology demonstrations.



WEDNESDAY, MARCH 25 // 10:00 A.M. - 2:00 P.M.  
// MUSEUM OF AVIATION CENTURY OF FLIGHT HANGAR

We are looking for Academia, Industry, Government/Military and other Organizations to display their creative robotic talents and/or interactive technological products!!!

We look forward to your participation in this fantastic opportunity to interface with our STEM Leaders of tomorrow!

If you have any questions and/or would like to participate, please feel free to contact:

**Robert Usher** at Robert.Usher@gmail.com (478) 222-0022  
*Event open to Students age 8 and up.*

**PREPARE TO BE AMAZED!**

# SCHEDULE OF EVENTS

## SUNDAY, MARCH 22

Registration	Marriott Courtyard, Warner Robins, Georgia	5:00 PM-8:00 PM
Hospitality Suite	Marriott Courtyard, Warner Robins, Georgia	5:00 PM-8:00 PM

## MONDAY, MARCH 23

Registration	Southern Landings Golf Course, Warner Robins, Georgia	10:30 AM-12:30 PM
Registration	Century of Flight Hangar, Museum of Aviation	2:30 PM-5:00 PM
Spring Golf Tourney	Southern Landings Golf Course, Warner Robins, Georgia	12:00 PM Tee Time
BBQ Sports Banquet	Southern Landings Golf Course, Warner Robins, Georgia	5:00 PM-7:00 PM

## TUESDAY, MARCH 24

Registration	Century of Flight Hangar, Museum of Aviation	7:30 AM-6:00 PM
Plenary Session	Scott Theater, Eagle Building, Museum of Aviation	8:00 AM-11:00 AM
Exhibits Open	Century of Flight Hangar, Museum of Aviation	10:00 AM-7:00 PM
Exhibitor Reception	Century of Flight Hangar, Museum of Aviation	5:00 PM-7:00 PM

## WEDNESDAY, MARCH 25

Registration	Century of Flight Hangar, Museum of Aviation	9:00 AM-2:00 PM
Exhibits Open	Century of Flight Hangar, Museum of Aviation	9:45 AM-3:00 PM
Crows N.E.S.T.	Century of Flight Hangar, Museum of Aviation	10:00 AM-2:00 PM
AOC Chapter President's Mtg	Century of Flight Hangar, Museum of Aviation	11:30 AM-1:00 PM
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 45!

Our Symposium Committee, Dixie Crow Chapter President, Matthew Bryant, 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 electronic warfare/information operations trade show.

Sincerely, Karen Brigance, *Co-Chair* | Kbrigance@merc-merc.org  
Lisa Frugè-Cirilli, *Co-Chair* | lisa.fruge@baesystems.com

**REGISTER NOW! [WWW.DIXIECROWSYMP.COM](http://WWW.DIXIECROWSYMP.COM)**

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or email: AFLCMC.WNY.AFTechProg@us.af.mil**

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# 2020 INDUSTRY & INSTITUTE/UNIVERSITY MEMBER GUIDE

Guide listings were updated based on changes received from companies during the month of January 2020. Please send any listings changes to Hope Swedeon, Production Editor, [hswedeon@naylor.com](mailto:hswedeon@naylor.com).

## SUSTAINING MEMBERS

### B

#### BAE SYSTEMS

65 Spit Brook Road NHQ3-1115  
Nashua, NH, USA 03060  
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[www.baesystems.com](http://www.baesystems.com)

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#### Boeing Defense, Space & Security

929 Long Bridge Drive  
Arlington, VA, USA 22202  
[www.boeing.com/defense](http://www.boeing.com/defense)  
President and CEO, Defense, Space & Security: Leanne Caret

**AOC contact:** Lawrence Burt

[lawrence.d.burt@boeing.com](mailto:lawrence.d.burt@boeing.com)

Boeing Defense, Space & Security (BDS) is one of The Boeing Company's three business units. Its portfolio includes manned and unmanned aircraft programs, space and satellite systems, intelligence and security systems, and extensive integration expertise. The world's second-largest defense company, BDS employs about 36,500 employees worldwide.

### C

#### CACI INTERNATIONAL INC

1100 N. Glebe Road  
Arlington, VA, USA 22201

**AOC contact:** Jerry Parker

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[www.chemring.co.uk](http://www.chemring.co.uk)

Group Chief Executive: Michael Ord

**AOC contact:** Claire Savage,

Head of Group Marketing and Communications

Chemring is organised under two sectors:

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#### COLLINS AEROSPACE

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**AOC contact:** Charlie Heidal, Manager, Sales & Business Development

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## E

### **ELECTRONIC WARFARE ASSOCIATES, INC.**

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[www.ewa.com](http://www.ewa.com)

Chief Executive Officer: Carl N. Guerreri  
**AOC contact:** Eileen Redd,  
Director of Marketing

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## G

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Base2 Engineering, LLC is a provider of complex, mission-oriented services and solutions for the Department of Defense and other U.S. Government clients. Base2 enables our customers to achieve and sustain their technological advantage in intelligence, defense, space and aviation. Base2's designs are traversing cyberspace, flying in unmanned and manned aircraft, sailing the seas, and orbiting the earth. Our staff provides expertise in the design, engineering, reverse engineering, development, prototyping and deployment of hardware, embedded software, software applications, and mechanical devices. We are experts in the reverse engineering and analysis (including design recovery and replication) of hardware, embedded firmware, and software.

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**AOC contact:** Gary DeYoung

Battlespace Simulations, Inc. (BSI) develops electronic warfare training software used to train EW principles to combat aviators worldwide, including all undergraduate USAF Combat Systems Officers (CSOs) in-flight on the T-1A CSO aircraft at NAS Pensacola. BSI's Modern Air Combat Environment (MACE) software is used on over 950 training systems worldwide, including desktop-based EW instruction and major weapon systems trainers for the A-10, F-16, C-130, MQ-9, AC-130, MC-130, CV-22, C-130, Joint

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Beca Applied Technologies (BAT) Limited is an arm of the greater Beca Company. Beca Applied Technologies provides services in the form of high integrity engineering, system safety, simulation, software and systems engineering.

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CEA Technologies Pty Limited, headquartered in Canberra, Australia, was established in 1983 with a goal of creating a center of excellence for the design & support of advanced electronic systems for the Australian Defence Force. From the outset, CEA Technologies was based on the provision of uncompromising design principles & robust through-life system support. CEA Technologies, Incorporated, is the U.S. subsidiary focused on support of these delivered systems to the U.S. Defense Community. The primary product is state-of-the-art element-level Digital Beam Formed Active Electronically Scanned Array radar systems with world-class Digital Beamforming capabilities.

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**AOC Contact:** Jeremy Hallett,  
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## COMMUNICATION POWER CORPORATION

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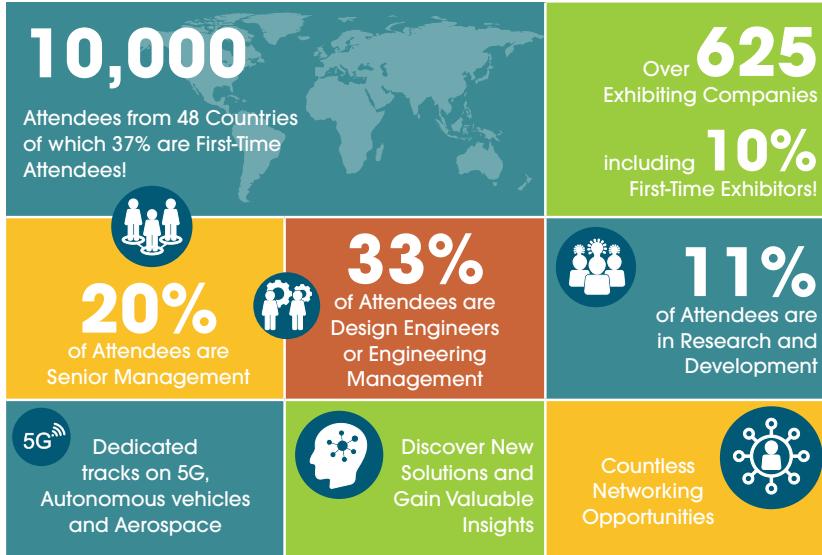
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### CRFS LTD

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CRFS design, build, program and deploy systems and solutions for RF Geolocation and intelligence alongside spectrum monitoring and management. We serve defense and homeland security customers as well as the civilian regulatory market.

## D

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Darkblade Systems Corporation is a Service-Disabled Veteran-Owned Small Business (SDVOSB) providing scientific, engineering, technical, operational support, and training services to Federal government and Commercial clients. Engineering specialties include development and design services for hardware and software systems fulfilling the mission needs of the Department of Defense and Intelligence Communities. Operational and Cyber services include full spectrum project and program support, including planning, training, management, and technical evaluation.

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[www.dBControl.com](http://www.dBControl.com)  
President: Mike England  
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dB Control supplies mission-critical, often sole-source, products worldwide to military organizations, as well as to major defense contractors and commercial manufacturers. The company designs and manufactures reliable high-power TWT Amplifiers (TWTAs), microwave power modules (MPMs), transmitters, and high-voltage power supplies with modulators for radar, electronic countermeasures (ECM), and datalink applications. After acquiring TTT-Cubed in 2019, dB Control also offers Instantaneous Frequency Measurement Units (IFM), Frequency Locked Oscillators (FLO), Digital Control Units (DCU), Antenna Control Units (ACU) and Integrated DCU's.

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DEWC comprises three separate businesses (DEWC Services, DEWC Systems and DEWC T&E) to support the Intelligence, Surveillance, Reconnaissance and Electronic Warfare (ISREW) requirements of the Australian Defence Force and its allies.

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**DEWC Systems** is dedicated to providing Australia with the technological superiority to ensure dominance of the electromagnetic battlespace. DEWC Systems is focused on developing innovative, state-of-the-art Electronic Warfare systems and subsystems for Defence and industry. DEWC Systems advances and realises the work of the DEWC internal R&D program through prototyping and production.

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Since our founding in 1992, DHPC Technologies has been devoted to supporting our national security with multi-discipline engineering solutions, technology assessment, modeling & simulation, software development and systems engineering expertise. With sustained growth over the past 20 years, we now have office locations in Woodbridge, NJ; Aberdeen, MD; and Huntsville, AL. DHPC Technologies specializes in providing technical services in the areas of systems engineering, testing, sensor/system evaluations, modeling/simulation and prototyping. Our customers rely upon us for independent evaluation and analysis to assist in the requirements determination, technology development and testing phases of complex electronic warfare programs. DHPC has industry leaders in engineering solutions for laser design and application, electronics and technology forensics,

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DragoonITCN is a US small business and is ISO 9001:2015 certified; manufacturing Special Test Equipment for Avionics and Weapon Systems. All legacy product lines are on GSA Schedule.

Best known for BCIT (Bus Characterization & Integrity Toolset) [www.dragoonitcn.com/products/bcit](http://www.dragoonitcn.com/products/bcit).

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**AOC contact:** Jon Cabra

For 40+ years, Dynetics has been a leader in research, development, test and engineering for government agencies and commercial firms in the areas of Intelligence, Systems Research and Development, Hardware and Software Product Development, and Integration.

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## E

#### ELBIT SYSTEMS EW AND SIGINT – ELISRA LTD.

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A world leader and provider for six decades of comprehensive combat-proven EW and SIGINT solutions, Elbit Systems – ELISRA offers advanced end-to-end, customized, multi-functional and modular integrated solutions operating across the entire electromagnetic spectrum (RF and EO). These systems include RWR, LWS, IR- MWS, ECM, DIRCM, C/F, ESM, ELINT, COMINT and COMJAM, Counter UAS, CYBER and C4I.

The prime contractor of EW systems to the Israel Defense Forces (IDF), the company is the developer of C3 system for the Anti-Ballistic Missiles (ABM) programs Arrow, David's Sling and the core of the Israel Test Bed (ITB) simulator for ballistic missile defense systems.

Battle experienced in all conflict zones of the last three decades, thousands of Elisra's EW and Intelligence systems and suites are successfully deployed worldwide onboard over seventy airborne, naval and ground platform-types, serving dozens of military forces, homeland security agencies and major defense contractors. Operational in Israel as well as in dozens of other countries they provide survivability, situational awareness, self-protection and targeting solutions.

Addressing emerging needs, Elisra offers networked, unified and interconnected capabilities. All of Elisra's systems – EW, SIGINT, C4I and Cyber – are integrated and interoperable amongst themselves and within a networked grid, effectively coping with current hybrid EW and Intelligence warfare challenges by real time reaction.

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#### ELDES S.R.L.

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 President and CEO,  
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ELDES was founded in 1993 to provide solutions for radar systems and radar simulators. In the Defence market we are world leader of HWIL radar simulators for EW systems evaluation. The E-PRS generic

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ELTA Systems Ltd., a group and subsidiary of IAI Israel Aerospace Industries, is one of Israel's leading defense electronics companies and a global leader in the field of Intelligence, Surveillance, Target Acquisition & Reconnaissance (ISTAR), Early Warning, HLS, Electronic Warfare (EW), Signal Intelligence (SIGINT) and Communications.

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**AOC contact:** Mr. Jon Jacocks  
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Meggitt Baltimore, Inc. is a part of Meggitt plc's Airframes System Division. It has over 50 years of experience in the design, development, and production of radomes and antennas for use in Electronic Warfare (EW), Radar, and Communication, Navigation, and Identification (CNI) applications.

#### **MEGGITT DEFENSE SYSTEMS**

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Meggitt specializes in airborne pods, countermeasure deployment systems, radomes, air data systems, flight deck displays and life support systems for aircraft and helicopters.

Meggitt is known for battle-proven intelligent air data systems and compact flight deck instruments that enable pilots to assimilate critical information in extreme environments. We have the facilities, personnel and experience to produce radomes that satisfy even the most demanding customer requirements. Our countermeasure deployment systems are designed to recover towed assets in flight. Airborne recovery allows for increased operational flexibility for training or operational flights.

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Micro Lambda Wireless, Inc. was founded in 1990 with the purpose of supplying YIG based components and assemblies to the microwave industry. Markets served include: ELINT & SIGINT Receivers, ESM, ECM & EW, Avionics & Scientific applications, SATCOM & TELECOM applications, and Test & Measurement instrumentation. Micro Lambda Wireless, Inc. is an ISO 9001-2015 certified company with a commitment to Total Quality Management and Just-In-Time concepts throughout the organization. Products include Low Noise Oscillators covering 600 MHz to 44 GHz, Wide Band Filters covering 500 MHz to 50 GHz, YIG-Tuned Multipliers covering 1 to 22 GHz and Frequency Synthesizers covering 50 MHz to 33 GHz. Product standardization focusing on repeatable manufacturing processes enable Micro Lambda Wireless to stock material, allowing for very short build cycles. Consistent product development has led Micro Lambda Wireless, Inc. to be a leader in YIG-Based components and synthesizers.

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MPG is a leading global provider of mission-critical engineered electronic components and subsystems comprised of four business units in five manufacturing locations. Our expertise is the design and manufacture of communications-based specialty products for demanding military, space, commercial aerospace, and telecom infrastructure applications where function and reliability are crucial.

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MilSource is the proud official US distributor of Techaya's MILTECH line of military-grade switching, routing and other communications solutions. These IP-based communication solutions are ideal for extreme conditions and unique tactical requirements. Developed for military and harsh mobile applications, Techaya's military-grade communications solutions feature mechanical packaging enhancements designed for MIL-ST D-810F and IP67 airborne, ground and marine environmental compliance and for high reliability.

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Mission Microwave was founded in 2014 to create the next generation of Solid-State Power Amplifiers (SSPAs) and Block Upconverters (BUCs) in the 7 to 31 GHz frequency range using commercial and custom designed RF devices. In company has grown rapidly to become the leader in high power Ka-Band amplifiers for advanced SATCOM systems with compact 200 watt amplifiers weighing under

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Modern Technology Solutions, Inc. (MTSI) is a 100 percent employee-owned engineering services and technology solutions company delivering first-choice capabilities to solve problems of global importance in the critical mission areas of missile defense, cyber security, intelligence, unmanned/autonomous systems, aviation, space and homeland security. MTSI's mission is to make important and lasting contributions to the nation's defense and security by providing leadership and best-value solutions to solve America's most technically challenging strategic problems. Founded in 1993, MTSI today has over 800 employees,

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MRC GIGACOMP is the representative and distributor of leading suppliers of RF and microwave components, subsystems and test equipment. MRC GIGACOMP have one of the strongest RF sales teams in Europe.

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Our product offering for the defence industry encompasses antennas, amplifiers, complex subsystems and test equipment, from DC to 110 GHz.

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My-konsult is specializing in the design, development and manufacturing of Electronic Attack and training systems. The company is also focusing on development of EW products that includes test and evaluation, airborne, ground and naval applications.

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MyDefence is specialized in developing sensors and effectors for military customers to mitigate the threat of malicious drones. Our combat proven Counter UAS products provide end-users with state-of-the-art technology for enhanced protection and situational awareness on the battlefield. By listening to our end-users and combining their learnings with our technology, we are producing innovative and versatile Counter UAS solutions for any type of mission.

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Kudelski Security Inc. is an innovative, independent Swiss provider of tailored cybersecurity solutions to businesses and governments. Our team of security experts delivers end-to-end cybersecurity consulting, products and services, leveraging over 20 years' experience in advanced threat detection, attack prevention, asset and reputation protection, and security assessments. Kudelski Security delivers and integrates customized turnkey solutions that strengthen cyberdefense capabilities. Kudelski Security provides solutions for threat monitoring and intelligence (Cyber Defense Center), secure 4G-LTE communications, and secure data sharing. Kudelski Security is headquartered in Switzerland. Its global reach and multi-disciplinary incident response is reinforced by key international partnerships.

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Narda is a leading supplier of measuring equipment in the EMF Safety, RF Test & Measurement and EMC sectors. The EMF safety product spectrum includes wideband and frequency-selective measuring devices, and monitors for wide area coverage or which can be worn on the body for personal safety. The RF Test & Measurement sector covers analyzers and instruments for measuring and identifying radio sources. The range of services includes servicing, calibration, and training programs. The company management system is ISO 9001:2015

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Based in Stockholm, Sweden, Novator Solutions develops test and measurement systems and provides consultant services. We are a National Instruments RF and Wireless Specialty Alliance Partner, and we work extensively with hardware and software from National Instruments. All of our developers are experts in these platforms, delivering systems of the highest quality to our customers. Our goal is to deliver top quality and excellent usability. We build long-term relationships with our customers and strive for 100% customer satisfaction.

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Nuvotronics, Inc. was established in 2008 with a vision to revolutionize microelectronics hardware. We developed a revolutionary 3D microcoax technology that we have leveraged into a track record of delivering disruptive solutions. Ideally suited for the rapidly growing microwave and millimeter wave marketplace, we provide customers SWaP advantages with a variety of components, assemblies, modules and sub-systems. These solutions are ideally suited for many defense applications, including space, radars and sensors (including phased array), electronic warfare, RF for munitions, and wideband receivers. Contact us to see how we can help you solve your toughest problems.

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Overlook Systems Technologies, Inc. is an engineering and analysis firm with a proven record of timely, responsive and cost-effective professional, technical and programmatic services to government and commercial clients. We have extensive experience in all aspects of Navigation Warfare operations and applications, including Electronic Warfare, Space Operations, spectrum deconfliction, Cyberspace and homeland security. Overlook brings Defense Department and International Global Positioning System (GPS) and additional Positioning, Navigation and Timing (PNT) technology analysis expertise for joint operations, threat and requirements analysis, and PNT Assurance testing, training and exercises. Our senior personnel are the leaders in GPS development, operations and policy formulation.

## P

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Parsons (NYSE: PSN) is a leading disruptive technology provider for the future of global defense, intelligence and critical infrastructure with capabilities across cybersecurity, missile defense, space, connected infrastructure and smart cities. Please visit [parsons.com](http://parsons.com), and follow us on LinkedIn and Facebook to learn how we're making an impact.

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Pentek designs embedded computer boards and recording systems for DSP, software radio and data acquisition as an ISO 9001:2015 certified company. Products feature high-speed digital and analog interfaces and FPGAs in AMC, XMC, FMC, PMC, cPCI, PCIe, and VPX suitable for both COTS commercial and rugged environments. SOSA™ aligned products are available.

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Phasor Innovation provides specialist engineering services to government and industry in the areas of radio frequency (RF), communications and electromagnetics engineering. Our expert capabilities cover all areas of RF related technologies including communications, satellite, radar, electronic warfare, antennas and electromagnetic compatibility. We specialise in custom antenna design, including high performance, wideband and covert antennas for EW and surveillance applications.

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Planar Monolithics Industries, Inc. has been in business for over 30 years as a manufacturer of electronic components for defense applications. Since its founding in November 1989 by Dr. Ash (Ashok) Gorwara, Planar Monolithics Industries, Inc., has become one of the leading suppliers of High Reliable, Low Cost Systems offering unique innovations in RF and Microwave Components and integrated Assemblies from DC to 50GHz. As Co-Founder, President, and CEO of several other successful start-up ventures, Dr. Ash heads a team of Technocrats and Management experts that possess the technology and talent to develop all of the unique products for applications in space, military, communications, telecommunications, commercial, and consumer electronics systems.

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QuantiTech, Inc., founded in 1991, is a Defense and Space industry company headquartered in Huntsville, Alabama with 700+ employees. We deliver superior technical, program, and technology services and solutions to our Government and Commercial Customers in core capabilities: Systems Engineering & Integration; Logistics Engineering; Intelligence and Cybersecurity; Test & Evaluation; Safety & Facilities Engineering, and Business and Program Management. QuantiTech's leadership team has 30+ years of experience executing highly technical and complex programs, delivering on-time and within-budget Prime contract performance across our entire Customer base.

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RADA Technologies, LLC (RADA USA), a subsidiary of Israel-based RADA Electronic Industries Ltd, is a defense electronics company specializing in the production and sales of All-Threat, Air Surveillance radars. RADA USA was established in 2018 to serve the U.S. defense and aerospace markets.

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RADX is a small business developer of the LibertyGT Family of COTS, real-time, scalable, modular, cost-effective software and integrated system solutions for advanced RF Test & Measurement (T&M). RADX also develops the FrontierEQ Family of reference technology and software for OEM SDR/CR applications. RADX is a Silver NI Alliance Member with expertise in real-time FPGA, CPU and GPU-based DSP implementations. Based on COTS PXIe, PCIe and SDR-based COTS, RADX LibertyGT and FrontierEQ COTS Solutions are employed by U.S. DoD, contractors and commercial companies for a wide range of mission-critical RF T&M and SDR/CR applications, including real-time spectrum analysis, multi-channel synchronized, spectrum recording, playback and channel emulation, and advanced, real-time radio T&M and wideband, adaptive SDR/CR systems. For Aerospace, Defence and Educational Customers, RADX products and solution are primarily distributed via TEVET, LLC ([sales@tevetllc.com](mailto:sales@tevetllc.com)).

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Research Associates of Syracuse (RAS), founded in 1986, is a small business in Rome, NY. RAS analyzes, models, designs, develops, and tests software and firmware for Electronic Warfare (EW) subsystems, signal detection, measurement, identification and direction finding applications. Areas of interest include cognitive and machine learning for challenging multi-agile emitters in contested and congested electromagnetic environments. We have experience in digital receivers, system equalization, intentional and unintentional modulation recognition, identification and tracking (e.g. Combat ID). RAS has contracted with multiple DoD organizations, primes, and mid- and small-tier companies. RAS licenses or sells Firmware Cores and software with Application Programming Interfaces.

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## 12<sup>th</sup> Annual Electronic Warfare Capability Gaps and Enabling Technologies



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12-14 MAY 2020

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## SPEAKERS



**Maj Gen Lance Landrum, USAF**

Deputy Director for Requirements and Capability Development (J8), Joint Staff



**Paul G. Zablocky,  
Ph.D.**, Program Manager, DARPA STO



**Mr. Bryan Clark,**  
Senior Fellow, CSBA

## Conference Objective:

The National Defense Strategy and the update to the Chief of Naval Operations Design for Maintaining Maritime Superiority identify the need to deliver warfighting solutions to achieve distributed operations and enable an integrated Naval Force structure as an urgent priority. This year's conference will focus on the Electronic Warfare gaps and enabling technologies required to develop distributed Force Level Electronic Warfare capabilities, integrated with kinetic fires, in order to provide enhanced platform survivability and lethality. EW and military leaders from across the Department of Defense will present EW warfighting gaps and requirements for integrated, multi-domain system of systems EW solutions and motivate the EW community to explore innovative concepts and agile solutions to address their needs. The forum will provide a Joint Services venue for EW professionals across DoD, Industry and Academia to gain insight on emerging technologies, digital engineering methodologies and capabilities that will enable distributed lethality.

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**AOC contact:** Mr. Steve Pilling

Sales Executive

Ultra Electronics Limited - EWST designs and manufactures multi-spectral EW and radar test and evaluations systems for flight line, laboratory and EW Open Range applications. The product portfolio includes battery powered hand held RF/UV/laser flight line confidence test sets (PTS8000), laboratory EW and radar target/ECM simulators (RSS8000 and Chameleon-II), field deployable EW range threat simulator systems with video tracking capabilities (PRS and MERTS).

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#### **AVALON SYSTEMS**

12 Douglas Drive, Mawson Lakes

South Australia, Australia 5095

[www.ultra.electronics.com.au](http://www.ultra.electronics.com.au)

Managing Director Ultra Electronics Australia: Doug Burd

**AOC contact:** Peter Weir

peter.weir@ultra-electronics.com.au

Ultra Electronics Avalon Systems is an Australian based company specializing in the development and integration of EW systems. Key capability areas include COMINT, SIGINT and Specific Emitter Identification, including the detection and processing of LPI signals. The EW systems designed and developed by Ultra Electronics Avalon Systems are used operationally in the Air, Land and Sea domains in Australia and international markets.

## V

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Virginia Beach, VA, USA 23462

Phone: +1 757-962-2545

[www.valkyrie.com](http://www.valkyrie.com)

Chief Operating Officer: Dave Streett  
Vice President, Business Development:  
David Klinedinst

**AOC contact:** Gregg Smith  
[gregg.smith@valkyrie.com](mailto:gregg.smith@valkyrie.com)

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Valkyrie supports Electronic Warfare (EW) and Electromagnetic Spectrum Operations (EMSO) through determining Fleet requirements and assisting with the development of distributed training capabilities to support existing and emerging spectrum-dependent shore/sea/air-based systems. We work extensively with the Systems Commands, Warfare Centers, Program Offices, Type Commanders, and Fleet training stakeholders to provide realistic training for current and future capabilities. Our EW/EMSO Team has over 100 combined years of fleet operational experience in the operation, interaction, integration and development of EW proficiency.

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[sameer.hemmady@verusresearch.net](mailto:sameer.hemmady@verusresearch.net)

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[www.viavisolutions.com](http://www.viavisolutions.com)

**AOC Contact:** Amy Lawrence  
[Amy.lawrence@viavisolutions.com](mailto:Amy.lawrence@viavisolutions.com)

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(GORE)

Performance Solutions Division

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Newark, DE, USA 19711

[www.gore.com/aerospace](http://www.gore.com/aerospace)

**AOC contact:** Greg Powers  
[gpowers@wlgore.com](mailto:gpowers@wlgore.com)

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Phone: +1 603-459-3619

**AOC contact:**

Mr. Stephen "Tango" Tourangeau

[stourangeau@warriorss.com](mailto:stourangeau@warriorss.com)

Warrior Support Solutions, LLC (WSS) remains the premier EW/EMSO authority to the US Armed Forces. We maintain the most up-to-date knowledge of EW/EMSO Plans and Programs. Our reputation is fostered by delivering expert briefings, writing accurate research reports, and providing relevant subject matter expertise to EW working groups. We maintain a network of over 1000 contacts, reaching back to the finest minds in EW/EMSO. In this age of OTA's and Middle-Tier Acquisition opportunities, WSS is a non-traditional Small Business available to partner with other non-traditionals and current DoD EW system providers to generate the most compelling solutions and lucrative business opportunities.

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[www.wgssystems.com](http://www.wgssystems.com)

President and CEO: Bob Wise  
CTO: Kirk Griffin

**AOC Contact:** Byron Parker  
[Byron.parker@wgssystems.com](mailto:Byron.parker@wgssystems.com)

WGS Systems, LLC (WGS) specializes in the design, development and integration of complex systems for military and homeland security in the communications, signals intelligence, electronic warfare, imaging, and data visualization/analytics markets. WGS products have been integrated onto manned and unmanned airborne platforms, fixed, mobile, manpackable terrestrial platforms, and maritime platforms. Our solutions include Communications Intelligence (COMINT), Electronic Intelligence (ELINT), mission management, regional security, and wireless networked communications systems.

## Z

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[www.zargesusa.com](http://www.zargesusa.com)

**AOC contact:** Tracy Johnson  
[Tracy.johnson@zargesusa.com](mailto:Tracy.johnson@zargesusa.com)

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## New EA Techniques (Part 14)

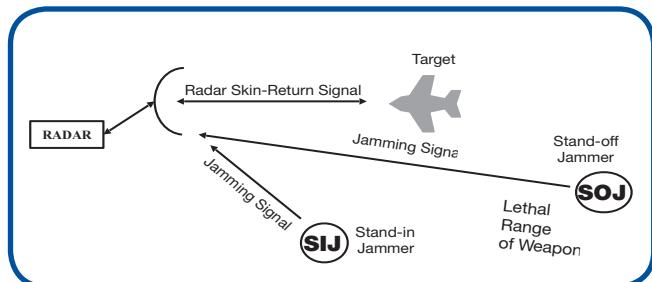
# Anti-Side-Lobe-Jamming Techniques

By Dave Adamy

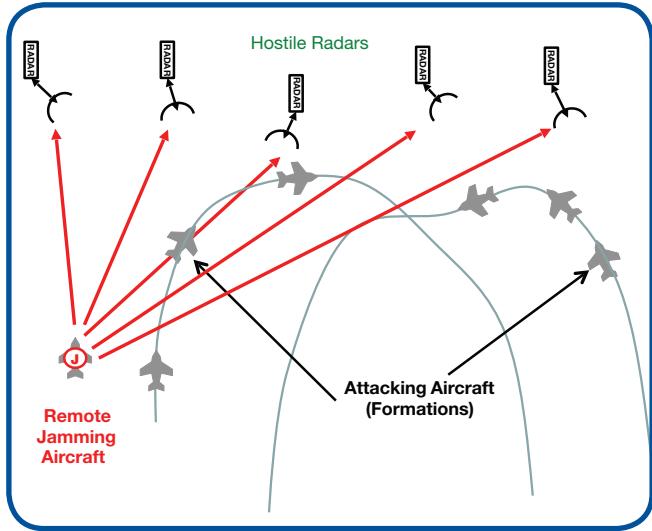
## REMOTE JAMMING

When a jammer is located away from the target that the enemy radar is attempting to track, the jamming energy is received in a side lobe of the radar's antenna. It can be either a stand-off jammer that is farther from the radar than the target, or a stand-in jammer that is closer to the radar than the target. These are shown in **Figure 1**.

In a typical application, a pair of stand-off jammers will cooperatively jam multiple hostile radars to help protect multiple strike aircraft formations through their whole mission as shown in **Figure 2**. Since each of these hostile radars is aimed at individual strike aircraft, they are typically pointed away from the remote jammer. Therefore, the jamming signal



**Fig. 1:** Remote jamming can be stand-off or stand-in. The jammer is not located on the target, and is assumed to transmit into a side lobe of the target jammer.



**Fig. 2:** A remote jammer jams all of the enemy radars within its effective range. The main beam of each hostile radar is aimed at an attacking aircraft, so the jamming signal is received in its antenna side lobe.

will be received in the side lobes of the hostile radar as shown in **Figure 3**.

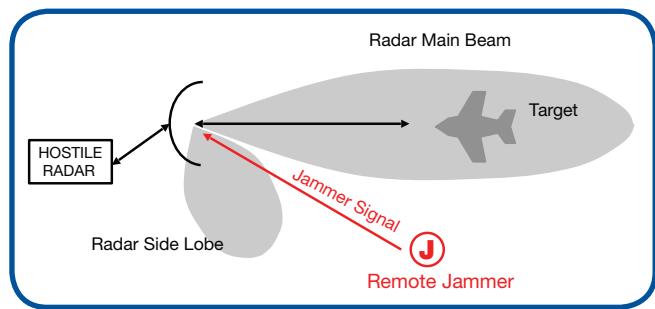
The jamming-to-signal ratio for remote jamming is given by the following formula as described last month:

$$\begin{aligned} \text{J/S} = & \text{ERP}_j - \text{ERP}_s + 71 + G_s - G_m - 20 \log R_j + 40 \log R_t \\ & - 10 \log RCS \end{aligned}$$

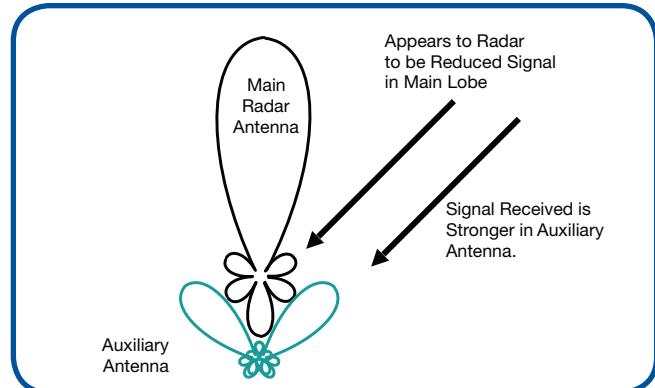
Note that the side-lobe gain is typically 20 dB or more lower than the main beam bore-sight gain.

## COHERENT SIDE-LOBE CANCELLER

**Figure 4** shows a coherent side-lobe canceller Electronic Protection (EP) subsystem. It works against narrowband jamming signals – for example frequency modulated (FM) noise. There are one or more auxiliary antennas optimized for reception of side-lobe signals. Each has more gain in the side-lobe direction than the side lobes of the main radar antenna. **Figure 5** shows this more clearly. Note that the auxiliary antennas have smaller diameters than the main radar antenna, and



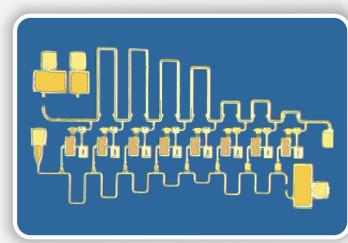
**Fig. 3:** The remote jammer signal is received in a side lobe of the hostile radar's antenna.



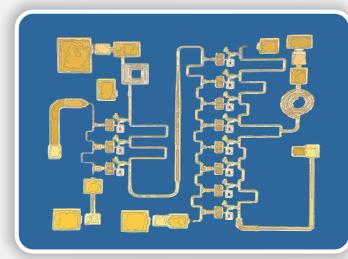
**Fig. 4:** A coherent side-lobe canceller has an auxiliary antenna optimized for reception of side lobe signals.

## New Broadband GaAs MMIC offerings from AMCOM!

**AMCOM's AM06013033WM-XX-R** is a broadband GaAs MMIC which operates between 6 and 13 GHz with 28 dB gain and 33 dBm output power. This MMIC is available in both bare die form (AM06013033WM-00-R) and packaged form (AM06013033WM-EM-R). The EM package is a ceramic package with a flange and straight RF and DC leads for drop-in assembly. The MMIC input and output are internally matched to 50 Ohms.



**AMCOM's AM00020026WM-00-R** is a broadband GaAs MMIC Distributed Power Amplifier die which operates between DC and 20 GHz. This amplifier has 13.5 dB gain, and 26 dBm output power. The chip input and output are internally matched to 50 Ohms.



**AMCOM's AM02018026WM-00-R** is a broadband GaAs MMIC Distributed Power Amplifier die which operates between 2 and 18 GHz. This amplifier has 23.5 dB gain, and 26 dBm output power. The chip input and output are internally matched to 50 Ohms.

## New Release! Compact SSPAs

Compact Power Amplifiers  
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## GaAs MMIC PAs

Model	Freq(GHz)	Gain(dB)	P1dB(dBm)	Psat(dBm)	Eff(%)	Vd(V)
AM003536WM-XX-R	0.01-3.5	23	35	36	20	20
AM002535MM-XX-R	0.03-2.5	24	34	35	25	20
AM012535MM-XX-R	0.03-2.5	20	33	33.5	20	20
AM009023WM-XX-R	0.05-9	21	21	23	20	12
AM008030WM-XX-R	0.05-10	18	30	31	20	12
AM012020WM-XX-R	0.1-2	30	16	17	8	8
AM011037WM-XX-R	0.2-1.0	31	37	37.5	40	8
AM103026MM-XX-R	0.9-3.2	22	25	26	10	14
AM132740MM-XX-R	1.3-2.7	26	38	39	30	14
AM142540MM-XX-R	1.4-1.8	25	39	40	35	14
AM153040WM-XX-R	1.4-3.4	18	37	38	30	12
AM143440WM-XX-R	1.5-1.8	20.5	38.5	39	35	12
AM143438WM-XX-R	1.5-1.8	20.5	37.5	38	30	12
AM153540WM-XX-R	1.5-3.5	18	39	39.5	35	14
AM183030WM-XX-R	1.6-3.3	30.5	30.5	31.5	20	8
AM183031WM-XX-R	1.6-3.3	31.5	31.5	32.5	25	8

## GaN MMIC PAs

Model	Freq(GHz)	Gain(db)	Psat(dBm)	Eff(%)	Vd(V)
AM00010037WN-00-R	DC-10	13	37	25	28
AM00010037WN-SN-R	DC-10	13	37	23	28
AM003042WN-00-R	0.05-3	24	42	35	40
AM003042WN-XX-R	0.05-3	23	42	33	40
AM206041WN-00-R	1.8-6.5	32	42	27	28
AM206041WN-SN-R	1.8-6.5	30	41	23	28
AM408041WN-00-R	3.75-8.25	33	42	27	28
AM408041WN-SN-R	3.75-8.25	31	41	23	28
AM07512041WN-00-R	7.75-12.25	28	42	27	28
AM07512041WN-SN-R	7.75-12.25	27	41	22	28
AM08012041WN-00-R	7.5-12	22	42	20	28
AM08012041WN-SN-R	7.5-12	21	41	20	28

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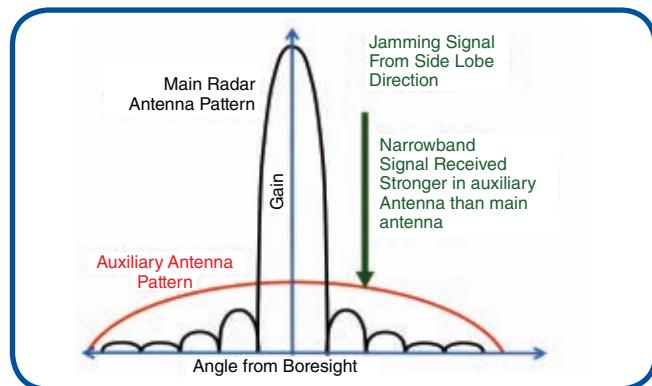
therefore have both less gain and wider beamwidth. As you can see from this drawing, the gain of this antenna at the frequency of each side lobe is above the gain of the side lobe.

As shown in **Figure 6**, each of the auxiliary antennas feeds a phase-locked loop which recreates the received jamming signal with a  $180^\circ$  phase shift. This phase-shifted signal is added to the output of the radar antenna, thereby cancelling the signal received in that. There must be one auxiliary antenna for each side-lobe jamming signal that is cancelled.

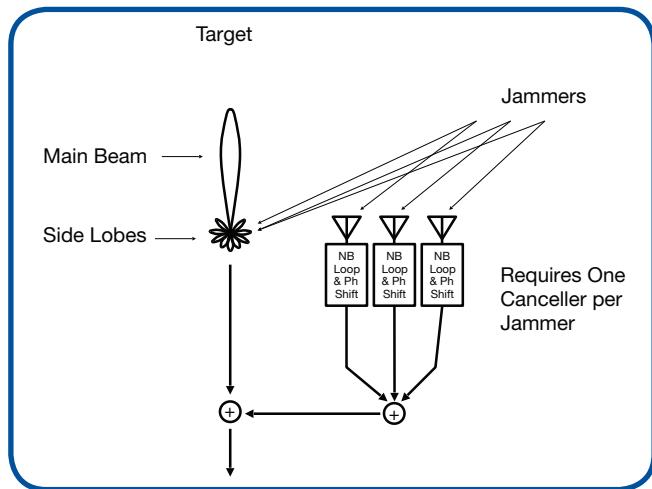
The spectrum of a pulsed signal looks like an array of many continuous wave signals. Therefore, random pulses can be added to FM noise to effectively create a large number of narrow-band signals. This can cause a limited number of auxiliary antennas to be tied up on the spectrum lines and prevent them from cancelling FM jamming signals.

### WIDE-BAND SIDE-LOBE JAMMING SIGNALS

A pulsed signal has a much wider frequency spectrum than an FM signal, as described above, but it is present only during a short period (the pulse duration). Thus, if the radar antenna output is turned off during that short period, the signal is eliminated from the input. This technique, called Side-Lobe Blanking, is used to counter pulse jamming into the side lobes.



*Fig. 5: The auxiliary antenna has more gain in the side-lobe directions than the side lobes. Note that a smaller antenna has a narrower beamwidth and less gain.*



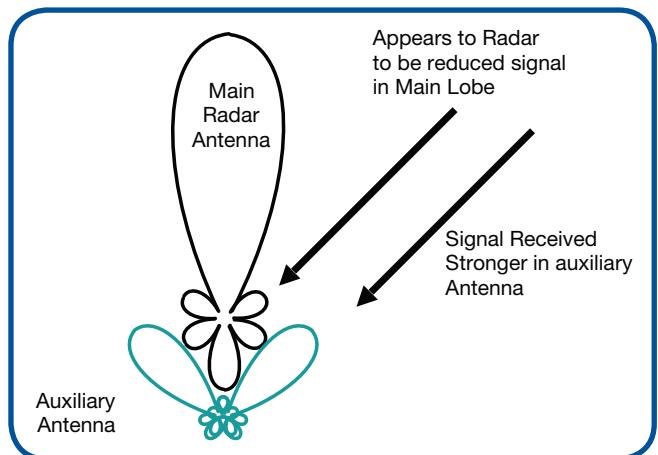
*Fig. 6: A coherent side-lobe canceller has multiple auxiliary antennas. Each receives a single jamming signal and produces a  $180^\circ$  shifted version of that signal to cancel that signal in the radar output.*

As shown in **Figure 7**, an auxiliary antenna with more gain in the side-lobe directions than the gain of the main antenna lobes can detect side-lobe pulse jamming. As shown in **Figure 8**, the auxiliary antenna can be used to drive a switch at the output of the radar antenna to turn the antenna output off during the brief period that the jamming pulse is present.

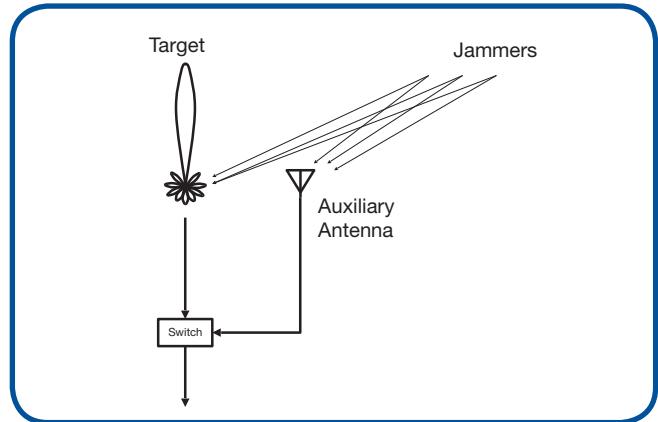
An approach to countering this EP technique is to generate cover pulses which cover the hostile radar's arriving skin return pulses. This will cause the side-lobe blunker to blank the radar's own signal. The timing of these cover pulses must be such that they arrive at the hostile radar at the same time as the skin return pulses from the target that is tracked. This requires complex calculation to account for the radar-to-target to jammer geometry. The math can be simplified by generating fairly long cover pulses at the expense of reduced jamming efficiency.

### WHAT'S NEXT

Next month, we will start a new series. This series will return to the Space EW series we began in the June 2016 to October 2017 JEDs. We will add information on the vulnerability of space-based intercept and jamming systems. For your comments and suggestions, Dave Adamy can be reached at dave@lynxpub.com.



*Fig. 7: A side-lobe blunker has an auxiliary antenna favoring the side-lobe directions. It detects wide-band (i.e., pulse) jamming signals from side-lobe directions.*



*Fig. 8: A side-lobe blunker processes the output of the auxiliary antenna to blank the output of the main radar antenna when the auxiliary antenna output is greater than that from the main radar antenna.*



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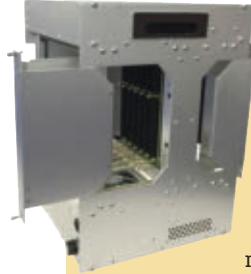
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# new products

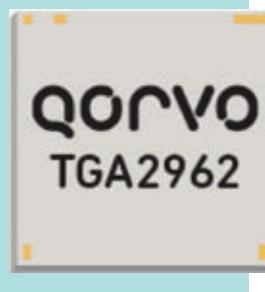


## OPENVPX DEVELOPMENT CHASSIS

Pixus Technologies has released a new version of its VPXD1000 series development chassis that allows for VITA 67 slot configurations for RF interferences over OpenVPX. The new chassis measures 12.6 in. wide, designed to allow for higher slot backplanes, up to ten slots at 1-in. pitch. Due to its size, the chassis can also be partitioned, using one segment for specialty RF devices or SOSA (Sensor Open Systems Architecture) implementation. *Pixus Technologies; Waterloo, Ontario, Canada; +1 (519) 885-5775; www.pixustechologies.com.*

## WIDEBAND GAN POWER AMPLIFIER

Qorvo has announced the release of the TGA2962, a 10-W GaN wideband power amplifier, designed for electronic warfare (EW), radar and test instrument applications. The TGAA2962 offers a frequency range of 2-20 GHz and 13dB large-signal gain, and was developed to provide 20-35% increased power efficiency. The power amplifier has also been designed with size constraints in mind, measuring 3.24 x 3.24 mm. *Qorvo, Inc.; Greensboro, NC, USA; +1 (972) 994-8546; www.qorvo.com.*



## A/D AND D/A CONVERTER

Pentek has introduced the Quartz Model 5550 eight-channel analog-to-digital (A/D) and digital-to-analog (D/A) converter 3U OpenVPX board with the Xilinx Zynq UltraScale+ RFSoC FPGA. The Model 5550 is designed for communications, electro-optical, electronic warfare (EW), radar and signals intelligence (SIGINT) applications, and offers eight 4 GSPS, 12-bit A/D converters and eight 4 GSPS, 14-bit D/A converters. *Pentek, Inc.; Upper Saddle River, NJ, USA; +1 (480) 488-6909; www.pentek.com.*



## GEN 3 SWITCH

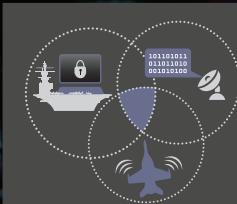
Mercury Systems has added a new gen 3 switch to its EnsembleSeries OpenVPX PCI Express (PCIe) family of switches. The SFM6126 is intended as a composable data center edge processing architecture for aerospace and defense applications, specifically for use in space-constrained, harsh operating environments. The 6U modules are able to switch both the control and expansion planes to support the inter-module data distribution architecture required by high-performance OpenVPX high-performance embedded edge computing (HPEEC) subsystems. The SFM6126 aims to provide the performance of a data center without the constraints of a data center, allowing for the deployment of next-generation autonomous platforms, cognitive electronic warfare (EW) systems, compute-intensive electro-optical/infrared (EO/IR), active electronically scanned array (AESA) Radar, artificial intelligence (AI) and sensor fusion applications. *Mercury Systems, Inc.; Andover, MA, USA; +1 (978) 967-1366; www.mrcy.com.*



## RF ANALYSIS AND PLAYBACK SYSTEM

Gigatronics has released a new fully coherent multi-channel streaming RF capture, analysis, storage, and playback system, available immediately. The Coherent Multi-Channel Playback, Acquisition & Storage System (COMPASS) is designed for use at all levels of system design, development, verification, validation and operational testing of radar and electronic warfare (EW) systems. Applications for this system include coherent electronic attack development/tests, DRFM-based jammer technique development/tests and advanced coherent EW technique development. COMPASS incorporates Gigatronics's AXIe based Advanced Signal Generation and Advanced Signal Analysis subsystem, which provides multichannel operation of both the RF Receiver front end and the RF upconverter. The subsystem offers a large RF operating range and high instantaneous bandwidth (1 GHz IBW @ RF/Microwave, 2 GHz IBW @ direct to digital), and the system as a whole offers flexibility, configurable for Capture and Analysis only, Streaming RF Playback only, or both combined in a single system. *Gigatronics, Inc.; Dublin, CA, USA; +1 (661) 714-1944; www.go-asg.gigatronics.com.*





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- Cyber/Electronic Warfare Advanced Technology    • Cyber/Electronic Warfare R & D

Abstracts for presentations must be unclassified and no more than one page of text or 400 words.

Please forward unclassified abstracts to Christine Armstrong at [armstrong@crows.org](mailto:armstrong@crows.org) and Dave Walman at [david.walman@navy.mil](mailto:david.walman@navy.mil) NLT March 30, 2020. If your abstract is selected, you will be required to send a classified abstract/briefing to Dave Walman for final review before being accepted into the agenda.

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## GRANITE STATE CHAPTER AWARDS SCHOLARSHIPS



The Granite State Roost Educational Foundation awarded three scholarships to three University of New Hampshire (UNH) engineering students at the Awards Ceremony held at UNH on 27 September 2019.

The scholarship is named after the Pentagon's former Deputy Director for Electronic Warfare, Tony Grieco. BAE Systems underwrites the scholarship in honor of Grieco, who was well known in defense and Congressional circles for his strong support of electronic warfare issues. The scholarship is given to candidates who show promise in science and engineering, and who are enrolled in a college-level science or engineering program.

Pictured from the left is Mr. Tom Perkins, BAE Systems, Mr. Davis Cole, Mr. Noah Payeur, Mr. Francesco Mikulis-Borsoi, and Mr. Stephen Yushak, Scholarship Chairman.

## 2020 AOC AWARDS NOMINATIONS DUE MARCH 15

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## APPLICATIONS FOR \$12,500 AOC/RAYTHEON SCHOLARSHIPS DUE MARCH 31

A fundamental part of the AOC's mission is investing in the next generation of Crows. One of the most significant ways we do this is by providing the AOC/Raytheon Scholarship to sophomore and junior year college students. We provide two scholarships annually, each in the amount of \$12,500, to students studying in the fields of engineering or engineering technology. These scholarships are funded by a generous donation from Raytheon.

Do you have a child, sibling, cousin, neighbor or friend studying in these fields? Encourage them to apply! Applicants must be sophomores or juniors in the 2020-2021 school year. Tell them not to wait; submissions are due by March 31, 2020.



## SUBMIT NOMINATIONS FOR THE 2020 AOC BOARD OF DIRECTORS BY MARCH 15!

Decide the future of the Association of Old Crows! Nominations for the AOC board of directors for the 2020 elections are ending soon! For regional directors, only members from that region are eligible to vote for their potential representative. Nominations are due NLT March 15, 2020. Positions that are eligible for election this year are:

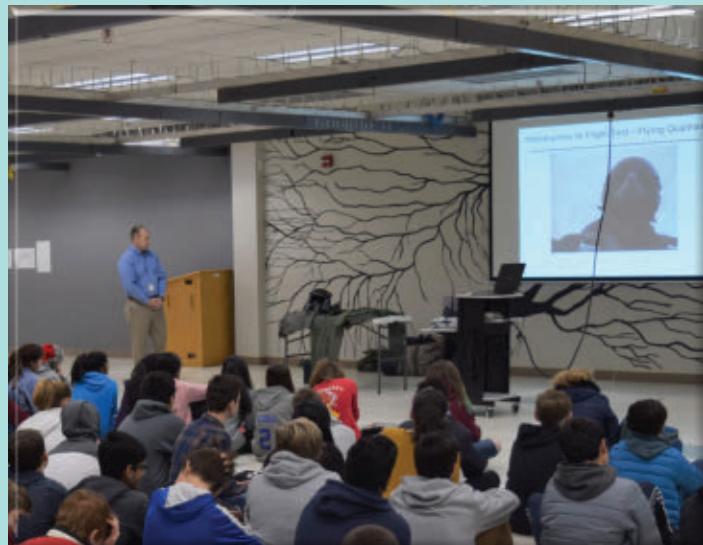
- At-Large Director (2 available)
- International Region II
- Northeast Region
- Southern Region

Go to [www.crows.org/page/elections](http://www.crows.org/page/elections) to download the nomination form, or contact [oneilin@crows.org](mailto:oneilin@crows.org) for more information.

## GRANITE STATE ROOST PROMOTES STEM THROUGH OUTREACH

The Academy for Science and Design in Nashua, NH recently hosted the AOC Granite State Roost's Earl "Skip" Stoltz at their biannual da Vinci Day, an outreach event where academia and industry partner to promote Science, Technology, Engineering and Mathematics (STEM) careers to students. Skip gave a presentation titled "Faster, Higher, Farther – Testing Aircraft to the Edge" to over 100 seventh- and eighth-grade students. In addition to the variety of questions Skip answered about aircraft and how STEM impacted his career path, the students loved trying on his flight gear!

If you have any interest in getting more involved with the Granite State Roost's STEM outreach program, please reach out to Matt Partridge at [mattthew.y.partridge@baesystems.com](mailto:mattthew.y.partridge@baesystems.com) or Jack Shepard at [jack.shepard@baesystems.com](mailto:jack.shepard@baesystems.com).



## DIXIE CROW CHAPTER HOSTS RECRUITMENT/RETENTION EVENT

The AOC Dixie Crow chapter welcomed 2020 with a band! The Retention/Recruitment Social at Wild Wing Café on 30 January had 98+ people in attendance. Ten new members were recruited on the spot with a commitment of more to follow over the following days.

The event was full of great food and beverage along with fantastic music provided by our local sensation: The "Calipers," with Gene "Joker" McFalls on guitar and vocals, Caleb Ringley on guitar, Jeff Sawyer on bass and Vic Dunston on drums.

The Dixie Crows host Retention/Recruitment events quarterly. If you're traveling to Robins AFB, drop Robert a note to see where we may be going next! Email: [robert.usher@gmail.com](mailto:robert.usher@gmail.com)



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## GRANITE STATE ROOST HOSTS ANNUAL HOLIDAY PARTY

The AOC Granite State Roost NH chapter held their Holiday party on 13 December at the Nashua Country Club. Attendees enjoyed dinner, hors d'oeuvres and dessert in the beautifully decorated venue before the "Yankee Swap" gift exchange. A few gifts were passed around several times, and there were a few unexpected gifts that appeared to make the night even more interesting!

Awards were given to the event sponsors, BAE Systems (Platinum), Mercury Systems (Silver) and Warrior Solutions (Gold).

Granite State Roost has several events lined up for 2020, including a curling event, a Fisher Cats game, MS MT Washington dinner cruise on Lake Winnipesaukee, and another holiday party to end the year. Tech Talks will

also be sprinkled among these events. Become a member today to receive emails about these great events!

The Granite State Roost maintains a strong commitment to advancing knowledge of Electronic Warfare and Electromagnetic Spectrum Operations (EMSO) by inspiring local industry to contribute their skills and products to serve the EW Com-



## THE PASSING OF A CROW: JAMES "BIG JIM" TALLEY (1939-2020)

Dedicated Old Crow and Senior Convention Volunteer, Jim Talley has passed. Jim was a great man who dedicated his life to the safety of America's warriors in war and peace. He was a member of the Association of Old Crows since joining in 1972. At first, it was to understand the complexities of his duties as a Naval Officer and later to enhance his work in highly classified electronic warfare research and development at the US Naval Research Lab (NRL). Like so many others working on classified projects, the scope of his many contributions to the field of EW cannot be published.

Upon retiring, he was determined to continue his work by consulting and volunteering with the Old Crow's Capitol Club. He volunteered for the last decade to attend, provide guidance, and support the annual International Symposium and Convention in Washington, DC. Jim proudly directed specific activities while, behind the scenes, discussing technical matters with briefers and participants. His inputs would add clarity and a richness to those presentations that otherwise would not have been had.

Jim Talley was truly an Old Crow's Old Crow. His many contributions to the Capitol Club and to the men and women of the armed forces may never be fully known. But Jim Talley's true dedication to the craft of electronic warfare, the Association of Old Crows, and to the Capitol Club will be greatly missed.

munity. The Granite State Roost continues to provide opportunities for interaction among its membership by holding social events throughout the year.

For additional information about the Granite State Roost, contact the chapter president, Mr. Duane Beaulieu, at [duane.a.beaulieu@baesystems.com](mailto:duane.a.beaulieu@baesystems.com). ↗





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<https://www.pmi-rf.com/product-details/rsm-618-65>

- Broadband Frequency Coverage
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- Includes DC-Coupled Log Video Amplifier
- DC-Coupled Frequency Discriminator
- Video Outputs:

**RSM-218-65:** 2.0 GHz to 4.0 GHz, 4.0 to 6.0 GHz, 6.0 to 10.0 GHz, 10.0 to 14.0 GHz, and 14.0 to 18.0 GHz

**RSM-618-65:** 6.0 GHz to 10.0 GHz, 10.0 GHz to 14.0 GHz and 14.0 GHz to 18.0 GHz

#### SPECIFICATIONS

Frequency Range	RSM-218-65: 2 -18 GHz RSM-618-65: 6 - 18 GHz
Frequency Flatness	$\pm 2.5$ dB Max, $\pm 1.75$ dB Typ
Dynamic Range	-65 dBm to 0 dBm
LOG Linearity	$\pm 2.5$ dB Max
VSWR Input	3.0:1 Max @ -20 dBm, 2.5:1 Typ
Tangential Sensitivity	-68 dBm Max
LOG Video Output	Rise Time: 25 ns Max Slope: 50 mV/dB ( $\pm 10\%$ Max)
RF Input Power	+15 dBm
Power	+15 VDC @ <950 mA (850 mA Typ) -15 VDC @ <450 mA (275 mA Typ)
Frequency Discriminator	Accuracy: $\pm 300$ MHz Max, $\pm 200$ MHz Typ Slope: $\pm 50$ mV/GHz ( $\pm 10\%$ Max)
Physical	Connectors: SMA Female Size: 5.5" x 9.6" x 1.5"



### Direction Finding Modules

#### LBDFM-052-BD-DP & HBDFM-218-BD-DP

<https://www.pmi-rf.com/product-details/lbdfm-052-bd-dp>  
<https://www.pmi-rf.com/product-details/hbdfm-218-bd-dp>

- Low Band (0.5 - 2 GHz) & High Band (2.0-18.0 GHz) Configurations
- Uni-Directional, Multi-Function Device that routes the signal present at the RF Input Connector through one of its four channels to the RF Output Connector, to amplitude modulate the input signal.
- Input and output ports can be switched to internal 50 Ohm terminations to ensure matched source and load impedance for interfacing devices during off-times and Isolation or VSWR tests.



#### SPECIFICATIONS

Frequency Range	LBDFM-052-BD-DP: 0.5 - 2.0 GHz HBDFM-218-BD-DP: 2.0-18.0 GHz
RF Input Signal Level Range	
<b>LBDFM-052-BD-DP:</b> +5 dBm to +8 dBm Typ, +10 dBm Max	
<b>HBDFM-218-BD-DP:</b> 0 dBm to +3 dBm Typ, +6 dBm Max	
RF Input Spectral Purity	
Input Spurious Levels: - 60 dBc Max	
Input Harmonic Levels: - 10 dBc Max	
RF Input Signal-To-Noise Ratio: 70 dB Min	
RF Output Power Level & Gain Compression:	
<b>LBDFM-052-BD-DP:</b> Power Out = +14 dBm Min at all frequencies with Input Power = +5 dBm and Attenuation set at minimum, Gain Compression at 0.9 dB Max	
<b>HBDFM-218-BD-DP:</b> Power Out = +21 dBm Min at all frequencies with Input Power = +0 dBm and Attenuation set at minimum, Gain Compression at 0.9 dB Max	
Physical	Connectors: SMA Female Size: 6.9" x 2.48" x 0.85"

### Digital Frequency Discriminator (DFD)

#### DFD-2G18G-5512

<https://www.pmi-rf.com/product-details/dfd-2g18g-5512>

- Broadband frequency coverage (2 to 18 GHz)
- Incorporates conduction cooling and the ability to be mounted via screw holes located on the underside of the unit or via the wedge locks located at the top of the unit.



#### SPECIFICATIONS

Frequency Range	2.0 to 18.0 GHz
Frequency Accuracy	3 MHz (Peak RMS) @ 3 dB SNR Typ
Peak Frequency Error	15 MHz
Linear Bandwidth	16 GHz
Dynamic Range	-50 to +15 dBm
Max Input Power, Survival	+17 dBm CW
Mean Frequency Resolution	1 MHz
Recovery Time (After High Power Pulse Input)	100 ns Max
Control Logic:	14-Bit TTL Digital Output (Single Ended)
Physical	RF Connectors: SMA female Power/Control: 51-Pin Micro-D Calibration/Test: 15-Pin Micro-D Size: 5.98" x 5.79" x 1.28"

### Analog Frequency Discriminator

#### FD-0518-10-118

<https://www.pmi-rf.com/product-details/fd-0518-10-118>

- 1.0 to 18.0 GHz frequency coverage
- Six Output Channels, Voltage vs Frequency
- Modular Design and Rugged Construction



#### SPECIFICATIONS

Frequency Range	1.0 to 18.0 GHz
Output Channels (6)	Channel 1: 1 to 2 GHz Channel 2: 2 to 4.2 GHz Channel 3: 4.2 to 6.1 GHz Channel 4: 6.1 to 8.7 GHz Channel 5: 8.7 to 12.5 GHz Channel 6: 12.5 to 18 GHz
Input VSWR:	2.0:1
Video Output Rise/Fall Time	20 ns Max
Video Impedance	100 $\Omega$
Operating Input Power	+10 $\pm$ 0.1 dBm
Accuracy:	$\pm 300$ MHz Typ, $\pm 450$ MHz Max
Physical	RF Connectors: SMA female TTL Control Connector: DB9 Size: 8.5" L x 5.0" W x 3.75" H

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