Department of the Navy SBIR/STTR Transition Program

Pending SYSCOM Review

Topic # N172-110
Virtual Antenna Array Mapping
Vadum

WHO

SYSCOM: NAVAIR

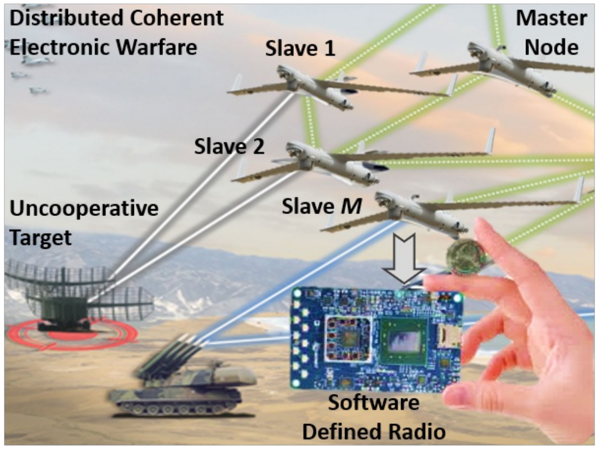
Sponsoring Program: PMA-234 Airborne Electronic Attack Systems

Transition Target: An external carriage electronic warfare weapon system

TPOC:
(805)989-8193

Other transition opportunities: The technology could be integrated into small tactical unmanned aircraft systems and electronic warfare drones.

Notes: Distributed Coherent Electronic Warfare (DCEW) protocol enables swarms of Size, Weight, and Power (SWAP) constrained nodes (e.g. Group I-III Unmanned Aerial Systems, UAS) to collectively jam an uncooperative emitter. A distributed phased array is implemented using Software Defined Radios (SDR) to achieve time, frequency, and phase synchronization.



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WHAT

Operational Need and Improvement: High performance phased array antennas are necessary due to their focused beam behavior that not only increase data rate and communication range, but also enable secure links. However, today's phased array antennas are rigid in nature, bulky (100s of pounds), expensive (>$10M per unit), and use too much power (100s of kW) in the battlefield. There is a need to develop a technology that takes any ad-hoc antenna array, such as antennas mounted on UAVs, and map the fields into a virtual phased array antenna without changing the original antenna array random layout.

Specifications Required: The DCEW protocol should be implemented in a minimum of 3 UAVs moving in excess of 10 miles per hour using SDRs to demonstrate the beam-focusing capability to a target node even though the vehicles are moving. During this phase a demonstration of the ability to control the beam (broadening, narrowing, and dynamic pointing) should occur. Further development will include a minimum of 5 UAVs moving in excess of 40 miles per hour. During this phase a demonstration of various waveform types including continuous wave (CW), pulsed, and swept will occur. In both Phases the algorithms may use the Global Positioning System (GPS).

Technology Developed: The Vadum DCEW protocol implements a Master-Slave architecture to achieve time, frequency, and phase synchronization with a minimum of intra-cluster overhead and no upper limit on UAS cluster size. An efficient transceiver design eliminates the need for complex timing and carrier recovery techniques. Retrodirective beamforming is achieved without the use of GPS. Phase synchronization is achieved using a novel hybrid of proven techniques, which enables the DCEW protocol to synchronize to an uncooperative target (i.e. a radar) in a single beam dwell.

Warfighter Value: UAS have the potential to penetrate increasingly sophisticated air defenses with less risk to human pilots and costlier aircraft. This technology enables an ad-hoc collection of SWAP-constrained nodes to coherently beamform, thus achieving higher stand-in jammer to signal power ratio (J/S), increased communication range/data rate, and lower probability of interception/detection (LPI/LPD). This is done with less power and less cost than associated with a traditional phased array.

WHEN

Contract Number: N68936-19-C-0021 **Ending on:** February 15, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Bench Top Wired Testing	N/A	Achieved expected signal gain, demonstration of DCEW convergence and retrodirective beamforming	3	February 2019
Indoor Static Wireless Testing	Med	Firmware integration, successful demonstration of major DCEW components	4	February 2020
Outdoor Static Wireless Testing	Med	System integration, demonstration of real-time DCEW convergence, telemetry capture, and tolerance to electromagnetic interference	4	August 2020
Airborne Demo - 3 Nodes, >10 mph	Med	Achieve and maintain expected gain with minimal fading, demonstrate beamforming using multiple cluster configurations	5	February 2021
If Option Exercised, Airborne Demo - 5 Nodes, >40 mph	Med	Demonstrate additional electronic warfare techniques against realistic threat waveforms	6	February 2022

HOW

Projected Business Model: For low rate initial production (LRIP), Vadum can manufacture DCEW nodes as standalone or integrated payloads for small UAS. Once proven, further commercialization of DCEW technology would most likely involve per-unit licensing of intellectual property (IP) blocks for implementation in specific UAS EW and Intelligence, Surveillance, and Reconnaissance (ISR) payloads.

Company Objectives: We anticipate the Navy SBIR/STTR Transition Program (STP) Forum will facilitate connecting with a prime or system integrator that wishes to add DCEW technology to an existing UAS swarm platform. Our short-term objective is to meet the needs of our program sponsor and apply DCEW technology to at least one Navy program of record. Future objectives include adapting DCEW technology to distributed coherent communications for other DoD customers. DCEW technology aligns with Vadum research and development of novel electronic warfare algorithms and software. Vadum is actively participating in DARPA's Adaptive Radar Countermeasures (ARC) program.

Potential Commercial Applications: DCEW technology is ideal for many wireless communications and networking applications. Ad-hoc beamforming can leverage dense hardware deployments, such as WiFi and Internet of Things (IoT), to reduce interference and increase transmission range. Conformal and ad-hoc phased array antennas can be implemented on vehicles, ships, or buildings with less cost and complexity. Additional military applications include LPI/LPD communications in congested and contested environments. Successful technology development could assist in multitude of situations where there is insufficient radio frequency (RF) power to communicate through a link where a commercial example is high-altitude assets like Google's Project Loon.

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