Missile Defense Agency SBIR/STTR Industry Day

Radar Research Area

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Agenda

- Research Area Objectives
- Topics
- Topics Overview
- Questions

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Radar Research Area Objectives

Provide subsystem improvements to enhance BMDS Radar performance for emerging threats to support existing and future radar systems through sensitivity, bandwidth, discrimination, countermeasure mitigation, open systems architecture, scalability, packaging and affordability.

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08.3 Radar SBIR Topics

- Wideband RF Beamformer
- High Power RF-MEMS Phase Shifters for Phased Array Antennas
- Calibration Techniques for Very Large Arrays
- Wide Bandgap Semiconductor Power Inverters and Converters for Next Generation Transmit Receive (T/R) Module Power Supplies
- Multi-static Sea-Based Radar Registration and Communication Methods
- Wideband Sub-Array Digital Receiver Exciter (DREX) Development and Packaging
- Innovative Hardware Technologies for Anti-Jam and Electromagnetic Attack Rejection in Ballistic Missile Defense System (BMDS) Radars

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08.3 Radar STTR Topics

- Innovative Photonic Time Delay Units for Radar Applications
- Innovative Thermal Management Solutions for Radar Transmit Receive (T/R) Modules

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SBIR Topics Overview (Cont)

"Wideband RF Beamformer"

Objective: Design an RF beamformer that provides 10 or more simultaneous independent RF beams for a 2:1 bandwidth phased array antenna.

Supplemental Information:

- The digital approaches to a wideband array require a massive amount of RF and Digital hardware. The optical approaches are good in that they handle multiple Gigahertz in each beam but can be lossy.
- The beamformer can be designed as receive only or combination transmit and receive system, with a combination system desired. One dimensional scan of a phased array is acceptable with a 2 dimensional scan desired. Instantaneous bandwidth greater than 60 MHz.
- The beamformer should work with a minimum scan of +/- 60 degrees for each beam.

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SBIR Topics Overview

"High Power RF-MEMS Phase Shifters for Phased Array Antennas"

Objective: Develop and demonstrate high-power Radio Frequency Micro Electro-Mechanical Systems (RF-MEMS) phase shifters for X-band phased array applications.

Supplemental Information:

- RF-MEMS-based phase shifters bring the potential of low insertion loss per bit and ultra-linear performance while requiring very low operating power.
- The goal of this program is to utilize RF MEMS devices having improved reliability in X-Band (8-12 GHZ) phase shifter networks.

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SBIR Topics Overview (Cont)

"Calibration Techniques for Very Large Arrays"

Objective: Develop calibration techniques for very large x- band phased array antennas larger than 10 square meters

Supplemental Information:

- These arrays are built up from Sub array panels on the order of .25 to .5 square meters. Each sub array or panel may have as many as 1000 elements or more
- There are many error sources that can occur in the process of using many beams in a large array; these include but are not limited to; panel alignment, fabrication errors, failed elements, thermal expansion vibrations from the pedestal and or air vehicle
- The solution should provide techniques that can be implemented to reduce the time to calibrate the array and can adapt to varying conditions. The calibration technique should also have a minimum impact on the phased array hardware

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SBIR Topics Overview (Cont)

"Wide Bandgap Semiconductor Power Inverters and Converters for Next Generation Transmit Receive (T/R) Module Power Supplies"

Objective: Develop and demonstrate wide bandgap semiconductor electronic components for supporting high voltage operation of next generation X-band T/R modules

Supplemental Information:

- The intrinsic properties of gallium nitride (GaN) make it ideal for use in next generation microwave/millimeter wave radar applications
- Use of wide bandgap semiconductors power switching devices could improve system performance and efficiency by enabling an 8X increase in switching frequency, reduced power conversion loss, adaptive digital control, reduced size and weight and increased level of integration.

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SBIR Topics Overview (Cont)

"Multistatic Sea-Based Radar Registration and Communication Methods"

Objective: Conduct research and development of multi-static sea-based radar registration and communication methods, and associated aperture coherence , correlation and optimization methods.

Supplemental Information:

- Effective sea-based multistatic, geometrically separated radar operations increase battlespace effectiveness through improved detection, tracking, and identification
- Innovative concepts are sought in the fields of communications and radar signal processing that identify and create methods of desensitizing or compensating the system from the rotational and translation registration errors.

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SBIR Topics Overview (Cont)

"Wideband Sub-Array Digital Receiver Exciter (DREX) Development and Packaging

Objective: Develop and demonstrate small sized wideband DREX technology for next generation X-band Radar Systems

Supplemental Information:

- Next Generation BMD X-Band Radar Systems are anticipated to utilize highly digitized sub-arrayed digital beam-forming (DBF) architectures.
- This type of architecture will require multiple DREX channels, scalable from 10s to 100s of channels. Cost, Size, Weight, and Power (CSWAP) of current state-of-the-art Radar DREX technology make implementing these highly digitized architectures prohibitively expensive.
- The architecture and interfaces should utilize open system (OS) principles to the maximum extend feasible to enable ease of integration and scalability.

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SBIR Topics Overview (Cont)

"Innovative Hardware Technologies for Anti-Jam and Electromagnetic Attack Rejection in Ballistic Missile Defense System (BMDS) Radars"

- **Objective: Identify, develop, and demonstrate novel or innovative advances in anti-jamming and electromagnetic attack protection hardware technologies that will support existing BMDS X-band, S-band, and other radar systems as well as communication and GPS systems**

- **Supplemental Information:**
  - **The focus of this research is to develop and demonstrate hardware technologies that provide protection and/or mitigation of the radar from jamming, high power microwave (HPM), ultra wide band (UWB), and electromagnetic pulse (EMP) attacks and at the same time improve signal-to-noise ratio (SNR) with minimal insertion loss.**
  - **Developing and demonstrating hardware technologies to defeat evolving advanced Active Electronic Counter Measures (ECM) and high-power (> 10 kW/cm2), fast-rise-time (< 5 ns) HPM, UWB, or EMP attacks through the radar front end.**
  - **Key areas of research interest include pulse limiters, advanced noise filtering devices, as well as other hardware devices for increasing signal-to-jamming or signal-to-clutter ratios.**
  - **Of particular interest are passive devices capable of increasing the signal-to-noise ratio and/or providing the required ECM/HPM/EMP protection.**

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STTR Topics Overview

"Innovative Photonic Time Delay Units for Radar Applications"

Objective: Develop and demonstrate an innovative photonic time delay unit technology providing improved wideband radar performance

Supplemental Information:

- Photonic time delay units offer improved wide bandwidth performance, smaller size, reduced power consumption, and greater stability
- This new generation of time delay units will be required to demonstrate the required performance levels in a packaging format compatible with current and future BMDS radars.
- The required performance must be maintained during normal operation and at environmental operating condition extremes typical of MDA radar systems

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STTR Topics Overview (Cont)

"Innovative Thermal Management solutions for Radar T/R Modules"

Objective: Develop and demonstrate low cost, manufacturable, chip-level thermal management solutions to reduce the operational temperature of high power RF power amplifiers

Supplemental Information:

- Next generation T/R modules based on gallium nitride semiconductor technology holds promise for revolutionary improvements in the cost, size, weight and performance of radar T/R modules.
- This new generation of high power microwave devices faces significant thermal challenges due to ever increasing power densities. GaN power amplifiers are capable of operating at several times the power density of GaAs based devices. Due to its relatively low thermal conductivity, GaN is unable to effectively remove heat generated during device operation.
- Efficient thermal management is essential for minimizing thermal energy near the transistor's active channel. Innovative concepts are sought that address thermal management challenges associated with GaN based T/R module technology.

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The End

Questions

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