



# Missile Defense Agency SBIR/STTR Industry Day

## 2009 Radar Research Area

Hank Barcikowski  
MDA/DV Sponsor

Marty Sargent  
Research Area Lead

12 August 2009



# Agenda

---



- Research Area Objectives
- Topic List
- Individual Topic Overview
- Questions



# Radar Research Area Objectives



The Radar Research Area focuses on finding the next "game changing" technology development for Ballistic Missile Defense (BMD) radars.

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



## 09.3 Radar Topics

### SBIR Topics

- Low Cost Digital Multi-Beam Receive Array
- Low Cost Photonic Multi-Beam Receive Array
- Innovative Waveforms and Related Signal Processing for Missile Defense Radars
- Clutter and Debris Mitigation Algorithms for Missile Defense Radars

### STTR Topics

- Software Defined Multi-Channel Receiver Development for X-Band Radar Systems
- Low Cost, High Performance Transmit/Receive Integrated Circuits (TRIC) on a Chip



# SBIR Topics Overview

## “Low Cost Digital Multi-Beam Receive Array”

**Objective:** Develop low cost, receive only phased array antenna technology that can support multiple simultaneous full field of view (FFOV) receive beams.

### Supplemental Information:

- Low cost FFOV receive only radar arrays have potential to be an efficient, affordable way to scale MDA radar capability in support of efforts to identify multiple simultaneous targets in the near future.
- Removing the transmit function from the phased greatly simplifies the multi-beam receive array design and should result in significantly lower fabrication costs.
- Trade analog vs. digital data multiplexing/manifolding.
- Investigate array architectures in particular cost/complexity trades for subarray cluster beams vs. full array arbitrarily steerable beams.



# SBIR Topics Overview (Cont)

## “Low Cost Photonic Multi-Beam Receive Array”

**Objective:** Develop multi-beam RF receive phased array based on photonics technologies to enable simultaneous multi-beam operation, to simplify the array design, to reduce production costs (improve producability), and to reduce the need for adjustments and calibration following fabrication.

### Supplemental Information:

- The architecture of a Transmit/Receive Array has significant design constraints due to the need for isolation between transmit and receive, and for switching between the transmit and receive functions. In addition, there are substantial cooling requirements due to RF power amplifiers and with other losses in the implementation; and the constraints of accomplishing accurate true time delay with the electronics circuitry.
- Removing the transmit function from the phased array (making a receive-only array) greatly simplifies the multi-beam receive array design and would result in a much lower fabrication cost.
- The use of the unique capabilities of photonics, such as very accurate true time delay, in the receive array design would enable accurate multi-beam forming and allow very rapid reforming of simultaneous multiple beams.



# SBIR Topics Overview (Cont.)

## “Innovative Waveforms and Related Signal Processing for Missile Defense Radars”

**Objective:** Develop innovative waveforms and related signal processing algorithms that will improve the capability of missile defense radars in target detection, discrimination, and tracking as well as reducing vulnerability to jamming and other countermeasures.

### **Supplemental Information:**

- Existing radars generally use linear frequency-modulated (LFM) waveforms. Narrow-band LFM waveforms are used for search mode and broadband LFM waveforms are used for tracking and discrimination. These waveforms are susceptible to jamming.
- The use of more sophisticated waveforms would improve jamming immunity as well as effect improvement in the areas stated in the previous bullet.
- Sophisticated communications waveforms have been developed by the wireless industry that could serve as the basis for much of the waveform development for radars.



# SBIR Topics Overview (Cont.)

## “Clutter and Debris Mitigation Algorithms for Missile Defense Radars ”

**Objective:** This topic seeks to develop innovative clutter and debris suppression/mitigation concepts and approaches which will enhance the ability of radar systems to perform detection, tracking, and discrimination.

### **Supplemental Information:**

- It is anticipated that the environment around a ballistic missile complex will include intentional and non-intentional clutter as well as a large number of small debris fragments. Clutter and debris interfere with missile defense radar detection, tracking, and discrimination .
- Algorithms that mitigate the effects of these intentional and/or non-intentional clutter and debris backgrounds while maintaining all required radar data on objects of interest will increase BMD Radar performance.



# STTR Topics Overview

## “Software Defined Multi-Channel Receiver Development for X-Band Radar Systems ”

**Objective:** Develop software defined multi-channel receiver to enhance X-Band radar system performance. Receiver channel selection and re-configuration will be entirely executed by software to enhance signal processing speed while minimizing the required hardware components. Shifting receiver control function from hardware to software should yield significant savings in phase array radar system development.

### Supplemental Information:

- Scalable multi-channel receivers mitigate the cost, weight and size barrier in low power density (LPD) antenna panel array technology where LPD is a key solution to reduce cooling requirement for BMDS radar system.
- Investigate the utility of software defined multi-channel receiver at X-Band. The successful development would improve BMDS radar system performance while reducing hardware components and thus costs.
- Take advantage of high-speed computing devices to re-configure radar receiver (up to 100 channels) to improve system dynamic range, quadrature coherency, and reliability.



## STTR Topics Overview (Cont)

### “Low Cost, High Performance Transmit / Receive Integrated Circuits (TRIC) On A Chip ”

**Objective:** Develop a low cost, low power density (LPD), single chip transmitter/receiver with on-chip controller and compensation networks for next generation X-band radar systems.

#### **Supplemental Information:**

- Advances RF front-end technology for LPD arrays to enable ease of transportability/mobility, enable discrimination of multiple targets, and maximize power aperture gain per dollar (PAG/\$).
- Reduces hardware and brings digital processing closer to the face of the antenna. Investigate advanced silicon technology for providing a single chip solution where the entire T/R function (both RF and digital) is implemented monolithically.
- The TRIC should include on-chip digital control compensation networks to enable adaptable T/R functionality and to ensure uniformity across the aperture.
- Digital control at the element level is also a key enabling technology for future radar concepts.



*The End*

Questions

??