

**Technology Innovation and  
Development –  
Industry Update  
The Lockheed Martin Perspective**

***Lockheed Martin MS2  
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***Dr. Doug Reep  
Director, Airborne Early Warning  
Radar and Advanced Programs  
MS2 Radar Systems, Syracuse, NY***

# Outline and Key Messages



- **Outline**

- *Current Trend in Phased Array Radar Technology*
- *Key PAR Enabling Technologies*
- *Technology Maturity Status*
- *Future Research Areas for the MPAR*

- **Key Messages**

- *Multi-function Phased Array Radar can benefit from advancement in DOD phased array technology and Commercial packaging*
- *Investment in MPAR specific technical areas is needed from the MPAR community*



# Current State of Multi-function PAR Radar



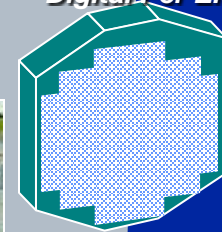
## Digital Phased Array

Digital Per Element

Digital Subarray



R&D  
(2006)



## Active Phased Array



EQ-36  
(2010)



SPY-4 VSR  
(2008)



COBRA  
(1980's)

## Digital Phased Array Radar

- **Faster volume scan rate**
- **High sensitivity (better detection of low-level signal)**
- **Better clutter cancellation**
- **Operational Flexibility (Multiple Simultaneous Beams, Beam Multiplexing)**
- **Digital Beamforming**
- **Better Calibration**

## Passive Phased Array



SPY-1A  
(1970's)

NWRT  
(2003)

## Passive Phased Array Radar

- **Tube Transmitter**
- **Fast Search rates**
- **Agile, Adaptive Scan**

## Active Phased Array Radar

- **Solid-State T/R Modules - no central Transmitter**
- **Higher sensitivity**
- **High Reliability**
- **Increased Performance**

# MPAR Program Challenges



- **Affordability**
  - **High performance phased array radar**
    - **High production cost must be overcome by R&D into use of mass market COTS technologies**
    - **Low operation and maintenance cost**
  - **Increased performance**
- **Simultaneous Multi-mission**
  - **Enhanced Hazardous weather mission**
  - **Aircraft surveillance and track**
  - **DHS mission**
- **Dual Pol phased array**
  - **Weather feature extraction**



# Mission Needs Drives MPAR Requirements



MISSION NEEDS	REQUIREMENT	SYSTEM DRIVERS
Hazardous Weather Detection	<i>Angular Resolution</i>	<i>Aperture size and number of dual pol T/R elements</i>
Weather feature extraction	<i>Differential Reflectivity Bias</i>	<i>Requires 45 dB of cross pol isolation for the simultaneous transmit configuration</i>
Simultaneous Weather and Aircraft surveillance	<i>Multi Function</i>	<i>Higher power, Digital Beam Forming and Multi frequency capabilities</i>
High range resolution	<i>Classification of Small and Low Non-cooperative Targets</i>	<i>Wide RF bandwidth and High clutter suppression capabilities</i>
Enhanced system detectability	<i>High System Dynamic Range and Clutter Attenuation</i>	<i>Multi receivers and Digital Beam Forming capabilities</i>
Ground Clutter Suppression	<i>High Clutter Attenuation</i>	<i>High stability architecture design (distributed waveform generators)</i>

# PAR Technology Maturity Scorecard



Basic Research   Applied Research   Advanced Research   Development/Transition   Fielded

**TRL**   **1**   **2**   **3**   **4**   **5**   **6**   **7**   **8**   **9**

Technology	1	2	3	4	5	6	7	8	9
<i>GaAs MMICs</i>	[Green bar from 1 to 9]								
<i>GaN MMICs</i>	[Yellow bar from 1 to 4]								
<i>Ultra-Low Cost Packaging</i>	[Magenta bar from 1 to 3]								
<i>Clutter Rejection</i>	[Green bar from 1 to 1]								
<i>Simultaneous Wx+Track</i>	[Green bar from 1 to 7]								
<i>Multi-Face Subarray Simultaneous Beams</i>	[Yellow bar from 1 to 6]								
<i>Digital PAR Transceiver</i>	[Yellow bar from 1 to 4]								
<i>Full Array DAR Processing</i>	[Magenta bar from 1 to 3]								
<i>15 dB Cross Pol</i>	[Green bar from 1 to 8]								
<i>25-45 dB Cross Pol</i>	[Magenta bar from 1 to 3]								

**Affordability**

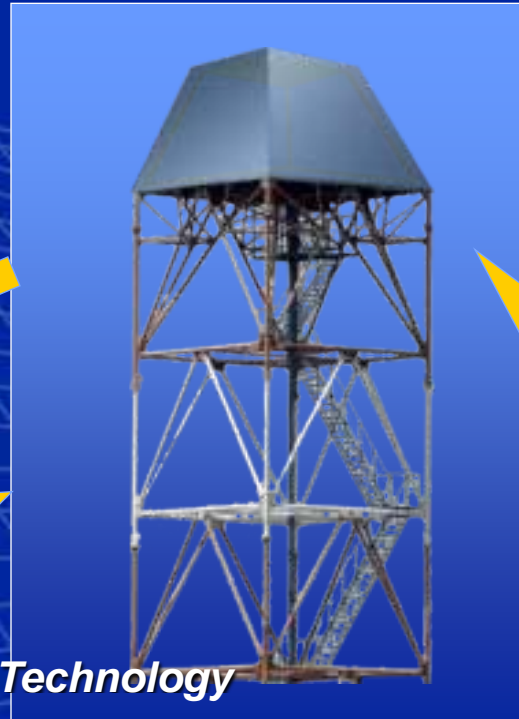
**Multi-mission**

**Dual Pol**

# Technology Development Enablers



## MPAR



*Weather Processing  
Dual pol phased array*

*COTS Signal Processing  
Low Cost Electronics  
RFICs*

**DoD**



*Phased Array Technology  
Air Cooled  
GaN MMICS*

**Commercial**

*COTS Signal Processing  
Low Cost Electronics*



**GaN MMICS**



# Possible Areas for MPAR R&D



## ***Demonstrate multi-mission time line***

***Derisk simultaneous weather and aircraft surveillance and track missions time line***

- Develop and build demonstrator to verify system's ability to support multi-mission scheduling

## ***Dual Pol Configuration for Phased Array***

***Achieve differential reflectivity bias requirement without driving system cost***

- Explore dual pol configurations and identify optimal configuration that will simplify system architecture and meet system performance requirements

## ***MIMO for Phased Arrays***

***Increases radar performance through use of multiple, independent transmit and receive chains***

- Explore application of MIMO techniques to subarray beamforming



# Way Forward



***Industry and DoD are investing in core technology enablers for other applications...***

***...for MPAR to become reality, the User Agencies need to do the same to apply these towards their applications***

***Time is NOW to fully fund R&D in order to meet 2015-2020 time frame for deployment.***

- Joint mission needs and requirements definition***
- Core enabling research, including testing and demos***
- Analysis of Alternatives and Cost-Benefits***

***MPAR is Achievable... But the Program Needs Agency R&D Funding to Transition From the “Vision” to an Engineering “Concept”***