Technology Innovation and Development –

Industry Update

The Lockheed Martin Perspective

Lockheed Martin MS2
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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

**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

**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
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

<table>
<thead>
<tr>
<th>Mission Needs</th>
<th>Requirement</th>
<th>System Drivers</th>
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<tbody>
<tr>
<td>Hazardous Weather Detection</td>
<td>Angular Resolution</td>
<td>Aperture size and number of dual pol T/R elements</td>
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<td>Weather feature extraction</td>
<td>Differential Reflectivity Bias</td>
<td>Requires 45 dB of cross pol isolation for the simultaneous transmit configuration</td>
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<td>Simultaneous Weather and Aircraft surveillance</td>
<td>Multi Function</td>
<td>Higher power, Digital Beam Forming and Multi frequency capabilities</td>
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<td>High range resolution</td>
<td>Classification of Small and Low Non-cooperative Targets</td>
<td>Wide RF bandwidth and High clutter suppression capabilities</td>
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<td>Enhanced system detectability</td>
<td>High System Dynamic Range and Clutter Attenuation</td>
<td>Multi receivers and Digital Beam Forming capabilities</td>
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<td>Ground Clutter Suppression</td>
<td>High Clutter Attenuation</td>
<td>High stability architecture design (distributed waveform generators)</td>
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# PAR Technology Maturity Scorecard

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<tr>
<th>TRL</th>
<th>Basic Research</th>
<th>Applied Research</th>
<th>Advanced Research</th>
<th>Development/Transition</th>
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- **GaAs MMICs**: TRL 9
- **GaN MMICs**: TRL 7
- **Ultra-Low Cost Packaging**: TRL 2
- **Clutter Rejection**: TRL 1
- **Simultaneous Wx+Track**: TRL 9
- **Multi-Face Subarray Simultaneous Beams**: TRL 8
- **Digital PAR Transceiver**: TRL 8
- **Full Array DAR Processing**: TRL 7
- **15 dB Cross Pol**: TRL 9
- **25-45 dB Cross Pol**: TRL 7

**Affordability**: TRL 9

**Multi-mission**: TRL 8

**Dual Pol**: TRL 7
Technology Development Enablers

**MPAR**

- **COTS Signal Processing**
- **Low Cost Electronics**
- **RFICs**

DoD

- **Phased Array Technology**
- **Air Cooled**
- **GaN MMICS**

Weather Processing
- **Dual pol phased array**

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
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"