12B.1 THE MULTIFUNCTION PHASED ARRAY RADAR INITIATIVE STATUS AND OUTLOOK

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ABSTRACT

Multifunction Phased Array Radar (MPAR) is a multiagency initiative to reduce risk associated with designing one type of phased array radar to replace the seven models of mechanically rotating conventional radars currently operated by four federal agencies. The effort investigates the potential for sharing data from approximately 330 multifunction radars, which would replace about 510 single-purpose installations. The Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) sponsors the Working Group for MPAR and the MPAR Executive Council. During 2010 the MPAR initiative advanced on several fronts. The Executive Council reviewed several potential risk-reduction options and provided input to the Interdepartmental Committee for Meteorological Services and Supporting Research on a recommended way forward. The Working Group tracked efforts toward completing a contract for the Technical Assessment Program, a vehicle to engage industry in reducing cost and technical risk. The Group also completed a new Unified Research and Development plan, updating a 2006 plan and adding risk and priority information, and updated the MPAR Risk Reduction Strategy to reflect current timelines and activities.

1. INTRODUCTION

Multifunction Phased Array Radar (MPAR) is an initiative to investigate the potential for replacing several weather and air surveillance radar systems with one system that could effectively perform the functions of those legacy systems. This paper provides background on the initiative, reviews current MPAR activities underway at the participating Federal agencies, and presents progress on several collaborative efforts facilitated by the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) that lay out technical and programmatic approaches to MPAR risk reduction and eventual procurement.

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2. BACKGROUND

Investigation into employing phased array radar (PAR) technology for weather applications has been underway since at least the mid-1990's (see, e.g., Owen, et al. 1997 and Owen, et al. 1998). Experiments comparing weather information derived from U.S. Navy SPY-1 PAR using the Tactical Environmental Processor to data from nearby WSR-88D radar (Maese, et al. 2000) showed excellent potential for PAR to eventually replace mechanically rotating conventional radar for remote sensing of weather information. The National Research Council, in a study on follow-on technology to the WSR-88D (NRC 2002), recommended exploring adaptive waveform selection and agile beam scanning strategies as well as establishing technical characteristics and costs of PAR systems.

In 2002, the Federal Committee for Meteorological Services and Supporting Research directed the Federal Coordinator for Meteorology to determine specific needs of the agencies, show the benefits of the phased array radar capability, and explore opportunities for expanded participation among other agencies interested in exploring the possibility of using phased array technology to meet both weather and aircraft surveillance requirements. Initial work on these tasks led to the formation of the Joint Action Group for Phased Array Radar Project (JAG/PARP) within the OFCM infrastructure. This group issued the report, *Federal Research and Development Needs and Priorities for Phased Array Radar* (OFCM 2006). Key findings of the report were that 1) a single MPAR network could perform all existing civil radar functions and meet emerging needs not met by existing radar systems, and 2) 334 MPAR units could potentially replace approximately 510 radar units in seven networks at lower life-cycle cost.

Meanwhile, a single U.S. Navy SPY-1 PAR antenna, originally built to support fire control systems on Aegis guided missile cruisers, was installed at the National Oceanic and Atmospheric Administration's (NOAA's) National Severe Storms Laboratory

(NSSL) in Norman, Oklahoma, and became part of the National Weather Radar Testbed (NWRT). It has been operating since 2004, collecting data to study the capability of an operational PAR to support weather surveillance. Agency acceptance of the JAG report led to the formation of a more permanent interagency body, the Working Group for Multifunction Phased Array Radar (WG/MPAR), in 2007. WG/MPAR, which is co-chaired by representatives of the four primary MPAR stakeholder agencies—Department of Transportation/Federal Aviation Administration (DOT/FAA), Department of Commerce/NOAA (DOC/NOAA), Department of Defense (DOD) and Department of Homeland Security (DHS)—has been the focal point for MPAR risk reduction and other associated interagency activities. The group planned and conducted the first MPAR Symposium and responded to a symposium action item to produce the initial MPAR Risk Reduction Implementation Strategy in January, 2008. Later that year, the National Research Council released the report, *Evaluation of the Multifunction Phased Array Radar Planning Process* (NRC 2008), which reviewed the JAG/PARP report and other related planning activities associated with MPAR. The NRC report recommended that the MPAR research and development (R&D) program be continued.

The WG/MPAR has met regularly since 2007, planning a second MPAR Symposium (November, 2009), serving as a vehicle for interagency communication and collaboration, engaging industry, and supporting other risk reduction activities. The MPAR Executive Council (EC) was established in 2008 to coordinate interagency efforts and resources and to provide oversight and guidance to the WG/MPAR. The EC/MPAR is chaired by the Federal Coordinator for Meteorology and includes senior executives from the four stakeholder agencies. Among other activities, the Council reviewed and responded to the action items from the second symposium and has reviewed potential risk reduction options.

3. CURRENT ACTIVITIES

3.1 NOAA's National Severe Storms Laboratory

Much of the research related to PAR applications for weather surveillance is being conducted at NSSL, most of it using the NWRT. Having demonstrated through their ADAPTS (Adaptive Digital signal processing Algorithm for PAR Timely Scans) program the basic concept of adaptive scanning to avoid expending radar resources looking at "empty space," NSSL scientists have moved on to second order adaptive scanning. This advanced concept adjusts update times and scan strategies based on the characteristics of different storms. Adaptive scanning is also being applied to range oversampling, which has demonstrated improved data quality while reducing scan time by a factor of two. Application of the data to improve warning and forecasting performance is also receiving attention. The Phased Array Radar Innovative Sensing Experiment (PARISE) brings operational forecasters to the NSSL Hazardous Weather Testbed to experiment with using PAR data as part of the warning process in an operational environment, and experiments are underway using PAR data to initialize storm-scale models. In collaboration with the University of Oklahoma, NSSL is modifying the NWRT to add eight channels to enhance aircraft tracking for multifunctionality experiments.

3.2 Federal Aviation Administration

The FAA has been supporting the MPAR risk reduction initiative through a variety of projects at the Massachusetts Institute of Technology Lincoln Laboratory (MIT LL). The Laboratory has developed a 64-element dual polarized panel (Figure 1) with a focus on high cross-polar isolation performance and low cost manufacturing techniques for transmit/receive units. The success of this panel prompted efforts to build a modified version that can be produced in greater numbers and mounted together to build up progressively larger arrays for more advanced testing and demonstration of operational concepts.

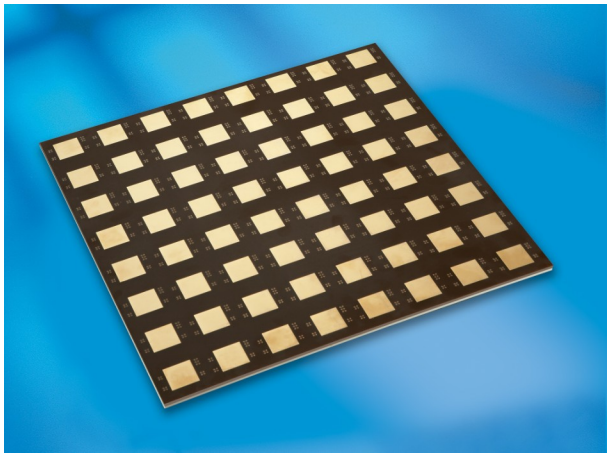

Figure 1. 64 Transmit-Receive element dual polarized phased array antenna panel developed by MIT Lincoln Laboratory.

The FAA has also developed a concept of operations for an MPAR radar system performing the combined functions of terminal weather support and terminal area air surveillance.

In response to enhanced funding in the proposed FY11 budget, oversight of the MPAR initiative at the FAA Headquarters shifted from the NextGen Operations Planning Office Systems Engineering Directorate to the Research and Technology Development Directorate, and day-to-day management has transitioned from the William J. Hughes Technical Center in Atlantic City, New Jersey to the FAA Headquarters. This change shifted the FAA MPAR activities to a more programmatic approach with increased emphasis on satisfying the decision point requirements of the agency's Acquisition Management System. This, in turn, has required a re-evaluation of the FAA's approach to MPAR activities, which is ongoing.

3.3 Department of Defense

The DOD has been involved in the WG/MPAR and EC/MPAR, but has not had a separate, identifiable MPAR program. Nevertheless, numerous DOD radar programs show potential to be leveraged for MPAR, and several efforts have been coordinating directly with the WG/MPAR. Both the Army and the Navy have Digital Array Radar (DAR) programs that are being tracked by the WG. The Army DAR is a small program supporting the development of a fully digital panel at Purdue University. The Navy program focuses on radar infrastructure based on open architecture defined by a non-proprietary government-owned Interface Requirements Document. The Air Force is investigating the potential use of an MPAR-like system to support the FAA-required "sense and avoid" capability for unmanned aerospace systems training in the United States. In addition, the Air Force Research Laboratory had been engaged with the WG to provide information on the Scalable Panels for Efficient, Affordable Radars (SPEAR), and Modular Open Systems Approach (MOSA) for common back-end programs. Meanwhile, the DOD has completed an Initial Capabilities Document for surveillance and is moving forward with an Analysis of Alternatives, which is expected to consider MPAR as an important option.

3.4 Department of Homeland Security

The DHS is closely tied to the DOD in surveillance programs, and remains heavily engaged with the WG. The DHS has funded several investigations of wind farm interference with radar signals and how to mitigate that interference. In addition, the DHS is deeply involved in the Integrated Surveillance and Air Domain Awareness initiatives—interagency efforts that are expected to rely on new-technology radar for key data.

4. MOVING FORWARD WITH MPAR

The President's budget for FY11 and succeeding years includes a significant increase in funding for MPAR risk reduction for both NOAA and FAA. However, that budget has not been passed by Congress, and it remains to be seen whether the new Congress will appropriate funding for 2011 at the requested level. Planning continues under the assumption that funding will become available in the latter half of the fiscal year so the agencies will be in a position to move forward with more robust risk reduction activities. Plans include updating the Risk Reduction Strategy and MPAR Unified Research and Development Plan, preparation for the Technical Assessment Program (TAP), and consideration of establishing an MPAR Risk Reduction Office.

4.1 MPAR Risk Reduction Strategy

The risk reduction strategy is a timeline showing the various activities that should take place to complete risk reduction and, to put risk reduction in context, show subsequent activities to procure and prepare to field MPAR. The strategy was developed 3 years ago, but the initial version had become outdated due to funding delays and changes in the initiative. The current strategy (Figure 2) is fundamentally sound, but may require some adjustment, especially to the TAP, in response to the FAA's increased programmatic emphasis. The timeline is anchored on milestones from the FAA roadmap for weather and air surveillance systems (FAA 2010), and notional milestones for NOAA and DOD are added to suggest how those agencies would proceed with associated programs. R&D activities, programmatic actions, and the procurement process are added to the plan, which also incorporates long lead time activities (e.g., site surveys/acquisition, radio frequency spectrum challenges, program management and oversight).

4.2 MPAR Unified Research and Development (R&D) Plan

The original MPAR R&D plan was published as part of *Federal Research and Development Needs and Priorities for Phased Array Radar* (OFCM 2006). An action item from the second MPAR Symposium in November 2009 (OFCM 2009) called for a review of technical challenges and development of a unified R&D plan. A vital component of the plan is a matrix that lists nearly 70 research elements, the MPAR initiatives that can be expected to address each element, and the timeframe for the work. The elements are divided into two groups: technology development and test, and proof of operational concepts. The plan also includes priorities, as recommended by the NRC (NRC 2009), and a measure of technical and programmatic risk for each element, which was requested by the EC/MPAR. The NRC report also called for cost information, and the plan does address that recommendation. However, it was not feasible to assign costs to individual research elements, so the costs were assigned instead to the research initiatives. The Unified R&D Plan (OFCM 2010) is a living document that will be updated as technical, programmatic and budgetary conditions evolve.

4.3 MPAR Technical Assessment Program

The TAP was conceived over 2 years ago as a way to engage industry and focus resources on innovative solutions to the three fundamental MPAR risk reduction challenges—reducing cost to target levels, demonstrating effective multifunctionality, and developing dual polarization technology (a capability being implemented on existing weather radar) with acceptable cross-polar isolation. Two models for the TAP have been considered. One model emphasizes industry outreach and would support a variety of potential solutions to the three risk reduc-

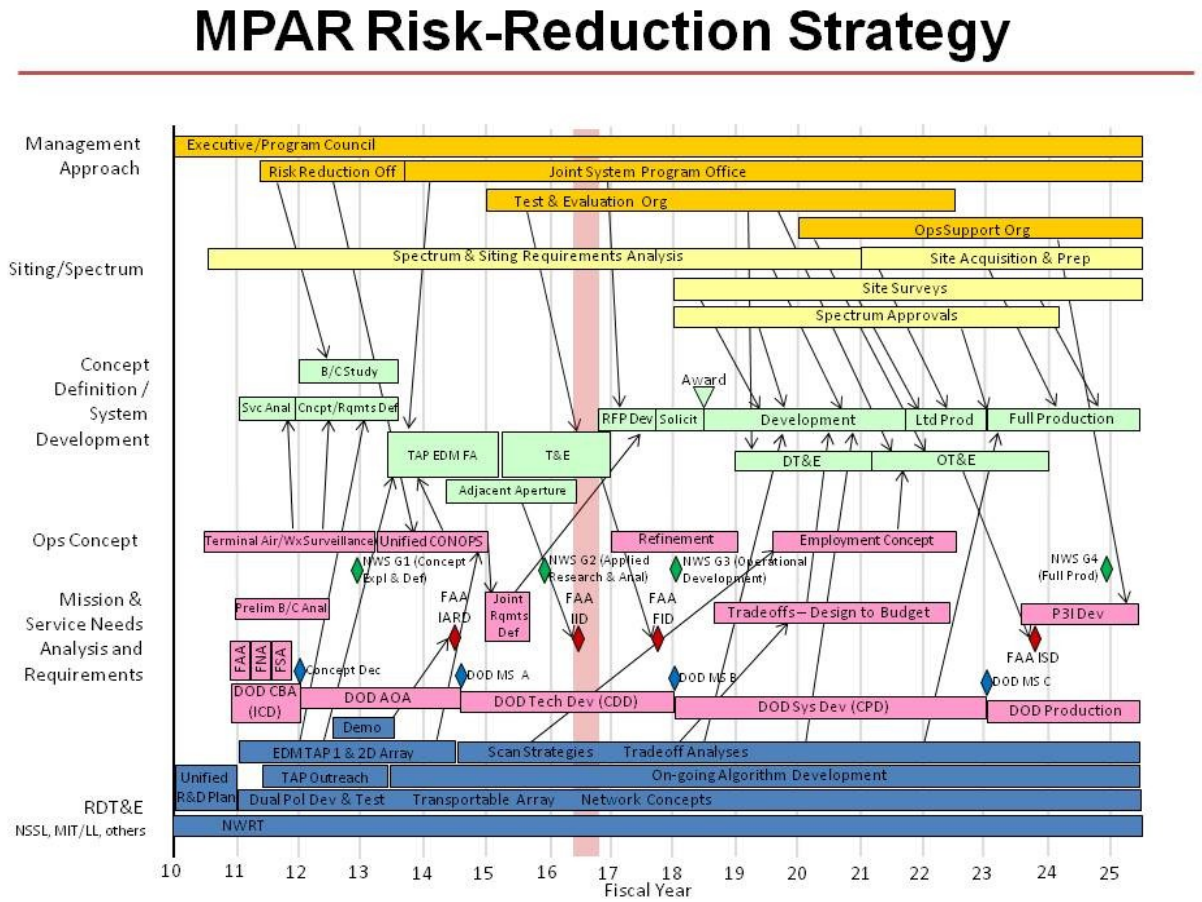

Figure 2. Revised MPAR Risk-Reduction Strategy based on milestones from FAA Roadmap with notional NOAA and DOD decision points.

tion challenges. Supporting several solutions, some of which may still be on the drawing board or even earlier in the development process, limits the size of the panels that could be developed within the available time and funding. It is assumed that a follow-on effort would be needed to build a large enough array for true operational demonstration based on the most promising solution. The other model would concentrate on developing an antenna array based on technology already demonstrated in a small dual polarized panel. This approach would limit funding for industry outreach and shift industry involvement to systems studies and open architecture trade analysis. It would provide a fast track to an antenna that could support operational testing, but could introduce higher risk by focusing on one technology. With sufficient funding both models could be pursued, but current budget projections do not appear to support that approach. The TAP partnering agencies (NOAA and FAA) are re-evaluating the alternative technology assessment options in light of potential programmatic changes. However, the resolution of the FY11 budget situation will have the greatest impact on the future of the TAP.

4.4 MPAR Joint Risk Reduction Office

Since its inception, the focal point for the MPAR initiative has been at the OFCM. With a significant increase in funding for MPAR risk reduction in the President's FY 2011 budget and key decisions approaching in the FAA roadmap, the establishment of a separate risk reduction office has been proposed. The office would provide dedicated day-to-day management of the interagency effort with oversight from the EC/MPAR and the coordination of the WG/MPAR. Tasks would include implementation of the Unified R&D Plan; facilitating exchange of interagency funds, plans, and budgets; and programmatic activities such as cost-benefit analysis, concept of operations, and requirements definition.

Initially the office would be administratively attached to NOAA's Office of Oceanic and Atmospheric Research under the Deputy Associate Administrator for Laboratories and Cooperative Institutions. Executive Council and Working Group engagement would include providing overall direction, maintaining the Risk Reduction Strategy and Unified R&D Plan, providing guidance for cost-benefit analysis, interfacing with other interagency communities (e.g., NextGen, Air Domain Awareness), and investigating and implementing future organizational options (Figure 3). It is expected that, should the Risk Reduction Strategy move forward as planned, the Risk Reduction Office would evolve into a program office to manage MPAR acquisition. The proposal to establish the office is currently under consideration by the Executive Council.

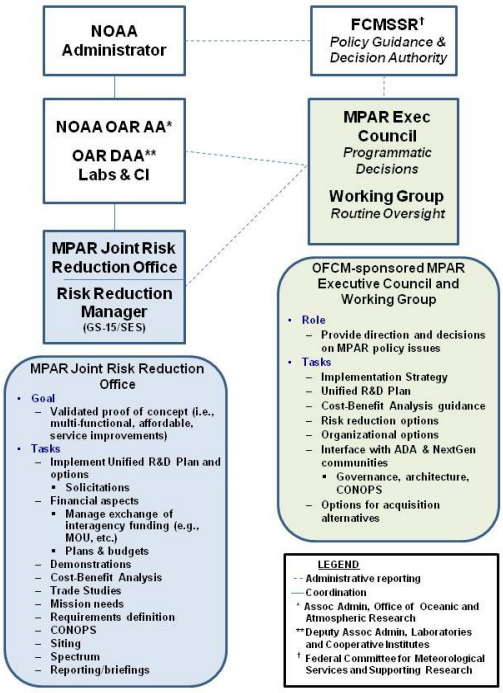

Figure 3. Organizational arrangement, roles, and tasks associated with proposed MPAR Joint Risk Reduction Office.

5. Summary

With a recently updated Unified R&D Plan and Risk Reduction Strategy, new funding in the President's budget, and a proposal to establish a dedicated Risk Reduction Office, the MPAR initiative is positioned to move into a new, more aggressive phase. What exactly that new phase will involve and whether it will actually happen will depend on the changing dynamics of the partnering agencies' involvement in the risk reduction process and the fate of MPAR funding in the FY11 and subsequent Federal budgets.

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