The Multifunction Electronic Warfare (MFEW) Advanced Development Model

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Introduction: In the almost 30 years since the development of the AN/SLQ-32 Surface Ship Electronic Warfare (EW) system, the number and sophistication of radar emitters and antiship missiles have increased dramatically. The resulting need for improved situational awareness, combat system coordination, threat detection and identification, and support for future improvements in electronic countermeasures against new and emerging threats led the Office of Naval Research (ONR) to establish a Technology Transition Agreement (TTA) in 2004 with the Chief of Naval Operations (CNO), the program managers for the new construction DDG 1000, and the Surface EW Improvement Program (SEWIP). This TTA established an ONR program under the Fleet Force Protection (FFP) Future Naval Capability (FNC) to develop and demonstrate a Multifunction Electronic Warfare (MFEW) Advanced Development Model (ADM), and mature and transition critical EW system technology to full-scale engineering development.

Based on the TTA and the secret DDG 1000 EW component specifications, ONR and NRL established the following key performance factors (KPFs) to focus the MFEW development: (1) frequency and spatial coverage, (2) sensitivity for signal detection, (3) system response time from signal detection to emitter report-ing, (4) electromagnetic environment requirements (for both on- and off-board emitters), (5) signal angle-of-arrival (AOA) measurement accuracy, (6) antenna radar cross section (RCS), (7) emitter classification requirements, including false emitter reporting rate, and (8) performance requirements against specified emerging threats.

ONR and NRL initiated the MFEW ADM program in FY05 by selecting and tasking seven contractors to study, develop, and propose system architectures for an MFEW ADM. In addition to the KPF objectives, ONR required that the design be modular and open; capable of being scaled to the size and operational requirements of multiple platforms; capable of future growth to perform additional EW functions; and capable of incorporation into an integrated sensor/communications system-of-systems under the real-time control of a Resource Allocation Manager (RAM). Based on these architecture design efforts, the Northrop Grumman Corporation (NGC) was selected in September 2005 to develop the MFEW ADM.

MFEW ADM Design and Fabrication: The MFEW design is based on a multi-element interferometer antenna (Fig. 1) combined with a frequency scanning architecture that uses a set of 16 to 24 wideband (400 MHz) tuners and digital receivers, each followed by a bank of digital narrowband (~32 MHz) filters and a corresponding set of detectors. The frequency scanning process is weighted by a priori estimates of signal concentration and known emitter parameters to optimize system response time while searching all frequency bands. The narrow bandwidth of the individual detec-
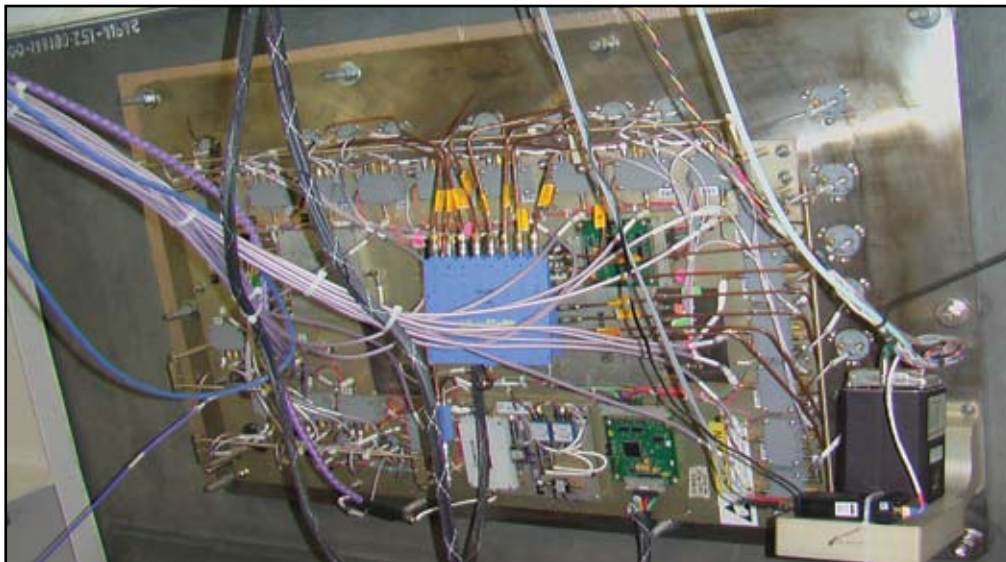

FIGURE 1
MFEW ADM antenna assembly as viewed from inside the above-deck shelter. The antenna elements are located around the perimeter of the electronics mounting plate, embedded in the deckhouse composite structure.

tion channels maximizes sensitivity while minimizing the effects of electromagnetic interference (EMI). Precision direction finding (PDF) is accomplished with an array of two orthogonal interferometers made from 14 of the 20 low-RCS dual sinuous receive elements that form the antenna. Degradation of AOA accuracy due to multipath signal reception is mitigated by a modified version of the multiple signal classification (MUSIC) algorithm.[1] The individual digital tuners and receivers are dynamically allocated between High Probability of Intercept (HPOI) detection and PDF functions as required. The quantity of receivers in a system, which impacts system response time, may be scaled based on cost/performance factors as required for any particular ship class or mission.

The MFEW ADM incorporates a data processor and associated output interfaces based on the Electronic Surveillance Enhancement (ESE) subsystem, which was previously developed by NGC for SEWIP Block 1. The new processor software is designed to operate with the NRL-developed Advanced Multi-Function RF Concept (AMRFC) Resource Allocation Manager,[2] and the NGC-developed human machine interface (HMI).

Test and Demonstration: The MFEW ADM was fabricated and delivered to the NRL in October 2007 (Fig. 2). NRL installed the system in two CONEX (Container Express) boxes; one containing the above-deck assembly, including the interferometer array embedded in a section of the new DDG 1000 destroyer composite deckhouse material, and the other containing the below-deck assembly, including the HMI operator controls and displays. These in turn

were mounted on a ship motion simulator at the NRL Chesapeake Bay Detachment (CBD) for testing (Fig. 3). Demonstrations included the detection and tracking of relevant land-based, shipboard, and airborne emitters within this maritime environment.

After a final demonstration to the TTA sponsors in May 2008, the system was shipped to San Diego and installed on the USS *Comstock* (LSD 45) (Fig. 4) in preparation for the RIMPAC 2008 multinational fleet exercises off the coast of Hawaii. *Comstock* and MFEW actively participated in the TAPA II (Technical Cooperation Program Anti-ship Missile Project Arrangement) technology segment of the exercise jointly with Canada and Australia.

Summary: The MFEW ADM program designed, built, tested, and demonstrated a critical new EW capability on a very aggressive schedule. It performs remarkably well against nearly all of the KPFs, and the MFEW technology is now being transitioned to the SEWIP Block 2 acquisition program. The resulting upgrade will be installed in various configurations throughout the Fleet starting in 2013. Detailed analysis of the MFEW test data continues in preparation for a final NRL report in 2009.

References
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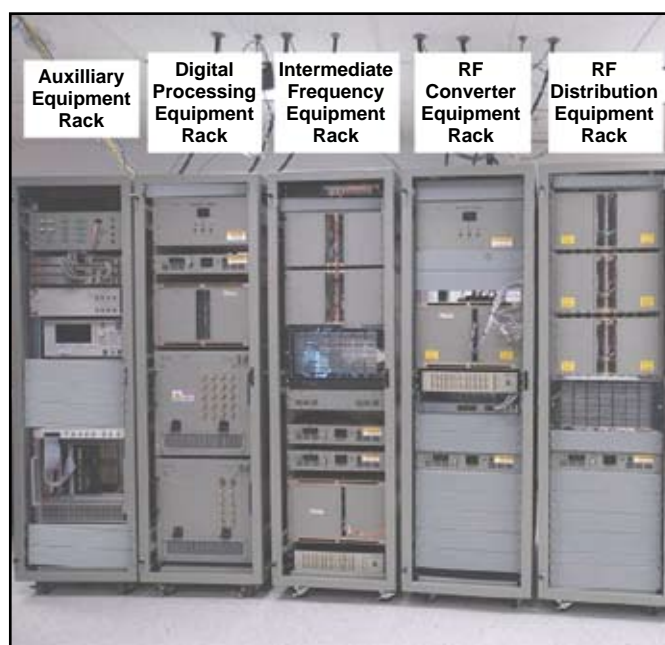

FIGURE 2
MFEW ADM equipment racks.

FIGURE 3
MFEW ADM above-deck shelter (on top of the Ship Motion Simulator) and below-deck shelter (on top of Building 12) at NRL-CBD. Inset shows the above-deck shelter in motion during testing with airborne emitters mounted on an NRL Learjet.

FIGURE 4
MFEW ADM shelters mounted aboard the USS *Comstock* (LSD 45) during installation in San Diego.