# Multi-Static Active Coherent (MAC) System

Executive Summary
- The Navy completed the initial operational testing of the Multi-Static Active Coherent (MAC) system on P-3C aircraft in October 2013.
- Operational test results indicate that the MAC system provides P-3C aircraft with a wide-area Anti-Submarine Warfare (ASW) search capability in select scenarios in some environments but it does not meet the program's requirements in other operational environments or scenarios.
- The IOT&E did not fully examine the capability of MAC across all operational conditions, representative operational environments, and target types. DOT&E agreed to limit testing during the initial phase because sufficient active source buoys were not available and because the MAC system would be installed and further tested on P-8A aircraft in several increments through FY19.
- In FY14, the Navy installed the MAC system on the P-8A Poseidon Multi-mission Maritime aircraft. Due to integration problems, the Navy delayed the initial MAC operational testing on the P-8A from March 2014 to November 2014.

System
- The MAC system is an active sonar system composed of two types of sonobuoys (source and receiver) and an acoustic processing and aircraft mission computer software suite. It is employed by the Navy's maritime patrol aircraft (P-3Cs and eventually P-8As) to search for and locate threat submarines in a variety of ocean conditions. To plan MAC missions, the Navy has updated the Active System Performance Estimate Computer Tool (ASPECT)/Multi-static Planning Acoustics Toolkit (MPACT) previously used to plan Improved Extended Echo Ranging (IEER) system missions.
- MAC replaces the Navy's current IEER system, which employs non-coherent sources to produce loud sounds that reflect off submarine targets. MAC employs new coherent source buoys that enable multiple pings, optimized waveforms, and various ping durations, none of which the legacy IEER system provided.
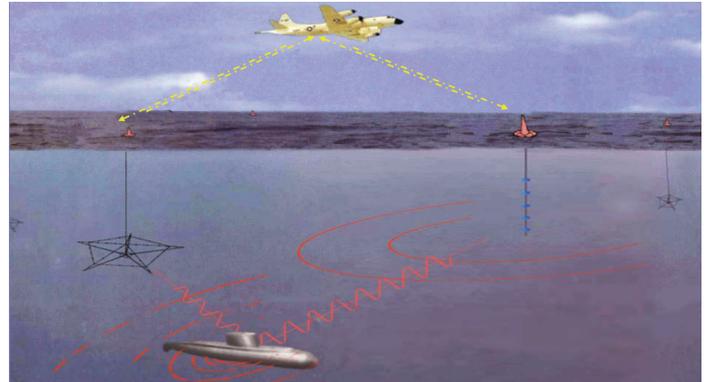
- The Navy initially intends to employ MAC on P-3C aircraft in a limited set of acoustic environments. Future increments of MAC will be employed on P-8A aircraft and in a wider variety of acoustic ocean environments in order to span the operational envelope of threat submarine operations. MAC will be the primary wide-area acoustic search system for the P-8A.
- MAC is expected to have fewer effects on marine mammals and the environment than the legacy IEER system.

Mission
The Navy intends for P-3C and P-8A crews equipped with MAC to support the search, detect, and localization phases of the ASW mission. MAC is particularly focused on large-area active acoustic searches for threat submarines.

Major Contractors
- Lockheed Martin – Manassas, Virginia
- Sparton Electronics Florida, Inc. – De Leon Springs, Florida
- Ultra Electronics, Undersea Sensor Systems Incorporated (USSI) – Columbia City, Indiana
- Boeing Defense, Space, and Security – St. Louis, Missouri

Activity
- The Navy completed operational testing of the MAC Phase 1 system on P-3C Multi-mission Aircraft in October 2013. Operational testing consisted of 3 developmental test events conducted off the coast of Jacksonville, Florida; 7 dedicated operational test events conducted in the Southern California Fleet Operating Areas (SOCAL); and 14 events in the Narragansett Bay Operating Areas (NBOA). Testing did not include the ASPECT/MPACT because its bottom environment

database was poorly populated causing it to inaccurately predict the probability of detection. The Navy conducted the operational testing in accordance with a DOT&E-approved test plan.
- Following the first five NBOA test events, the Navy paused operational testing to investigate observed performance problems. The Navy identified operator training and material problems on the P-3C aircraft as probable causes of the

degraded performance. The Navy required these events to be repeated.

- DOT&E issued an IOT&E report in July 2014.
- In FY14, the Navy installed the MAC system on the P-8A Poseidon aircraft. Due to integration problems, the Navy delayed the initial MAC operational testing on the P-8A from March 2014 to November 2014.
- The Navy and DOT&E commenced developing a Test and Evaluation Master Plan to identify deferred MAC testing and to plan for the Phase 2 MAC improvements. To efficiently utilize test resources, DOT&E is requiring the test program be consistent with and utilize MAC events programmed in the recently approved P-8A Increment 2 Test and Evaluation Master Plan.
- The Navy started operational testing of the MAC installed on the P-8A aircraft off the coast of Florida in November 2014.

Assessment

- Operational test results indicate that the MAC system provides P-3C aircraft with a wide-area ASW search capability in some environments and for select target scenarios, but MAC falls short of what the fleet identified as the capability needed to protect high-value units. Initial testing identified that detection performance strongly relies on the characteristics of the ocean environment and the tactics employed by the target to evade detection. Testing to understand the effects different threat types and environments have on performance will continue through FY19 in conjunction with the P-8 program.
- The IOT&E did not fully examine the capability of MAC across all operational conditions, representative operational environments, and target types. DOT&E agreed to limit testing of the initial phase of MAC because sufficient active source buoys were not available and because the MAC system would be installed and tested on P-8A aircraft beginning in FY14 and continuing through FY19.
- Although the MAC system demonstrated detection capability against evasive undersea targets, acoustic operators were expected to quickly distinguish system submarine detections from a variety of non-submarine clutter detections, some of which appeared target-like. Complicating this task, completed test analysis identified that the MAC system detections of target and non-target clutter varies with environmental conditions and likely target types. The data also show operators are only able to recognize a small fraction of valid system submarine detections as a possible target and spent time assessing and prosecuting false targets.
- The Navy uses ASPECT/MPACT to develop MAC search plans and to estimate theoretical system performance. In addition to the known shortfalls with the environmental databases used by ASPECT that the Navy deferred, the planning tool performance estimates are highly dependent on the wide-range of potential mission planning input parameters estimated by the mission planner. As a result, ASPECT performance estimates can widely vary when compared to test

results. Since ASPECT does not have a good estimate for the operator recognition of the submarine target, it overestimates ASW detection performance.

- For additional information, see DOT&E's classified IOT&E report on the MAC System on P-3C Aircraft dated July 2014.

Recommendations

- Status of Previous Recommendations. The Navy has partially addressed the FY13 recommendations.
  1. The Navy Program Office is investigating fleet exercise data to assess detection performance and to gather data for developing future algorithm and software improvements. Although fleet exercise data includes new environments where the fleet operates in peacetime, the Navy has not investigated MAC performance variability with a variety of submarine target types.
  2. The Navy has not completed development of a sustainable MAC training program or completed the formal updates to tactics guidelines and documentation.
- FY14 Recommendations. The Navy should:
  1. Plan and complete the outstanding MAC operational testing and investigate MAC system and operator performance against different target types. This testing should be in conjunction with P-8A MAC introduction and improvements.
  2. Implement the recommendations in DOT&E's IOT&E report. DOT&E provided 15 recommendations to improve the MAC system performance and 5 recommendations to improve test realism, minimize test limitations, and improve data collection. Significant unclassified recommendations include—
     - Investigate and develop improved methods for aircrews to sample and characterize the time and space variability of the search area environment.
     - Investigate and develop tactics to improve the operator's ability to transition system detections to high confidence target detection. Consider measures to balance operator workload and update search plans based on the actual conditions experienced in the search area.
     - Investigate the system's capability for longer range detections based on the environmental conditions in the search area.
     - Investigate and develop improvements to the ASPECT planning system and the supporting databases.
     - Complete the MAC upgrades to aircrew trainers and training documentation.
     - Improve the operator's capability to utilize the passive detection capability of the MAC receiver buoys.
     - Conduct future testing and exercises using a variety of target surrogates that execute tactics appropriate for their assigned mission. The targets and tactics should be validated as representative of the threats.