Multi-Static Active Coherent (MAC) System
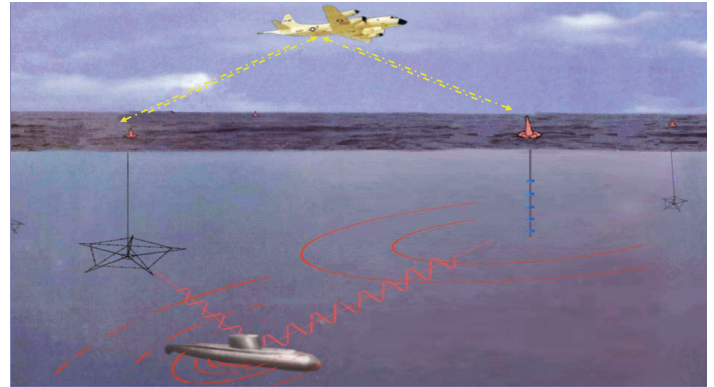
Executive Summary
- The Navy completed the initial operational testing of the Multi-Static Active Coherent (MAC) system on P-3C aircraft in October 2013.
- Initial operational test results indicate that the MAC system provides P-3C aircraft with some limited wide-area Anti-Submarine Warfare (ASW) search capability in select scenarios but it does not meet the program's requirements in some operational environments.
- 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.

System
- The MAC system is an active sonar system composed of two types of buoys (source and receiver) and an acoustic processing 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 is updating the Active System Performance Estimate Computer Tool (ASPECT)/Multi-static Planning Acoustics Toolkit (MPACT) currently 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

Activity
- The Navy certified the MAC system ready for initial operational testing on P-3C aircraft in October 2012, but waived testing of ASPECT/MPACT because its bottom environment database was poorly populated causing it to inaccurately predict the probability of detection for the planned MAC search. Because of technical problems integrating the existing multi-static wide-area ASW search system (IEER) on P-8A aircraft, the Navy delayed testing the P-8A wide-area requirements until MAC was initially tested on P-3C and installed on P-8A.
- Due to a shortage of MAC system source buoys, the Navy identified four system developmental test events that used

realistic buoy placement that could supplement operational test data and reduce the initial phase of operational testing. DOT&E reviewed the available data and test execution and determined that three of the four events were conducted with sufficient operational realism to be valid for the operational evaluation. The Navy conducted the three events on P-3C aircraft in the deep-water operating area off the coast of Jacksonville, Florida, in the spring of 2012. The test design supplemented these three events with five additional deep-water events near San Diego, California.
- The Navy conducted seven deep-water operational test flights with P-3C aircraft in the Southern California operating areas

in January 2013, to obtain five events that met the operational conditions specified in the Navy's requirements documents. Two events were invalid because of P-3 system-of-system and target problems or because the test platform was diverted to higher-priority tasking (counter-drug operations) during the test.

- The Navy conducted five of the eight planned shallow water MAC events with P-3C aircraft in the Narragansett Bay operating area in May 2013. 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 that the testing be repeated.
- The Navy completed eight additional MAC test events in the Narragansett Bay operating area in October 2013, all eight of which were valid for assessment.
- MAC test data analysis is in progress to support an initial assessment of the MAC operational effectiveness and suitability.
- The Navy and DOT&E are developing a Test and Evaluation Master Plan for the future installations and incremental upgrades of MAC capability on both P-3C and P-8A aircraft that reflects the test program in the recently approved P-8A Increment 2 Test and Evaluation Master Plan. Funding for the MAC operational testing on P-8A must still be obtained.
- The Navy conducted all operational testing in accordance with a DOT&E-approved test plan.

Assessment

- Preliminary operational test results indicate that the MAC system provides P-3C aircraft with some limited wide-area ASW search capability in select scenarios but it falls short of what the fleet identified as the capability they need to protect high value units. Initial testing revealed unexpected performance shortfalls that are still being investigated. The latest results from the test events conducted in October 2013 in the benign environment of the Narragansett Bay operating area appear to meet the desired low threshold, but cannot be used to characterize the system's capability in other, more

difficult environments where it will be used in war. 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 in FY14. Additional testing is also required to examine planned MAC system-of-system upgrades.
- Although the MAC system detection algorithms display possible submarine contacts, the operator must quickly distinguish the actual submarine target from a variety of clutter and false contact presentations. Complicating this task, completed test analysis identified that the MAC system presentation of the target, clutter, and false targets varies with environmental conditions and likely target types. The data also suggest operators are only able to recognize a small fraction of the valid system detections as targets.
- The Navy uses ASPECT/MPACT to predict the expected system performance while planning MAC missions. In addition to the known limitations in ASPECT/MPACT that were deferred, the planning tool also appears to overestimate performance because it does not have a good estimate for operator recognition of a submarine target.

Recommendations

- Status of Previous Recommendations. The Navy has addressed all previous recommendations.
- FY13 Recommendations. The Navy should:
  1. Conduct testing to identify target and false target characteristics in a variety of threat environments and with a variety of submarine target types.
  2. Incorporate information about the characteristics of both valid and false target presentations into the training program as future MAC training and testing occurs.