# Mobile User Objective System (MUOS)

Executive Summary

- The Navy program manager conducted a government developmental test from June 1 – 30, 2015, in preparation for operational testing.
- The Navy's Commander, Operational Test and Evaluation Force (COTF) conducted the Mobile User Objective System (MUOS) Multi-Service Operational Test and Evaluation (MOT&E) from October 19 through November 20, 2015. COTF is planning to conduct a two-phased cybersecurity assessment on the MUOS system in conjunction with the MOT&E in November 2015 and 2QFY16.
- The program manager has made progress integrating the end-to-end MUOS capability. Technical Evaluation results suggest that deployed users can reliably make point-to-point data and voice calls and point-to-net data calls. MUOS group communications, which allows the system to maintain links between all users in group networks, is not as reliable and may lead to the loss of mission information and situational awareness for some users.
- As of October 19, 2015, there were over 200 high-priority hardware and software problems remaining on the system. The program manager has prioritized them and is fixing as funding allows; however, most of the problems will not be fixed in time for the MOT&E.
- The geolocation capability is still in development and therefore, will not be ready for testing in the 2015 MOT&E. This capability will need to be operationally tested once it is mature. Geolocation is the ability to locate a legacy Ultra-High Frequency (UHF) electromagnetic interferer on the ground.

System

- MUOS is a satellite-based communications network designed to provide worldwide, narrowband, beyond line-of-sight, point-to-point, and netted communication services to multi-Service organizations of fixed and mobile terminal users. The Navy designed MUOS to provide 10 times the throughput capacity of the current narrowband satellite communications. The Navy intends for MUOS to provide increased levels of system availability over the current constellation of UHF Follow-On satellites and to improve availability for small, disadvantaged terminals.
- MUOS consists of six segments:
  - The space segment consists of four operational satellites and one on-orbit spare. Each satellite hosts two payloads: a legacy communications payload that mimics the capabilities of a single UHF Follow-On satellite and a MUOS communications payload.
  - The Ground Transport Segment is designed to manage MUOS communication services and allocation of radio resources.

Space Segment — Ground Transport Segment
Network Management Segment — Satellite Control Segment
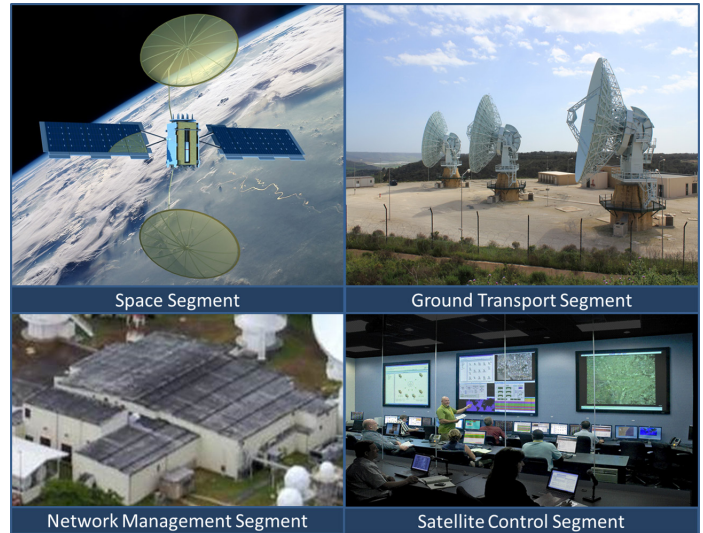
- The Network Management Segment is designed to manage MUOS ground resources and allow for government controlled precedence-based communication planning.
- The Ground Infrastructure Segment is designed to provide transport of both communications and command and control traffic between MUOS facilities and other communication facilities.
- The Satellite Control Segment consists of MUOS Telemetry, Tracking, and Commanding facilities at the Naval Satellite Operations Center Headquarters and Detachment Delta.
- The User Entry Segment provides a MUOS waveform hosted on MUOS-compatible terminals. The Army's Program Manager Tactical Radio is responsible for developing and fielding MUOS-compatible terminals. The Air Force and Navy are upgrading legacy UHF radios to be MUOS-compatible.

Mission

Combatant Commanders and U.S. military forces deployed worldwide will use the MUOS satellite communications system to accomplish globally assigned operational and joint force component missions, especially those involving highly mobile users. Such missions include major conventional war; regional conflicts; search and rescue; humanitarian or disaster relief (including severe weather events); homeland security; homeland defense; counter-narco-terrorism; non-combatant; evacuation operations; very important person travel; strategic airlift; global mobility; global strike; Intelligence, Surveillance, and Reconnaissance; training; logistics support; and exercise support.

Major Contractors
- Lockheed Martin Space Systems – Sunnyvale, California
- General Dynamics C4 Systems – Scottsdale, Arizona

Activity

- The Navy successfully launched the MUOS-3 satellite on January 20, 2015. The satellite is reached its geosynchronous orbital slot over the Atlantic Ocean on August 2, 2015.
- The Navy successfully launched the MUOS-4 satellite on September 2, 2015. The satellite is in transit to the geosynchronous orbital test slot in preparation for contractor testing in 1Q-2QFY16.
- In 1QFY14, MUOS-5 production began and the Navy anticipates a launch in 3QFY16.
- From January 2014 through May 2015, the program manager conducted end-to-end integration efforts with the Army-developed AN/PRC-155 Manpack radio using the MUOS waveform, including multiple satellites, the MUOS Ground Infrastructure and Transport Segments, and the Network Management Segment.
- In January through May 2015, the program manager conducted several communications demonstrations including one with U.S. Northern Command in the Arctic, one with the U.S. Pacific Command in the Antarctic, and a risk reduction demonstration with a MUOS terminal operating aboard a U.S. Air Force C-17 Globemaster III over the Pacific Ocean.
- The Navy program manager conducted a government developmental test from June 1 – 30, 2015 in preparation for operational testing.
- COTF conducted the MUOS MOT&E from October 19 through November 20, 2015, in accordance with the DOT&E-approved the Test and Evaluation Master Plan and test plan.
- The geolocation capability is still in development and therefore, will not be ready for testing in the 2015 MOT&E. This capability will need to be operationally tested once it is mature. Geolocation is the ability to locate a legacy UHF electromagnetic interferer on the ground.
- COTF is planning to conduct a two-phased cybersecurity assessment on the MUOS system in conjunction with the MOT&E in November 2015 and 2QFY16. COTF conducted the phase-one Cooperative Vulnerability and Penetration Assessment in November 2015 and is planning a phase-two Adversarial Assessment in 2QFY16.
- In September 2015, the program manager requested a deferral of the geolocation capability from the MOT&E.

Assessment

- The program manager has made progress integrating the end-to-end MUOS capability. Technical Evaluation results suggest that deployed users can reliably make point-to-point data and voice calls and point-to-net data calls.
- MUOS group communications, which allow the system to maintain links between all users in group networks, is not as reliable and may lead to the loss of mission information and situational awareness for some users.
- The ability of MUOS to create, analyze, and implement communications plans is problematic. The system occasionally freezes when analyzing what network resources are available and the network data MUOS produces is sometimes inaccurate. Without a valid and accurate communications plan, the MUOS cannot create configurations for all of the radios and users cannot establish communications with one another.
- The fault management system of the Network Management Segment provides a large number of faults, unclear faults, and erroneously prioritized faults to the system operators. This leads to poor failure awareness on the part of the system operators. Uncorrected failures could lead to loss of communications for deployed end-users.
- During developmental test periods, hardware failures at the Radio Access Facilities led to the loss of as much as half of the communications resources on a single satellite.
- As of October 19, 2015, there were over 200 high-priority hardware and software problems remaining on the system. The program manager has prioritized them and is fixing as funding allows; however, most of the problems will not be fixed in time for the MOT&E.
- The operational testers expect to find system deficiencies during the planned cybersecurity assessment based on known cybersecurity vulnerabilities discovered during the program manager's developmental testing.
- The geolocation capability is still in development and therefore, will not be ready for testing in the MOT&E.

Recommendations

- Status of Previous Recommendations. The Navy adequately addressed all previous recommendations.
- FY15 Recommendations. The Navy should:
  1. Update the Test and Evaluation Master Plan to include future testing of the geolocation capability once it is mature and re-testing any fixes to problems found during MOT&E.
  2. Fund the MUOS program at a level whereby they can address the high-priority hardware, software, and cybersecurity problems in time for the next operational test event.