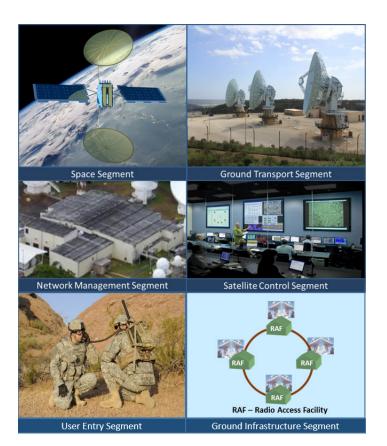# Mobile User Objective System (MUOS)

Executive Summary

- The Navy Commander, Operational Test and Evaluation Force (OPTEVFOR) conducted an FOT&E of the Mobile User Objective System (MUOS) with users from the 25th Infantry Division and 3rd Marine Regiment from April 11 through July 26, 2019.
- MUOS is operationally effective in providing reliable worldwide Spectrum Adaptive (SA) – Wideband Code Division Multiple Access (WCDMA) communications to tactical users.
- MUOS is operationally suitable. The MUOS met the user-defined operational availability (Ao) threshold for the Ground Transport Segment, Satellite Control Segment, and the Ground Infrastructure Segment. During the FOT&E, four of the five Network Management Segment (NMS) functions demonstrated an Ao that met the user-defined threshold criterion.
- The DOD did not fund or design MUOS to be a survivable system. However, the MUOS design makes it resilient to electronic attacks.

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 Ultrahigh Frequency Follow-On satellites and to improve link 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 Ultrahigh Frequency Follow-On satellite and a MUOS communications payload.
  - The Ground Transport Segment is designed to manage MUOS communication services and allocation of radio resources.
  - The Network Management Segment consists of a single Network Management Facility 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 Project Manager for Tactical Radios is responsible for developing and fielding MUOS-compatible radios. The Air Force, Navy, and Marine Corps 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 operational missions, especially those involving highly mobile users. Such missions include armed conflicts; search and rescue; humanitarian or disaster relief; homeland security; and homeland defense.

Major Contractors

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

Activity

- The Navy conducted a government developmental test Technical Evaluation from November 26 through December 21, 2018, in preparation for operational testing.
- OPTEVFOR conducted integrated testing with other Service Operational Test Agencies and Program Office participation from November 27, 2018, through April 9, 2019.
- OPTEVFOR conducted the FOT&E with users from the 25th Infantry Division and 3rd Marine Regiment from April 11 through July 26, 2019, in accordance with the DOT&E-approved Test and Evaluation Master Plan and test plan.
- OPTEVFOR conducted a two-phase cybersecurity assessment of the MUOS system in conjunction with the FOT&E.
    - A Cooperative Vulnerability and Penetration Assessment from January 7 – 18, 2019.
    - With Navy Information Operations Command support, an Adversarial Assessment from May 13 – 24, 2019.
- OPTEVFOR tested the geolocation capability at U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (SMDC/ARSTRAT) from June 17 – 18, 2019.
- OPTEVFOR accredited the MUOS Performance Model (MPM) to evaluate capacity and link availability requirements on March 11, 2019.
- DOT&E assessed NMS capabilities based on the following five functional areas: Planning and Provisioning, Situational Awareness, Network/Fault Management, Geolocation, and WCDMA processing.
- The Program Office changed the maintenance concept and now permanently stations three Intermediate–level (I-level) maintainers at the MUOS facility at Wahiawa, Hawaii, that includes the NMF, Radio Access Facility, and Switching Facility.
- DOT&E published a report in October 2019 evaluating the system based on the FOT&E.

Assessment

- MUOS is operationally effective in providing reliable worldwide SA – WCDMA communications to tactical users.
- DOT&E participated in OPTEVFOR's verification of the MPM and concurred with their accreditation.
- Based on the MPM results, MUOS meets the user-defined capacity requirements. This simulation suggests that MUOS will provide a high communication link availability.
- SMDC/ARSTRAT is able to provision radios and manage satellite resources. Following their standing operating procedures, SMDC/ARSTRAT watchstanders demonstrated the capability to create a beam management region, configure satellite beams and carriers for each MUOS satellite, and analyze those configurations for viability.
- DOT&E calculated that MUOS provides a high probability users will receive an effective voice call regardless of receiver position.
- MUOS demonstrated a high probability of successful data transmission.
- The Program Office has improved fault monitoring but the faults presented to the network managers sometimes conflict, show a problem where there is none, or the maintainers discover a problem that the system has not reported.
- The Program Office made significant improvements to the MUOS situational awareness at the NMS and at the remote locations, such as the SMDC/ARSTRAT's Global Narrowband Watch Office and Regional Satellite Communication Support Centers.
- During the FOT&E, the operational testers observed the MUOS NMS security personnel perform a bulk load of cryptographic keys in the MUOS Key Management System. This capability was not available during the 2015 Multi-Service Operational Test and Evaluation.
- During the FOT&E, MUOS network managers successfully demonstrated compromised terminal operations with 40 of the Army's 25th Infantry Division soldier radio operators. The MUOS watchstander was able to remove the compromised terminal from the network and rekey the remaining terminals.
- MUOS is operationally suitable. MUOS met the user-defined Ao threshold for the Ground Transport Segment, Satellite Control Segment, and Ground Infrastructure Segment.
- During the FOT&E, four of the five NMS functions demonstrated an Ao that met the user-defined threshold criterion.
- The I-level maintainers are keeping MUOS operating, but they are working 45 – 60 hour or more workweeks. The Navy needs more I-level support to sustain MUOS, especially as MUOS scales up in operations.
- The DOD did not fund or design MUOS to be a survivable system. However, MUOS has mitigations in place that provide resilient capabilities.

Recommendations

The Navy should:
1. Continue to make improvements to the fault management system.
2. Increase the staffing level for I-level maintainers.