Cellular Satellites

Joint Communications With Integrated Acquisition

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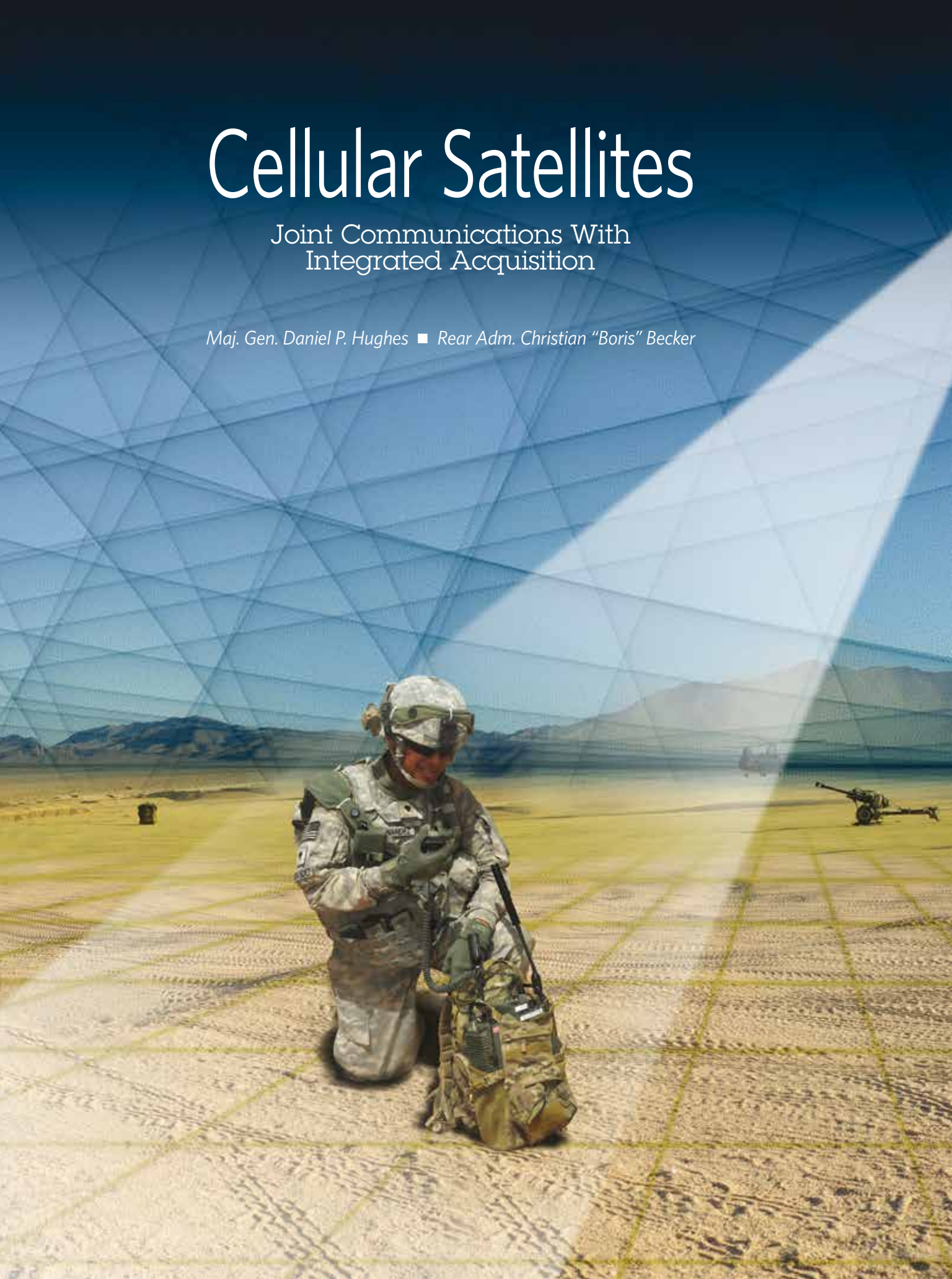

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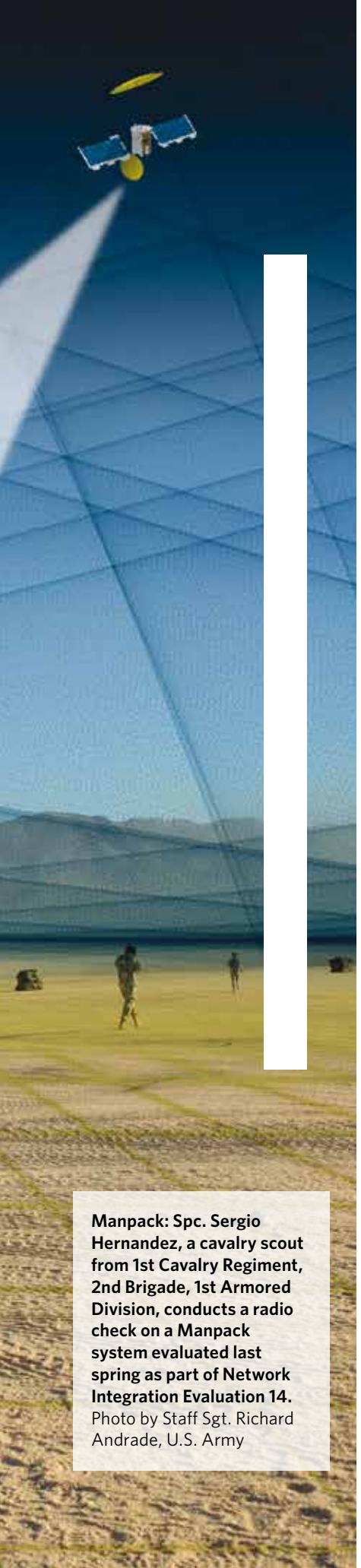

Manpack: Spc. Sergio Hernandez, a cavalry scout from 1st Cavalry Regiment, 2nd Brigade, 1st Armored Division, conducts a radio check on a Manpack system evaluated last spring as part of Network Integration Evaluation 14. Photo by Staff Sgt. Richard Andrade, U.S. Army

It's a familiar image: a Soldier crouching with a radio, next to a spidery antenna pointing skyward to reach a distant satellite. But that view of military communications is on the verge of change—being replaced by troops rapidly exchanging data while moving seamlessly around the battlespace.

This progress is possible due to the Mobile User Objective System (MUOS), the next-generation narrowband military satellite communication system that will support worldwide, multi-Service users in the Ultra-High Frequency (UHF) band. MUOS will use Earth-orbiting satellites as the equivalent of cellphone towers in space, providing smartphone-like service that keeps users connected while on the move and in challenging urban, jungle or mountainous terrain. As the current UHF satellite constellation reaches the end of its life, MUOS will replace it with a communications capacity that is more than 10 times greater.

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Through this improved connectivity, MUOS will provide military radios with a secure version of what users would expect from commercial cellular service: mission voice, data and video on demand. It will connect warfighters on ships; in submarines, aircraft and vehicles; and while dismounted and on the move—providing the vital link between troops in advanced positions or remote areas and the rest of the Department of Defense (DoD) military global network. Using MUOS will allow troops to stay in communications beyond line of sight, whether they are on the other side of a mountain or the other side of the world, thereby enabling a more agile and expeditionary force.

This exponential increase in capability also brings a significant value proposition. MUOS supports all Service branches and interfaces with Defense Information Systems Network (DISN) capabilities, reducing duplication and providing improved joint communications across the tactical and strategic environments. MUOS will function on numerous new or modified radios that industry is developing, supporting a competitive radio marketplace that will drive innovation and lower costs.

More than just satellites, MUOS is a complex DoD orchestra comprised of a five-satellite constellation, four ground stations across the globe, an integrated waveform, the radios, and a complex software to manage the network. It also requires that all these individual segments of the system work together seamlessly and reliably, which requires close coordination and teamwork across the programs delivering these capabilities. The acquisition warfighters of the Army Program Executive Office (PEO) for Command, Control and Communications-Tactical and of the Navy PEO Space Systems have come together to meet this challenge and are on track to achieve MUOS Full Operational Capability in 2017.

Capability Progress

MUOS satellites carry two distinct payloads. The legacy UHF payload provides the capability of the UHF Follow-On satellite constellation, while a new UHF MUOS waveform payload will significantly increase availability and throughput to the user. The dual-payload design supports a gradual transition to MUOS capability, allowing backward compatibility with legacy UHF terminals while providing a next-generation waveform to support communications on the move and higher data rates for dismounted users. The new MUOS waveform leverages widely used commercial Wideband Code Division Multiple Access (WCDMA) cellphone technology.

The first satellite, MUOS-1, was launched from Cape Canaveral, Fla., in February 2012 aboard an Atlas rocket, and transitioned into operational use for legacy terminal users in November of that year. MUOS-2 launched in July 2013 and relocated to its operational slot more than 22,000 miles above the Earth in January 2014, where it also provides legacy UHF communications. MUOS-3 was launched in January 2015 and will be followed by MUOS-4, currently on the launch schedule for this summer.

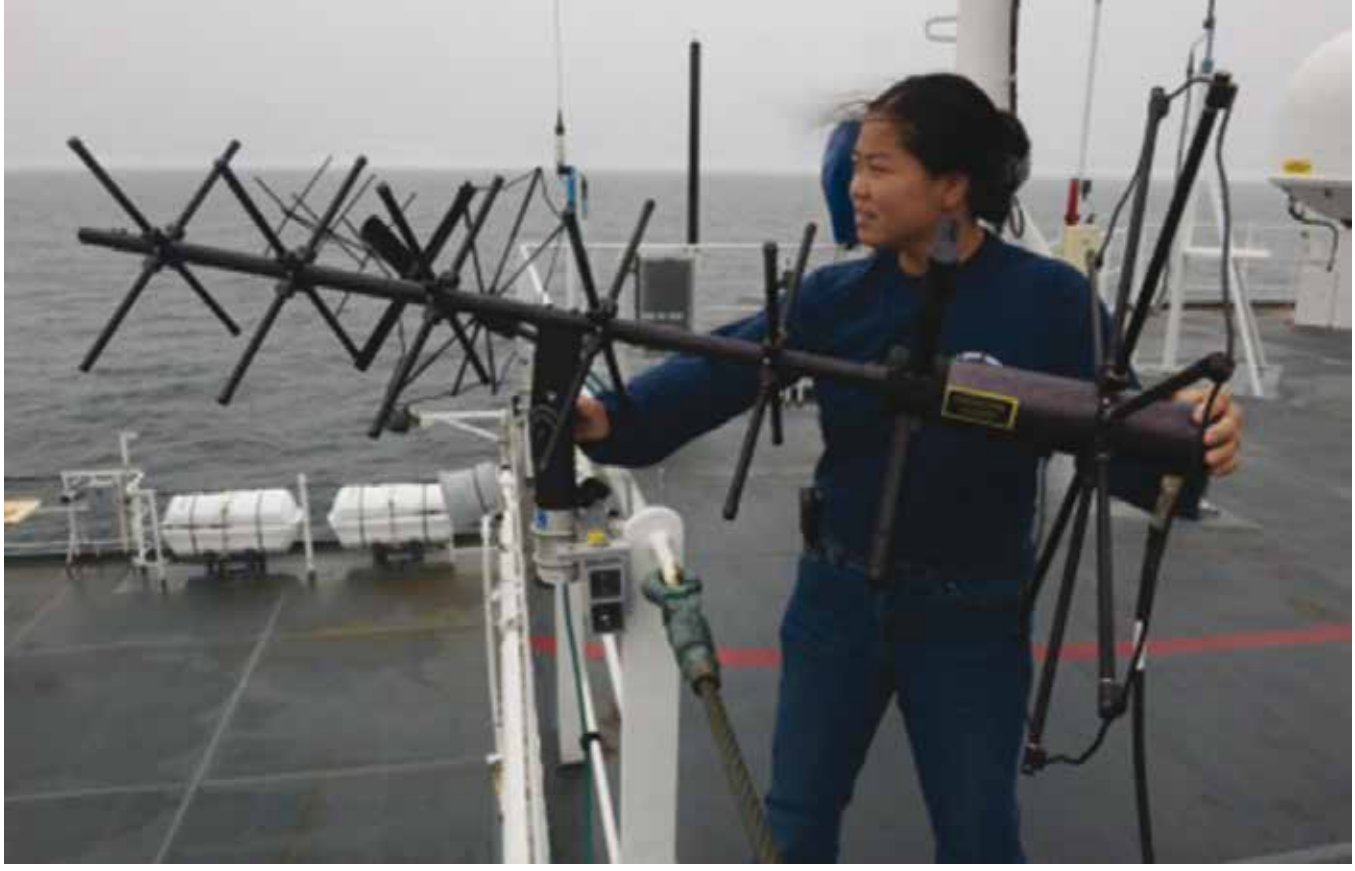
Operationally, user information will flow to the satellites via UHF WCDMA links, and the satellites will relay that information to one of four interconnected ground sites in Hawaii, Virginia, Italy and Australia via a Ka-band feeder link. These facilities identify the destination of the communications and route the information to the appropriate ground site for Ka-band uplink to the satellite and UHF WCDMA downlink to the correct users—a rapid, behind-the-scenes process that is transparent to the warfighter.

To prove these capabilities, MUOS is progressing through a series of rigorous developmental and operational tests, while simultaneously leaning forward with select capability demonstrations in a variety of challenging environments. A major step took place in March 2013 with the first end-to-end system test, and testing has continued with progressively more complex integration and scenario-based events. While each piece of the program conducted earlier laboratory evaluations to ensure they were meeting their individual requirements, the end-to-end tests bring all of the components from multiple programs together and demonstrate secure voice and data calls through MUOS-1 and the ground network. Utilizing the Army's Handheld, Manpack and Small Form Fit Manpack Radios, testers have completed a series of different call types, lasting from 3 minutes to 24 hours, with data rates up to 64 kilobytes per second. The test results have shown increased stability of the system, while allowing engineers to reduce risk by addressing integration issues that had not arisen during individual component tests.

In conjunction with the ongoing end-to-end tests, the team has supported several demonstrations to gauge MUOS potential in different operational scenarios while reducing risk for future record testing. One such demonstration was performed at the Arctic Circle in October 2013, where very high latitudes pose a challenge because the satellite is in geosynchronous orbit above the equator, and therefore harder to see. The MUOS team tested the ability of the Manpack Radio to reach the MUOS satellite communications network at latitudes up to 89.5 degrees north. The demo included both fixed-site locations around Anchorage and Barrow, Alaska, and aboard an aircraft operating above the Arctic Circle. The Manpack Radio successfully completed multiple point-to-point voice and data calls, as well as group calls connecting more than five radios.

Another demonstration, the Navy Submarine Ice Exercise, was conducted in March 2014. MUOS was operational for 15 days at Ice Camp Nautilus, a temporary research facility set up on the ice for Arctic submarine exercises, where operators successfully demonstrated long-term connections across multiple enclaves in a challenging environment.

In August 2014, the Air Force Research Laboratory conducted an airborne MUOS risk-reduction event featuring the in-flight demonstration of the MUOS waveform ported onto two different radios developed by two vendors—the PRC-155 HMS Manpack and the ARC-210—on a C-17 aircraft. Both radios



An advanced program lead for Lockheed Martin adjusts a UHF antenna aboard the Coast Guard Cutter Healy while under way near Alaska last August. The program lead works with narrowband military satellite systems and was onboard the Healy to test the capabilities of the Mobile User Objective System in the Arctic.
U.S. Coast Guard photo by Petty Officer 1st Class Shawn Eggbert

performed well, transmitting and receiving over the air while the aircraft was on the ground and while airborne, and recording progress in voice quality, data exchange and airborne call completion rates.

The MUOS team further stressed the system during North American Aerospace Defense Command/Northern Command Arctic Shield and ICE CUBE in August 2014 and Pacific Command Operation Deep Freeze in November 2014, where they demonstrated MUOS network performance through multiple nodes in extreme latitudes. Other demonstrations continue, including assessments of communications performance with different applications and antenna configurations including the Joint Strike Fighter and a scenario-based integration event with Naval Special Forces.

The demonstrations have produced a wealth of valuable information. Of primary focus and importance is the Multiservice Operational Test and Evaluation (MOT&E) Phase Two scheduled for December 2015. The scope of the MOT&E is significantly expanded from the initial end-to-end tests and will use two satellites, route calls through at least two ground stations instead of a single location, and involve larger quantities of radios and Defense Information Systems Agency (DISA) teleports. To prepare for the MOT&E, the Navy and Army team have developed a 10-step approach designed to increase reliability and validate integration of the waveform, and ground and terminal software configurations heading into the test. Although this plan required delaying the MOT&E, it will not affect the satellite launch schedule or the timeframe for achieving Full Operational Capability (FOC). The MUOS team will continue to conduct disciplined preparation and risk-reduction activities on the path to the MOT&E and FOC.

Joint Acquisition Approach

The acquisition of this complex system across several program offices has not been without its challenges. A Red Team Assessment of the technical viability and probability of success offered lessons learned and recommended way ahead for MUOS. In May 2012, Under Secretary of Defense for Acquisition, Technology, and Logistics Frank Kendall signed an Acquisition Decision Memorandum that clearly defined roles and responsibilities and that continues to drive the program's success.

The Navy's Communications Satellite Program Office has overall responsibility to deliver MUOS end-to-end capability. It is supported by the Army's Project Manager for Tactical Radios, which supplies the Manpack Radio, and Project Manager Joint Tactical Networks (JTN), which provides the MUOS waveform along with the network management system that provisions the radios and displays network information such as phone numbers and call groups. The Joint Tactical Networking Center maintains an information repository of

secure networking waveforms and applications for the DoD, which allows for interoperability across the Joint Services and continuous upgrades to waveform capability.

The MUOS waveform is part of that repository and available to industry, enabling a competitive environment where different vendors can develop terminals and radios that support MUOS. Six vendors have already evaluated their hardware's connectivity with MUOS by using three laboratories that opened in 2014—a Lockheed Martin facility in Sunnyvale, California; a General Dynamics facility in Scottsdale, Arizona; and a JTNC facility in San Diego. By realistically simulating the MUOS satellite network and various challenging environmental conditions, the laboratories support the integration of new and existing terminals with MUOS capability. A Memorandum of Agreement between the Navy, Army and DISA will define the roles and responsibilities to bring to operational status the recently released MUOS Military Standard (MIL-STD), which defines the process and criteria by which the government will certify terminals as they meet qualification standards.

The involvement of multiple Service branches and systems in MUOS has posed schedule challenges, such as the need to adjust acquisition and technology development timelines to account for other components.

For the Manpack Radio, which will be the primary MUOS terminal for ground users, the Army is moving forward with a competitive procurement of approximately 70,000 radios through the program's Full Rate Production (FRP) phase. The Manpack, delivered in vehicle-mounted and dismounted configurations, is the Army's first two-channel, software-defined radio capable of supporting advanced and current force waveforms. Under a full and open competition, Non-Developmental Item approach, the Army plans to award contracts to multiple vendors, creating a "radio marketplace" where vendors will compete for delivery orders as needed, after they achieve technical and operational requirements. The competition now is under way, with FRP scheduled to begin in Fiscal Year 2017.

To enable compatibility with MUOS, the Army developed the MUOS High Power Amplifier (MHPA) accessory to replace one of the Manpack's standard High Power Amplifiers. The MHPA includes special circuit boards and a full duplex modem that allow the MUOS waveform to run on the standard Manpack Radio. This technology, which eventually will become part of the radio itself, also is planned for use by the Navy, Marine Corps and Air Force.

The involvement of multiple Service branches and systems in MUOS has posed schedule challenges, such as the need to adjust acquisition and technology development timelines to account for other components. With such an integrated system, the status of each segment affects the others—requiring both a holistic approach to configuration management and certain inevitable trade-offs for the sake of a capability that ultimately will benefit thousands of joint users. What has kept the program moving forward is a solid foundation of defined responsibilities and areas of expertise, open communications, flexibility to adapt to unexpected contingencies, and, above all, the professionalism and commitment of the civilians and the Soldiers and Sailors dedicated to delivering this capability to the joint warfighter.

Conclusion

Shoot, move and communicate—of these fundamental Soldier skills, the ability to do the latter is changing rapidly. With our adversaries taking full advantage of progress in the commercial communications market, continued modernization is essential for the U.S. military to maintain information dominance in the future.

MUOS is a critical piece of this plan, replacing the aging UHF satellite constellation with a significant increase in narrowband communication capability. Users will notice the difference: more bandwidth that is accessible on demand as opposed to preplanned channels; better voice quality; and reliable service, even in remote regions, urban environments or inclement weather. By combining satellites with cellular technology, MUOS will provide troops on the move with high-speed voice, data and network connectivity.

To deliver these improvements, the MUOS team must manage significant technical and programmatic complexity, as well as interface with multiple vendors in a competitive environment. While much work remains to be done, a disciplined yet flexible multi-Service acquisition approach, grounded in documentation and cooperation, has enabled the team to confront the challenges together as we work toward mission success.

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