The AN/TPQ-53 system (shown here in its fully upgraded configuration) is the Army's next-generation counter-fire target acquisition radar. It is scheduled to replace the EQ-36 QRC in 2019. (Paul Salce/Lockheed Martin Corp.)

Untying the Gordian Knot

A tiered approach to radar coverage revisited

By Maj. Andrew Johnston

In the past, radar coverage for U.S. Army brigade combat teams and division artillery (DIVARTY) was viewed as a complicated if not intractable problem. Past attempts at "cutting" or "untangling" this knot resulted in a tiered multi-system approach. Multiple radar systems and additional sensor platforms were required to protect the force from the threat-set present in Iraq and Afghanistan. However, the battlefield of the future requires increased capability and flexibility from fewer sensor platforms and electromagnetic spectrum emitters in smaller, more geographically dispersed units. Fortunately, a significant paradigm shift in sensor management is possible with targeted investment in the coming years.

Jan. 31, 2017, marked a milestone for the AN/TPQ-53 program as Lockheed Martin rolled the 100th Q-53 off the assembly line in Syracuse, N.Y. On March 30, 2017, the Army awarded Lockheed Martin a full-rate production contract for the production of an additional 74 systems. From its humble origins in the Multi-Mission Radar Science and Technology Objective and EQ-36 Programs, the Q-53 has emerged as the world's most advance weapons locating radar, providing a capability described by the 101st Airborne Division fresh from a deployment, as a "game changer." The C-130 capable, Q-53 is replacing both the AN/TPQ-37 and AN/TPQ-36 FireFinder radars in the Army inventory. A detailed modernization strategy that utilizes pre-planned product improvements (P3I) and receives adequate funding will enable the Q-53 to serve as the key platform for a multifunction Fires sensor capability over the next 25 years.

Pre-planned product improvements

P3I consist of three key upgrades to modernize the platform for Army 2025 and beyond. These upgrades will consist of software enhancements, a refreshed signal data processor (SDP) and transition to Gallium

Nitride (GaN) Transmit/Receive Modules (T/R).

Initial work focuses on planned software improvements to increase range and accuracy of the system and provide improved projectile classification. Updates simplify clutter mitigation and enhance electronic protection features of the system. New software increases the system's ability to correctly classify rockets, artillery and mortars down to the subtype. These changes serve to improve the system's reliability and availability, resulting in fewer system aborts and less downtime in the field.

A planned transition to Next Generation Graphical User Interface allows a common user interface on both the Q-50 and Q-53 radar systems. It reduces the training requirements and eases potential issues in the transition of operators between radar systems.

Key hardware changes mitigate technical obsolescence in current low initial rate production systems. A new improved SDP features faster processing and improved cooling with open architecture to accommodate future growth. Radars in the in force today rely on Field Programmable Gate Arrays to convert signal data received by the antenna into computer language for processing. Like all modern computer systems, the hardware underlying the Q-53 is subject to Moore's Law in that processing capacity has increased significantly since the first system was produced in the late 2000's. A redesigned SDP uses commercial-off-the-shelf technology consisting of single board computers and graphical processing unit cards. The chassis design features efficient conductive cooling and reduced power consumption, greatly increasing the performance of the system. This modernization effort alone increases the processing power of the radar by two-and-a-half times the original capacity, while allowing significant capacity for future growth.

The T/R modules on board the Q-53 are 10 years old and obsolete. They will be replaced with the now affordable GaN technology. Currently, Q-53 radars consist of 1024 T/R modules in groups of eight, called an octapack. Today these modules use Gallium Arsenide high power amplifiers to transmit and receive radio frequency energy. Commercial industry has transitioned to GaN, a newer technology commonly used in Blu-Rays, LED televisions, and the latest smartphones. GaN technology, overtime, is less expensive, features improved reliability, requires less energy consumption and produces less heat. The thermal efficiency of GaN T/R modules creates an additional benefit as fully populated GaN array will allow for a significant increase in the range of the radar. In fact, when combined with the new SDP, it may be possible to see doubling in the range capabilities of the system.

Counter unmanned aerial system

Separate from planned program of record (PoR) efforts to improve the Q-53 is a developmental effort aimed at new and emerging threats. Under this effort Lockheed Martin is developing a Q-53 air surveillance capability and integrating an identify friend or foe capability into the Q-53 radar. This two-year effort will see the Q-53 potentially add the ability to detect and classify unmanned aerial systems (UAS) at ranges greater than the Q-50, which grew out of the LSTAR and BSTAR (air surveillance) efforts. This effort could be become the foundation for true multi-mission radar capability at division and brigade combat levels in the Army. Adding air surveillance capability to the Q-53 provides cross domain sensing capabilities to maneuver commanders and will posture the Fires force for success on the battlefield of 2025 and beyond. Additional future capabilities could include ground, sea surveillance, or extended range providing additional sensor capabilities to a field artillery brigade, division, or other future Fires formations at the strategic level.

AN/TPQ-50

With its evolution from a Special Operations Command requirement to a PoR, the Q-50 CTA Radar adds considerable capability, in its specific role as a short range 6400 mil radar, to Army formations. The Q-50, like its predecessors the Q-48 and Q-49, consists of a modular radar, with an antenna composed of 24 columns mounted on a central mast. The Q-50 adds a dedicated M1151 Humvee prime mover as a component of the system and a 5kw generator for dedicated power. While not nearly as capable as the Q-53 in terms of range or accuracy, the Q-50, can provide close-range 360-degree coverage, freeing the Q-53 to support the "deep fight" in a potential high intensity conflict with a near-peer. Additionally, the Q-50 is configured to accompany forcible entry units during parachute or air assault operations. This unique capability makes the Q-50 ideal for protecting friendly drop zones, helicopter landing zones, C2 nodes, assembly areas and forward arming and refueling points where friendly forces face the greatest threat from enemy special operators and mortar teams infiltrating behind the forward line of troops.

As this threat evolves to include small Class I and Class II UAS capabilities, the Fires Center of Excellence continues to experiment with the potential of adding air search capability to a system similar to the Q-50. Future capabilities may include enhanced CTA performance, air search, or multi-mission capability and/or an on-the-move capability. The key to future technology insertion in the Q-53 program will be technology readiness level of new potential technology and the amount of resourcing provided to the program.

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