

## Radar Upgrades Extend System Life for Customers

Lockheed Martin recently completed an FPS-117 radar upgrade in Germany and is now under contract to perform a similar system enhancement in Romania.

Under a November 2003 contract, Lockheed Martin upgraded the synthesizers and preprocessors on eight German Air Force ground-based radars to avoid obsolescence and extend their usefulness for an additional 20 to 30 years beyond their expected 20-year lifecycle. The Bundesamt fuer Wehrtechnik und Beschaffung (Germany's Federal Office of Defense Technology and Procurement) originally acquired the radars from Lockheed Martin under a 1988 contract. The systems have been operational and providing air surveillance for the country since the early 1990s.

Besides the technology upgrade, the actual upgrade schedule required deft coordination to ensure that each time a radar was being upgraded that the operational availability of the other seven was maximized.

### Team Effort

"The program management and engineering teams stuck to an ambitious schedule and were a highly effective team," observed Frank Mekker, Lockheed Martin's program manager. In addition to the help that subcontractors provided to the German and Lockheed Martin field teams, the German Air Force's Material Command was supported by experts from its Depot



Germany's Grosser Arber Mountain is the site of one of the FPS-117 radars that was recently upgraded by Lockheed Martin. (Photo provided by Hubert Merkel)

and the 2nd German Air Division. The Procurement office was supported by the Bundeswehr Technical Center for Information Technology and Electronics.

"With all the upgrades now complete, the German Air Force has an even more reliable air surveillance capability that is easier to maintain," Mekker added.

Lockheed Martin was awarded a contract by the Romanian Ministry of Defense (MoD) to significantly upgrade five FPS-117 long-range radars originally delivered to Romania in 1998 and 1999. The radars are used for air traffic control and strategic air surveillance. The upgrades will extend the service lives of the radars for 15 to 20 years.

When the upgrades are complete, the electronics that provide each radar's signal processing and data processing capability – currently housed in four cabinets – will be replaced with modernized electronics that fit into one

cabinet. As a result, the radars will have the same capabilities and reliability as new FPS-117 radars.

"These technology upgrades provide a fourfold reduction in components in each radar. This equates to improved reliability and maintainability, as well as a real reduction in life-cycle support costs," said Kevin Hines, Lockheed Martin program manager.

Colonel Eng. Marin Mocanu of the Romanian MoD represented his country in negotiations for the upgrade contract. "This upgrade is for our primary national air defense system," he said. "Eliminating

obsolescence and maximizing the radars' capabilities will assist us with our applications to join NATO and the European Union."

The L-band FPS-117 radar provides continuous high-quality surveillance on air targets at ranges out to 250 miles. With more than 125 systems operational around the world, the FPS-117 is the most successful three-dimensional (3-D) solid-state radar ever built. The United Kingdom also contracted Lockheed Martin for an upgrade of two of its long-range radars.

"These radars have demonstrated a greater-than-98 percent availability since their installation and the upgrades will help maintain that level of availability for at least another 15 years," said Greg Larioni, Lockheed Martin's vice president for ground-based surveillance and airborne radar. "One of the biggest strengths we bring to our radar customers is the dependability of our products."

## SR4 Continues Strong Development Mode

The Scalable Solid-State S-band Radar (S4R) team successfully displayed live tracks with an internally developed Engineering Development Model (EDM) in Moorestown, New Jersey, this past winter.

The S4R EDM is an active, electronically steered, antenna-based radar system designed to be scalable to support multiple missions, including air surveillance, cruise missile defense, ballistic missile defense, counter target acquisition and littoral operations. The

proven design is derived from the S-band antenna developed for the U.S. Navy's Volume Search Radar on the DDG-1000 next-generation destroyer.

The S4R EDM was developed using Silicon Carbide (SiC)-based high-power Transmit/Receive (T/R) modules. SiC provides greater power than other commonly used materials due to its increased heat tolerance. With more power, the radar has longer range and provides more precise target discrimination.

Transmit/Receive modules are the

most critical components of a solid state antenna. They serve as multiple function circuits that generate and transmit signal power over the full face of the radar, receive the reflected radar signal, amplify it for processing and electronically steer the radio frequency beams in space.

"This system provides evidence of a proven approach using high-power Silicon Carbide technology," said Carl Bannar, vice president of MS2's Radar Systems line of business. "In addition, the total system approach provides flexibility for multiple mission needs."

## SPY-1F Radar Makes Waves During Debut

Norway's Aegis-equipped Fridtjof Nansen joined the USS Gridley and Spain's Méndez Núñez for the first-ever three-nation Combat System Ship Qualification Trials (CSSQT) in the eastern Pacific this past June.

The Fridtjof Nansen's participation marked the introduction of the SPY-1F radar system. SPY-1F is a smaller, lighter version of the SPY-1D radar system, providing robust performance with Evolved Sea Sparrow Missile (ESSM) and SM-2 missile capability on frigate and corvette-sized ships.

The performance of Fridtjof Nansen's SPY-1F and Aegis Weapon System during the CSSQT were outstanding. Despite the difficult Southern California radar environment, the SPY-1F provided exceptional search frame times, minimal littoral clutter effects (false tracks, folded clutter suppression issues) and outstanding sea skimmer detection ranges.

The SPY-1-ESSM-Target Illumination System (TIS) was flawless during fire control loop performance, including perfect ESSM launch acquisition and the highest and furthest ESSM intercepts ever.

Also notable was the SPY-1F's ability to detect and track a smaller-than-threat supersonic high diver at greater than five-time maximum ESSM range in the littoral.

The Norwegian frigate Roald Amundsen, also equipped with a Lockheed Martin-developed SPY-1F Aegis Weapon System, was commissioned in May.



The Norway first-in-class Fridtjof Nansen (foreground), with Lockheed Martin's SPY-1F radar and Aegis Weapon System, demonstrated its capabilities against a variety of air threats, including sea-skimming and high-diving supersonic missiles, during trials in the Eastern Pacific in June. Also taking part in the Combat System Ship Qualification Trials were the Méndez Núñez (middle) and the USS Gridley.

## Thousands View New Denmark Radar at Air Show



The Royal Danish Air Force displayed one of its two new Lockheed Martin TPS-77 mobile, long-range surveillance radars at an air show at the Aalborg Air Force Base on June 10. The air show featured an array of Danish, European Union and United States military aircraft and attracted an impressive 75,000 people for the one-day event. The radars, which were delivered to their home base in Karup several months ahead of schedule, were formally accepted by the Danish government this summer. Pictured (l to r) are: Major Niels Korning, Operations Expert, C2 Branch, Danish Defence Acquisition and Logistics Organization; Henrik Hornhaver, Technical Director, Danish Defence Acquisition and Logistics Organization; and Tim Petersen, radar program manager, Lockheed Martin. "As a result of the teamwork we have enjoyed with our Lockheed Martin colleagues, Denmark now has a significantly improved surveillance capability," said Hornhaver.

### MAKING CONTACT

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# Radar Sense

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## Lockheed Martin Awarded \$120 Million to Develop U.S. Army Enhanced Counterfire Target Acquisition Radar

Expertise and field experience drive quick delivery of critical new U.S. Army radar system

Every day of the 14 months that U.S. Army Colonel Lee Flake spent in Iraq added to the field artillery officer's conviction that something needed to be done to improve the Army's capability to detect incoming mortar and rocket fire — and soon.

Existing radar systems were limited to 90-degree search sectors, which allowed the enemy to observe the direction of the antenna and attack from the rear. One of the systems was effective at detecting short-range mortars but much less effective in tracking rockets from farther out. The other system had the opposite limitations.

Plus, the rigorous demands of around-the-clock operation and the harsh Iraq environment were causing both systems to show their age. The 30-year-old radars were prone to breakdowns, and spare parts were hard to get.

Today, Flake is engaged in an effort that will help remedy those shortcomings. He retired from the Army in 2005 and is now director of the Lockheed Martin MS2 EQ-36 Counterfire Target Acquisition Radar program in Syracuse, New York.

### Aid to the Warfighter

Lockheed Martin was awarded a contract valued at approximately \$120 million to provide the U.S. Army with five EQ-36 (technically, the Enhanced AN/TPQ-36) radars. The contract was awarded by the Army's Program Executive Officer-Intelligence, Electronic Warfare & Sensors (PEO-IW&S). The radars will be delivered within 30 months. In all, Radar Systems could provide 197 systems to the Army worth nearly \$2 billion.

The Army will use EQ-36 systems to replace aging TPQ-36 and TPQ-37 radars. The EQ-36 will provide soldiers with the capability to detect, classify, track and determine the location of enemy indirect fire such as mortars, artillery and rockets aided by a 360-degree search capability. Moreover, they will be more reliable, more mobile and have greater range.

"I saw the problems that our soldiers were having with the old systems," says Flake, whose last assignment in Iraq was chief of staff of the First Armored Division. "We're determined that we're not going to just hit the ground running on this program; we're going to rocket off the starting line. We need to get these radar systems in the hands of our units in the field."

The EQ-36 will provide soldiers with the capability to detect, classify, track and determine the location of enemy indirect fire.

MS2 in Syracuse is the lead systems integrator on the program, but other Lockheed Martin sites also have key roles. MS2 in Moorestown, New Jersey, is providing the transmit/receive modules and antenna, and Lockheed



This artist's concept shows the Lockheed Martin EQ-36 Counterfire Target Acquisition Radar. This system will provide U.S. Army soldiers with the capability to detect, classify, track and determine the location of enemy indirect fire such as mortars, artillery and rockets.

Martin Simulation, Training and Support in Orlando, Florida, will lead the development and production of the EQ-36 training system and curriculum that will be embedded in each unit. In addition, Lockheed Martin Missiles and Fire Control contributed significant expertise to the program.

### MMR-ATO Plays Key Role

Other key teammates include Syracuse Research Corp., which is responsible for the digital signal processor; Tobyhanna Army Depot, which will provide sustainment and maintenance support; and Burttek, Inc., which will provide the operations shelter and stationary platform.

The role of Syracuse Research has

Continued on page 3, "EQ-36"



## Technology, Mission Requirements Key Radar Day Discussions

**M**ay 1 might have been "May Day" to some, but for Lockheed Martin it was "Radar Day." The company, together with the U.S. Air Force Electronic Systems Center, presented a full day of presentations and demonstrations at Hanscom Air Force Base in Bedford, Massachusetts.

Event attendees included Air Force personnel as well as engineers from The MITRE Corporation and Lincoln Labs, two U.S.-funded high-tech research and development centers located near Hanscom AFB.

The morning featured several presentations by the Lockheed Martin team that addressed key missions of Lockheed Martin radars, including battle control, homeland air and cruise missile defense, and space situational awareness. Rich Byrne, vice president, command and control, for MITRE, also spoke on five challenges facing the future of sensors.

The afternoon session was highlighted by two breakout sessions that took an in-depth look at system architecture and hardware development, respectively, that incorporated both tech talks and equipment demonstrations.

"Events like Radar Day help us demonstrate our capabilities and investments in the future state of radar and creates a dialogue with our customer to confirm that we are headed down the right path," Carl Bannar, vice president and general manager, Radar Systems, said. Bannar kicked off the day by providing an overview of the Lockheed Martin Radar Systems line of business. ☒



**A Full 360 of Information.** Radar Day attendees spent the morning session listening to discussions on Lockheed Martin's current radar portfolio and its future state. A full slate of presenters spoke on operational performance and physical requirements issues, mission applicability, interoperability and affordability. Complemented by the afternoon demo sessions, the day focused on the growing importance of rapid acquisition and open architecture and demonstrated the significant investment Lockheed Martin has made to develop a number of innovative technologies



**The Digital World.** Lockheed Martin MS2 Advanced Systems Senior Manager Tim Ehret (right) answers questions about the digital radar system prototype displayed at the conference. The prototype, in development in Moorestown, New Jersey, translates between digital and RF signals at each antenna element. This enables replacing standard RF devices like phase shifters and beamformers with digital processor algorithms. The result is a streamlined architecture that provides high performance operation, as well as reduced size, weight and cost.



**Monitoring From Afar.** Steve Duniyk (right), ground-based radar technical director, shows U.S. Air Force Senior Master Sergeant Marcus Jellerson (left), and Carl Bannar (middle), vice president and general manager, Lockheed Martin Radar Systems, a demonstration of the remote management system (RMS). Today, more than 50 Lockheed Martin radar systems worldwide utilize this capability that connects them to the RMS lab located in Syracuse, New York. Beside full Command and Control, RMS provides customers the ability to remotely monitor, assess and troubleshoot any connected FPS-117 or TPS-77 radar system to decrease system downtime and lower life-cycle support costs.



**Protecting the U.S. and its Neighbors.** Dr. Kurt A. Olsen (left, speaking), Lockheed Martin Senior Fellow, spoke on homeland air and cruise missile defense. Olsen outlined the radar challenge, surveyed key Lockheed Martin Theater Air and Missile Defense radars, defined a vision, and outlined a path forward for North American air security and missile protection. The talk included time for questions and answers, and led to a lively two-way technical exchange and continuing technical discussions during the day.



**The Future is Now.** Don Ferguson (right), manager of Advanced Monolithic Microwave Integrated Circuits (MMIC) and Transmit/Receive (T/R) Modules Design, discusses the advances of Lockheed Martin's advanced T/R technology for air, ground and maritime radar platforms, UHF through Ka-Band. This high performance, high reliability technology is risk-reduced through demonstration in radar platforms such as the Multi Sub Array Demonstrator and Littoral Combat Radars (LCR) operating at Lockheed's Joint Solid State Advanced Radar Center. Lockheed Martin MS2 is currently applying advanced High Voltage Gallium Arsenide (HVGaAs) technology to the U.S. Army EQ-36 and U.S. Navy DDG1000 Volume Surveillance Radars.



**Lighter, Stronger, Flexible.** Technology advances in NanoTechnology are now enabling materials to be fabricated with properties that previously were unattainable. Walt Werner, principal engineer, describes Lockheed Martin's pioneering work on the development of ultra-lightweight nano-composite antennas that provide large advantages such as durability under large strain, oxidation resistance, and the ability to be embedded into the skins of military platforms. Remarkably, these nano-enabled antennas have only 0.007% metal content yet have demonstrated performance close to that of antenna elements fabricated with solid copper.

## EQ-36 (continued from page 1)

been particularly significant, says Mark Starr, vice president of multi-mission radars at MS2. Before bringing the company onboard for the EQ-36 program, MS2 worked with Syracuse Research on the Multi-Mission Radar Advanced Technology Objective (MMR-ATO), which resulted in the development of technology that is being leveraged for the EQ-36.

"I can't stress enough the advantage we gained from the MMR-ATO program," Starr says. "The technology was tested at the Yuma Proving Ground, which proved our concepts indeed worked and demonstrated beyond any doubt that our design was achievable, low risk and cost competitive."

**The EQ-36 radar campaign theme, "It's About the Soldier,"** has been very well received by the U.S. Army customer.

The risk reduction achieved by the MMR-ATO program was critical because of the complexity of the tracking task that the EQ-36 will perform.

"Tracking an in-flight projectile is difficult because it's a very small object moving very quickly, and it's not just detecting the object, but also determining if it's something you want to track," Starr explains.

When it determines which objects are in fact projectiles, the system uses algorithms to determine where actual projectiles are going to land — and it does it while the system's antenna is rotating.

### "It's About the Soldier"

Perhaps the greatest challenge facing the EQ-36 team, however, is schedule. It now has just 30 months in which to deliver the first systems. Although the schedule is tight, both Starr and Flake say the team recognizes that it is by necessity, and that everyone is committed to getting the life-saving radar into the field.

"Under Lee's leadership, everyone is thinking like a soldier and recognizing the customer's critical need for these radars," Starr says. "We're all just damn proud to be part of the team."

For more information about the Lockheed Martin Radar Systems' EQ-36 radar, please contact Kurt Norman at kurt.d.norman@lmco.com, 315-456-1538. ☒

## Lockheed Martin's Aegis Weapon System Milestones: 100th System, Ballistic Missile Defense, International Growth

**S**ince this past winter, Lockheed Martin's Aegis Weapon System achieved several key milestones, including the delivery of the 100th Aegis Weapon System, completing a simultaneous intercept of a ballistic missile and cruise missile and winning a contract for the first three Aegis-equipped destroyers for Australia and a fifth shipset for Spain.

### 100th Aegis Weapon System

During a ceremony last winter to deliver the 100th Aegis Weapon System, Chief of Naval Operations Adm. Mike Mullen announced that the destroyer receiving the system will be named Wayne E. Meyer, after the retired rear admiral who is widely regarded as the "Father of Aegis."

"I can think of no better name for a new destroyer than Wayne E. Meyer, and no better tribute to the man who inspired and delivered Aegis to our fleet," said Adm. Mullen. "He is a legend, a man of great vision and leadership." He added, "It is just as impossible to overstate the contributions of Aegis to our nation's defense as it is to imagine where our great Navy would be without the contributions of Adm. Meyer."

Aegis is the most successful air defense weapon system and multi-mission combat system in the history of the U.S. Navy. Aegis delivered revolutionary capability to the fleet immediately upon its introduction in 1983 and the periodic delivery of progressive spiral development upgrades has since maintained the Aegis Weapon System at a state-of-the-art technology level to take on new, more complex threats. The Aegis Weapon System set for the Wayne E. Meyer (DDG-108) holds eight times more computing power and costs 66 percent less than the Aegis baseline produced 24 years ago.

### Aegis Ballistic Missile Defense

During a test in April, the Aegis Ballistic Missile Defense (BMD) Weapon System proved its multi-mission capability by simultaneously engaging two targets — a ballistic missile and an anti-ship cruise missile — in the Pacific Ocean off the coast of Hawaii.

The test represents the Aegis system's eighth successful ballistic missile intercept in 10 attempts, and the first intercept while simultaneously



*The plug is pulled – signifying the completion of testing and readiness for delivery – on the 100th Aegis Weapon System. Pictured, left to right, Rear Adm. Michael Frick, Assistant Secretary of the Navy Dr. Delores Etter, Rep. Jim Saxton, Chief of Naval Operations Adm. Mike Mullen, Rear Adm. Wayne E. Meyer (ret.), Fred Moosally, Lockheed Martin MS2 president, Rear Adm. Charles Hamilton and Rear Adm. Brad Hicks.*

engaging an air threat. In addition to its record of intercepts, Aegis BMD has successfully supported more than 15 ballistic missile defense system tracking tests since June 2004.

Early this year, the U.S. Department of Defense's Missile Defense Agency awarded Lockheed Martin \$979 million for continued development and evolution of the Aegis BMD Weapon System.

Capability improvements planned in the next phase of Aegis BMD include equipment and computer program development and incorporation of the Aegis BMD Signal Processor (Aegis BSP) into the AN/SPY-1 radar, which as a system provides an advanced discrimination capability to defeat more complex ballistic missile threats. The Aegis BSP, which will be installed on all Aegis BMD ships beginning in 2010, is an open architecture design, allowing for quick and affordable upgrades as signal processor technology evolves.

In addition, Lockheed Martin will develop an adjunct computing suite that will house several computing devices and software components that continue Aegis BMD's migration to open architecture (OA). This move for Aegis BMD is in parallel alignment with the U.S. Navy's Aegis Open Architecture initiative to transform the (non-BMD) Aegis Weapon System to a fully OA system. BMD

capability will be included in modernized, OA combat systems in Aegis cruisers and destroyers starting in 2012.

### Aegis' International Growth

The U.S. Navy recently awarded Lockheed Martin \$260 million for Aegis Weapon Systems to equip three Australian Air Warfare Destroyers (AWD) and one Spanish F-100-class frigate.

The four will be next-generation Aegis Weapon Systems — among the first to include 100 percent commercial off-the-shelf hardware and a fully OA computing environment. Lockheed Martin will synchronize production of the systems for Australia and Spain with the U.S. Navy's Aegis modernization program, which calls for delivery of the first fully open architecture Aegis Weapon System to the USS Bunker Hill in 2008.

The latest contract is a modification to a June 2006 award of \$85 million for Australia's AWD long-lead material items. The modification covers the production phase for Aegis Weapon Systems for the three Australian destroyers and for Spain's fifth Aegis-equipped ship.

The Aegis Weapon System, the foundation for Aegis BMD, seamlessly integrates the SPY-1 radar, the MK 41 Vertical Launching System, the Standard Missile family and the weapon system's command and control system. ☒