Eyes On The Skies

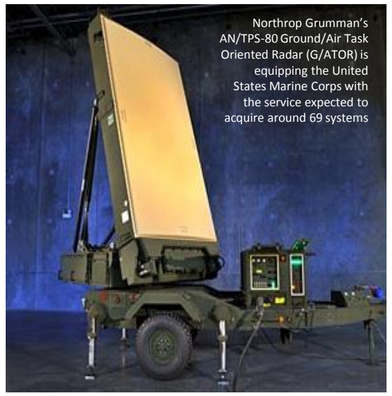
Ground-based air surveillance radar developments

WORDS THOMAS WITHINGTON

Several factors are driving forward the acquisition of new ground-based air surveillance radars around the world notably the replacement of obsolescent systems, a need to counter new threats and improved radar technology offering enhanced capabilities…

Armed forces around the world are looking to replace radars which have been in their inventories for the past 30 years. The United States is leading the pack with both the US Air Force (USAF and the United States Marine Corps (USMC) involved in ambitious programmes to replace their legacy air surveillance radars with the new Three-Dimensional Expeditionary Long-Range Radar (known as the 3DLERR) and the AN/TPS-80 G/ATOR (Ground/Air Task Oriented Radar). The latter system is being produced by Northrop Grumman for the USMC, with the company awarded a contract in August 2013 worth $24.5 million to cover the commencement of production engineering and anticipated cost growth. The radar is being procured in several increments which add increasing functionality. For example, the Increment-I radars will perform Identification Friend or Foe (IFF) and weapons location. Increment-II radars will have Mode-5/S enhancements to their IFF interrogators to give them compatibility with NATO and civilian protocols for aircraft identification. Increment-III radars will have enhancements to their electronic countermeasures resistance and health and usage monitoring with Increment-IV radars retaining an air traffic management function. The USMC is expected to procure around 69 AN/TPS-80s including 17 Increment-I, 38 Increment-II/III and 14 Increment-IV examples.

The USAF is still to choose which company will fulfil its 3DELRR requirement which replaces its legacy Northrop Grumman AN/TPS-75 S-band (2.3-2.5/2.7-3.7 Gigahertz/GHz) 240-nautical mile (444-kilometre) range radars. Northrop Grumman, Raytheon and Lockheed Martin are all involved in the competition with all three firms commencing the manufacturing and development phase of this initiative in 2013. Reports in April articulated that the USAF plans to award a contract for the 3DELRR procurement by the third quarter of this year. Low rate initial production of the radar could then commence in early 2018 with the first deployments occurring two years later.



Northrop Grumman's AN/TPS-80 Ground/Air Task Oriented Radar (G/ATOR) is equipping the United States Marine Corps with the service expected to acquire around 69 systems

Recapitalisation

The past year has witnessed significant acquisitions of air surveillance radars as other nations around the world seek to overall their existing capabilities. For example, both Finland and Estonia have acquired new Thales GM-403 medium-range systems which offer an instrumented range of 250nm (470km). More recently this May, Thales announced that it had signed a Memorandum of Understanding (MoU) with SKTB Granit of Kazakhstan to form a joint venture known as Granit Thales Electronics for the production of GM-400 radars to equip the Kazakh Air Force. A total of 20 radars will be produced under the terms of the MoU, although there is no word on when these radars will enter service. Looking towards the Asia-Pacific region, the Philippines has moved towards updating its ground surveillance radar capabilities with the acquisition of three air search radars from Israeli defence electronic specialists IAI (Israel Aerospace Industries) Elta Systems. The radars will enter service over the next two years, with Israel lending a single radar to the Philippines as a stop-gap measure to provide coverage while the new radars are being produced. The type of radar which the Philippines is to acquire has not been revealed, although it is thought to be Elta's EL/M-2288ER S-band radar which is designed for fixed site installation with a detection range of up to 232nm (430km).

Threats

New and emerging threats are acting as powerful incentives for the acquisition of air surveillance radars. These threats include the proliferation of Unmanned Aerial Vehicles (UAVs), ballistic missiles and low-observable so-called 'stealth' aircraft. UAVs are being seen as an increasing threat, not only as a platform by which intelligence can be gathered, but also as a possible delivery system for explosives or weapons of mass destruction. A UAV equipped with a warhead containing a biological or chemical agent could in effect become a poor man's cruise missile. Ballistic missile proliferation, particularly around the Middle East and Asia-Pacific regions continues to pose a threat to many nations, while the development of advanced fifth-generation combat aircraft such as the Sukhoi PAK-FA and the Chengdu J-20 with airframes and subsystems designed to reduce their Radar Cross Section (RCS) also pose a danger.

Thales' GM-400 family of air surveillance radars has sold well around the world. In 2013, Finland and Estonia both took delivery of new GM-403 radars to enhance their airspace control and to replace legacy systems

Radar designers are meeting such challenges with products such Selex ES's KRONOS family of air search radars. These C-band (5.25-5.925GHz) systems are specifically designed, according to the company, to detect targets low RCS targets such as UAVs and stealthy aircraft. Moreover, these systems can also be used to provide ballistic missile defence given the range at which they can detect their targets. To this end, Selex ES produces three KRONOS variants including the KRONOS Grand Fixed, KRONOS Grand Mobile and KRONOS Land. The instrumented ranges afforded by these radars are circa 100nm (185nm), and they include a number of measures such as wideband frequency agility and ultra-low sidelobes to reduce the radar's detection and interception by electronic countermeasures.

Ballistic missile proliferation is concentrating the minds of air defenders with a number of countries procuring air surveillance radars specifically designed to provide detection and tracking of such threats. In this regard, the United Arab Emirates has procured Raytheon's AN/TPY-2 X-band (8.5-10.68GHz) radar for air defence. The radar itself forms a key part of the Lockheed Martin Terminal High Altitude Area Defence surface-to-air missile systems entering service with the US Army, although it has also been used extensively by the United States as a stand-alone system to provide ballistic missile defence at a number of forward-deployed locations in Israel, Japan, Qatar and Turkey. As the world's largest transportable X-band radar it is able to detect ballistic missiles at very long ranges, potentially at up to 540nm (1,000km). Like many of the air search radars on the market, and discussed in this article, the AN/TPY-2 uses a Phased Array Antenna.

Main image: An Air Defense Tactical Operations Center Enhanced Operator-Maintainer prepares to employ an Air and Missile Defense Regiment Sentinel radar. The air defense system enhanced the U.S. Border Patrol's efforts to detect and respond to suspected low flying aircraft used by transnational criminal organizations to transport illicit drugs across the U.S.-Mexico border in Southern Arizona.
Image: Armando Carrasco, JTF North Public Affairs

What this means in practice is that the radar's antenna is equipped with a multitude of elements each of which is fed by a phase shifter. This allows electronic beam steering of the Radio Frequency (RF) transmissions which the radar is making as the phase of the signal which is emitted by the element can be changed in such a way as to move the radar's RF emissions in a particular direction. This allows static radars (i.e. non-rotating) to 'see' across a wide angle, rather than only in a straight trajectory from the antenna face. The United States is not the only nation involved in the provision of radars for ballistic missile detection. Elta Systems has developed the EL/M-2080 Green Pine L-band (1.215-1.4GHz) missile detection radar which reportedly has a range in the region of 269nm (500km). Also using Phased Array technology, the EL/M-2080 has been acquired by the Israeli Air Force to provide target acquisition and fire control for the country's Boeing/IAI Arrow-3 ballistic missile defence SAM system. A further development of the EL/M-2080 is the EL/M-2080S Super Green Pine which is believed to have a range extension to 485nm (900km).

Saab has enhanced its air surveillance radar portfolio by adding a number of new products which were launched by the firm in May this year. Among them is the Giraffe 4A which has a range of 151 nautical miles (280 kilometres)

Technology

As noted above, improvements in radar technology are offering additional incentives to countries seeking to enhance and upgrade their air surveillance radar inventories. The employment of Active Electronically Scanned Array (AESA) technology is arguably the single most important technological evolution in radar technology since its proliferation during the Second World War. An AESA radar uses a multitude of Transmit/Receive (T/R) modules mounted on the face of the radar antenna. These T/R modules are, for all intents and purposes, individual miniature radars which generate their own RF signal and process the echo as the RF signal hits the target and is returned to the antenna. The development of T/R modules has occurred thanks to advances in the miniaturisation of electronics.

AESA radars offer several useful advantages. Firstly, they can be difficult to detect as their T/R modules can change the frequency of the RF energy that they emit. This can be done in a several times a second creating a frequency-hopping transmission which is difficult to detect. This is a similar principle to that used by frequency-hopping tactical radios. The difficulty of interception for an AESA radar has the corresponding attraction of making them hard to jam. Basic electronic warfare techniques call for a radar's frequency to be determined and then jammed using a signal broadcast on that same frequency, or at a slightly different frequency, but nevertheless still recognised by the radar to fool the radar's signal processor regarding the speed or location of a target. Other attractions regarding AESA design include 'graceful degradation'. The scores of T/R modules embedded on a radar's antenna allow some to fail, but the radar to still function reducing the number of single-point failure items compared to legacy, non-AESA mechanically-scanning radars. It is also possible to design an AESA-based radar using flat panels positioned in such a fashion next to one another in a cubic or pyramid pattern to provide 360 degrees of coverage thus removing the need for a rotating antenna.

The performance advantages offered by AESA technology, coupled with the proliferation of the threats discussed above and the need to recapitalise legacy inventories of ground-based air surveillance seem certain to keep the radar market buoyant for many years to come.

'The employment of AESA technology is arguably the single most important technological evolution in radar since the Second World War'

NATIONAL PROGRAMMES

CZECH REPUBLIC

Czech radar specialists Retia will deliver its second two-dimensional (range and azimuth) ReVISOR ground-based air surveillance radar to the Czech armed forces by November 2014.

The company has already delivered a single radar to the 25th Ground Based Air Defence (GBAD) Regiment of the Czech Armed Forces, which was handed over in April 2014. The ReVISOR is a short-range X-band (8.5-10.68 Gigahertz) radar which has an instrumented range of 13 nautical miles (25 kilometres), and a 16400 feet (5000 metres) ceiling.

Employing Active Electronically Scanned Array (AESA) technology, the radar has an integral Identification Friend or Foe (IFF) secondary radar and can exchange its data using the ASTERIX (All Purpose Structured Eurocontrol Surveillance Information Exchange) and AWCIES (Air Command and Control System Wide Common Information Exchange Standard).

One of the key features, according to Retia experts with whom the author conversed at the June 2014 Eurosatory exhibition held in Paris, is the radar's accuracy which is particularly effective against targets with a low radar cross section such as Unmanned Aerial Vehicles. To this end, targets can be detected with up to 50 metres (164 feet) in range and up to 0.25 degrees in terms of azimuth accuracy.

In service with the Czech armed forces, the ReVISOR radar will be used to provide air surveillance and fire control data to units of the 25th GBAD Regiment which operate the Saab RBS-70 short-range surface-to-air missile system. The Czech Republic signed a contract for the procurement of the RBS-70 laser-guided GBAD system in 2004.

LATVIA

Latvia has approved 158 million euros into boosting its air surveillance and anti aircraft capabilities.

Defence Minister Raimonds Vejonis announced that the injection would fund new air surveillance radars, individual anti-aircraft defense systems and weapons and the modernization of current air-defense capabilities.

"If we implement our plans, we will be able to identify low-flying aircraft in our border areas, as well as significantly improve our anti-aircraft capabilities," Vejonis said, also highlighting the need for the Czech Armed Forces to purchase anti-tank weaponry.

So far, a total of thirteen companies have bid for the chance to supply air surveillance systems and these have since undergone evaluation by the Defence Ministry and National Armed Forces, with approval understood to have been taken by Vejonis.

This year, Latvia – alongside Romania, Bulgaria, Turkey, Poland and Japan – has been vocally concerned about an influx of Russian aircraft patrolling near to its borders following the Ukraine crisis.


Defence Minister Raimonds Vejonis

PERU

Peru is readying to purchase four new ground-based air surveillance radars before the end of the year, according to Defence Minister Pedro Cateriano.

In a statement made in July during a visit to France, Cateriano announced the plans for a government-to-government agreement with his French counterpart on the deal in order to help Peruvian investment.

The contract for ground-based 3-D radars would be part of the PEN2.735 billion (USD968 million) air-and-ground surveillance network that has been in the works since 2006.

The Peruvian Air Force has specified that the system includes an air surveillance component comprising the four radars plus a single airborne early warning and control aircraft; a ground surveillance component composed of airborne and land-based systems capable of detecting illegal mining and logging activities deep in Peru's jungles; a meteorological surveillance component; an electro-magnetic surveillance component capable of detecting illegal communications on Peru's electromagnetic spectrum; and a command-and-control (C2) centre.


Defence Minister Pedro Cateriano