

# GBAMDS growth path charted through to laser weapons

■ Trevor J Thomas/CANBERRA

The 2009 Defence White Paper has reignited hopes the ADF will bring forward its plans for a new ground-based air and missile defence system (GBAMDS), with extended capabilities to prevent troops deployed on combat operations being unnecessarily exposed to rockets, artillery and mortar fire. According to DWP'09, the new capability “will replace or upgrade the Army’s GBAMDS (currently based on the Saab RBS-70 missile), with more advanced systems.”

Australian land forces last possessed a dedicated ground-based air defence system in the form of the British Aerospace ‘Rapier’ system, which after its B1M upgrade – that took it to the peak of its capability – was proposed to be wholly replaced in the 2001 Defence Capability Plan (DCP) under the guise of Joint Project 117. In the 2004 DCP, this project disappeared altogether, and it was not until the 2006 DCP that the capability requirement reappeared in the form of phase 7 of project Land 19.

In the meantime, Australian maritime logistics and supply forces deploying to the Gulf were deemed to require some form of air defence, resulting in the shoulder-fired RBS-70 missile being adapted for operations on vessels by way of a tripod bolted to the deck and a fixed adaptation of the shoulder fired unit to the tripod.

For wider land forces protection, the RBS-70 missile was further upgraded following purchase of the more advanced ‘Bolide’ missile, which – when mated to a Lockheed Martin PSTAR radar – currently provides the ADF with a rudimentary integrated GBAMDS capability, supported by a sophisticated simulation based training capability located at Woodside in Adelaide. As noted in the 2009

Defence White Paper, operational experience in the Middle East has increasingly confirmed that when deployed on operations – even in basic operations – Australian forces are likely to be exposed to rocket and mortar fire.

In more sophisticated battle spaces, this threat would naturally escalate to more concentrated artillery fire, hence the need for a counter rocket, artillery and mor-

tar (C-RAM) system. As threats potentially advance, such a system would also prospectively embrace a counter to enemy tactical unmanned aerial surveillance vehicles.

Hence, the ADF’s commissioning in August 2008 of an outsourced survey of potential C-RAM systems, irrespective of the ADF at the time not anticipating the in-service date for such an ac-

quisition to be much earlier than 2018. The long delay (perhaps to be reversed in the 2009 DCP), in some part, is explained by official suspicion of the maturity of such systems, and hence, potential high costs and uncertainties associated with developmental systems that do not fit neatly within post-MorTIMER procurement reforms.

In evidence to a Parliamentary Committee in 2008, the Chief of the Defence Force, Air Chief Marshal Angus Houston, was recorded as saying he still regarded C-RAM to be a new, emerging technology, not fully developed. He said the various sea- and land-based radar and weapon solutions currently deployed by allies (principally the US and the UK) were “haphazardly pieced together, and did not represent a truly integrated, multi-layered, system-of-systems design.”

Air Chief Marshal Houston added, “the products on offer today vary widely in their effectiveness, with the return fire of some C-RAM systems, for instance, unable to discriminate between incoming rockets and coalition forces.”

A fully functional C-RAM system requires a sense-and-warning capability provided by a 360-degree radar connected to a command and control system capable of queuing a kinetic or laser-based engagement device to engage incoming rockets, artillery and mortars. The UK and the US initially both deployed multi-beam 3D radar on bases in Iraq to serve as a warning system, without the ability for interception fire.

In other instances, both countries have also deployed Raytheon’s ‘Centurion’ system. This weapon employs a trailer-mounted gatling gun adapted from the ‘Phalanx-1B’ system that provides last minute defence against incoming missiles on warships, intercepting – principally rockets and mortars – fired sporadically and in low volume against



LASER ‘CENTURION’ – RAYTHEON PHOTO

## Key Points

- **The 2009 Defence White Paper has confirmed** a long-running ADF requirement for a new ground-based air defence system (ie: vide Joint Project 117 in the 2001 DCP), however, the new system is also expected to be able to protect deployed forces from rocket, artillery and mortar fire.
- **Replacement systems, or an upgrade to the current RBS-70** are currently being advanced under phase 7 of project Land 19 (for an in-service date of 2018), however, interim solutions are being more actively investigated to provide greater warning time of attack for troops.
- **ADF interest in counter rocket and mortar defence systems** was sparked 4 January when a soldier was killed in Afghanistan as a result of the impact of a weapon within the confines of a (usually safe) forward operating base.
- **An extensive out-sourced analysis of industry responses** to a worldwide capability study of ground-based air and missile defence system technology suppliers was provided to the Capability Development Group at the end of October last year.

coalition bases. The Dutch are also known to have deployed a counter-artillery radar system that provides some warning.

Canadian forces are also seeking to acquire a C-RAM capability to protect their troops, and in May, the Bundeshwer confirmed that German forces would be equipped with the Rheinmetall Group's C-RAM system, dubbed the *Nachstbereichs-Schutzsystem* (NBS), "very short-range protection system". The NBS employs the company's 'Skyshield' technology.

Over the past five years, the ADF has also used legacy counter-artillery radars in Iraq and Afghanistan to provide early warning of incoming rounds – usually 107 millimetre or 122 millimetre rockets. Such rocket attacks are fairly inaccurate, although the CDF conceded ADF personnel had been "extremely lucky" up until the death of Private Gregory Michael Sher.

In the absence of a dedicated C-RAM capability, Australian troops in Afghanistan have adopted more pro-active methods to protect themselves from sporadic rocket and mortar attack. This has involved the utilisation of unmanned aerial vehicles as a surveillance multiplier combined with active patrolling to prevent insurgents establishing positions close to Australian bases from which to launch rocket and mortar attacks.

The new GBAMDS/C-RAM system prospectively to be acquired under phase 7 of project Land 19 is intended to deploy as a component of the ADF Air Defence System, or independently in conjunction with Joint or Coalition air and missile defence weapons.

Officials have made a number of visits to companies overseas in the past nine months to assess the maturity and suitability of various systems, albeit having stated (prior to release of DWP'09), such visits should not be construed as Defence wanting to bring forward the acquisition of new capability.

More active investigations, however, appear to have been pursued in relation to interim systems, including mobile radars that

could deliver 360-degree coverage of incoming attacks in order to provide troops at risk in Afghanistan with greater warning time.

The ADF's most recent Saab RBS-70 'Bolide' ground-based short-range air defence missile system uses an unjammable laser beam riding guidance system, has an intercept range of 8km, and altitude coverage in excess of 5,000m. Its adaptive proximity fuse function is also said to provide a high capability against small targets, such as cruise missiles and UAVs.

The missile's combined warhead, with both fragmentation and shaped charge effect, accordingly provides a high kill probability against any aerial threat, whilst targets down to ground level can also be effectively countered. It can be set up, ready to engage enemy aircraft in 30 seconds and has the capacity to identify whether an aircraft is friend or foe.

In a more complete system configuration, several fire units can be connected to a surveillance radar – such as a 'Giraffe' or HARD – enabling all C4I functions. Even if the RBS-70 is not interfaced with a surveillance radar, it can still be used autonomously.

The 4th generation of the RBS-70 system is said to feature a non-cooled laser transmitter minimising reaction times and logistic support, and incorporates the 'Bolide' all-target missile, BORC clip-on thermal imager, a digital IFF Interrogator, a PC-based training simulator and an external power supply for training.

**O**n 5 June 2008, the Department of Defence released a worldwide Capability Study (managed by Aerospace Concepts) inviting all extant GBAMDS system technology suppliers to provide a range of operational employment, technical, human systems integration, logistics and costing information about their systems and technologies.

Complete analysis of industry responses is understood to have been provided by the end of October, and subsequently used to develop broad options for con-

sideration within Capability Development Group, and ultimately, for informing deliberations in the just-released Defence White Paper.

Five operational scenarios were canvassed in the solicitation paper. The first two represented GBAMDS protection of a mobile combat team operating in open, urban terrain. The third scenario saw GBAMDS protecting a fixed Forward Operating Base (FOB) situated in complex urban terrain and occupied by a battle group, whilst concurrently protecting a mobile combat team as depicted in the first two scenarios.

The fourth scenario represented GBAMDS integrated in an air defence missile system assigned to protect an airfield required for the conduct of operations. The last scenario represented the protection of an amphibious littoral lodgement of a brigade-sized task force by GBAMDS as part of an integrated air defence missile system. The capability study was entirely solution-independent with each respondent having to specify the Technology Readiness Level (TRL) of their proposed system.

Unlike DWP'09's apparent restriction of the Land 19/7 replacement system to C-RAM, the GBAMDS Capability Study sought improved threat detection and engagement capability against a broad threat set, and including: fixed- and rotary-wing aircraft, fixed- and rotary-wing unmanned air vehicles (UAVs) and uninhabited combat air vehicles (UCAVs), rockets, artillery and mortars, stand-off weapons and cruise missiles.

The ultimate capability envisaged pictured some combination of the components of airspace surveillance and identification, target tracking, target interception and destruction, and battle damage assessment. The whole system was to be managed by a networked command, control, communications, computing and intelligence system.

The capability was further envisaged to have to operate in an integrated environment with other Allied or Coalition air and missile defence capabilities, including fighter, airborne early warning

and control aircraft, and air- and missile-defence ships. Although most extant C-RAM systems employ kinetic-based interception, Defence also appears interested in acquiring directed-energy systems although, surprisingly, such technologies were not mentioned in a list of priority industry capabilities anticipated to be nurtured under special defence-industry development policies canvassed in DWP'09. Potential GBAMDS/C-RAM offerings of relevance include:

**Saab 'Giraffe' AMB radar:** Saab reported 28 November 2008 it had received orders worth over SEK 300 million for services and additional capabilities based on its 'Giraffe' agile multi-beam (AMB) air-defence search radar, a 3D radar with 360 degree missile-tracking and locating capability. Six customers, including Sweden, France, Estonia, the US and the UK have bought the 3D 'Giraffe' AMB system, adding to an installed base of several hundred radar systems of various models sold to more than 25 countries.

Britain and the US have deployed similar systems in Afghanistan. Saab officials indicate the latest system improvements have turned the 3D 'Giraffe' AMB into a true multi-mission surveillance system with simultaneous air defence, air & sea surveillance, military air traffic control; and counter rocket, artillery and mortar (C-RAM) alert.

**The 'Centurion' C-RAM:** Raytheon's 'Centurion' system is a land-based version of the 'Phalanx' Weapon System currently deployed by the US and the UK in the Middle East. The system is capable of intercepting rockets, artillery and mortar rounds in the air before impact, by way of firing self-destruct rounds in order to minimise collateral damage.

The 'Phalanx' was first tested for 'Centurion' missions in November 2004, and is well adapted for use in complex urban environments where insurgents fire a few rounds before paling into the landscape – thus making it difficult to neutralise them. The 'Centurion' Weapon System is

powered by a generator and has a water chiller cooling system and an enclosed control station.

Raytheon Missile Systems in Louisville (Kentucky) awarded General Dynamics Armament and Technical Products a US\$18m contract on 8 January 2009 to produce gun systems for the 'Phalanx' Block 1B Close-In-Weapon System (CIWS) and the 'Centurion' Land-Based 'Phalanx' CIWS C-RAM system.

The 'Phalanx' system combines a proven 20mm M61A1 Gatling gun, firing M-246 or M-940 self-destruct rounds at a selectable rate of 3,000 or 4,500 shots per minute, with advanced search and track Ku-band radar to provide autonomous target detection and engagement. The upgrade adds enhanced fire control capability, six optimised gun barrels and an integrated forward looking infrared (FLIR) system.

In the 'Centurion' configuration, a 'Phalanx' Block 1B CIWS is mounted on a stabilised, wheeled platform to protect ground forces and high-value sites against RAM threats. The land-based Phalanx B was first deployed in Iraq in May 2005. It was tasked with protecting the Green Zone and Camp 'Victory' in Baghdad, and Logistics Support Area 'Anaconda' in Balad. The system is also deployed by the British Army in southern Iraq.

**SL-AMRAAM:** Raytheon's surface-launched version of the Advanced Medium-Range Air-to-Air Missile (AMRAAM) flown by

numerous Air Forces, is said to provide warfighters with a quick response high-firepower, non-light-of-sight (NLOS) operator fire-and-forget capability – with the ability to emplace and fire in less than 60 seconds.

It is capable of defeating cruise missiles, unmanned aerial vehicles and tactical aircraft that threaten forward manoeuvre forces, including critical assets and/or vital areas. Launchers can also be deployed at a single location or widely dispersed across a netted and distributed battlefield.

**LM's EQ-36 Counterfire Target Acquisition Radar:** Lockheed Martin (LM) unveiled at the AUSA Exposition in Washington DC in October 2007 its operational prototype of the US Army's new Enhanced AN/TPQ-36 radar, also known as the EQ-36 Counterfire Target Acquisition Radar.

The EQ-36 is designed to provide soldiers with the capability to detect, classify, track and determine the location of enemy C-RAM indirect fire in either 90 degree or 360 degree modes. EQ-36 systems are slated to replace ageing TPQ-36, TPQ-37 and other Cold War-era radars, which only operate in limited 90-degree modes.

For its EQ-36 prototype, LM is also developing the existing counterfire capabilities of partner, Syracuse Research Corporation's, operational Advanced Technology Objective (ATO), a sensor system developed for the Army's Intelligence & Informa-

tion Warfare Directorate (I2WD). Under a US\$120m contract, LM is providing the US Army with five Enhanced AN/TPQ-36 radars within 36 months – the first two systems will be delivered in the northern summer of 2009, the third and fourth by fall 2009 and the fifth in early 2010.

**TPQ-37 Upgrade:** The US Army on 23 December (2008) awarded ThalesRaytheonSystems a US\$217m firm-fixed-price contract to provide production modification kits and power amplifier modules, as part of the Reliability Maintainability Improvement (RMI) program for the AN/TPQ-37 'Firefinder' long-range weapon locating radar.

This contract followed an April 2008 initial production award taking combined contracts to more than \$285m. Program enhancements include a modular, aircooled transmitter and new common radar processors that will be applied to the Army's entire 'Firefinder' radar fleet, as well as to the fleet of AN/TPQ-36 radars. The upgrades will provide higher system availability and extend the expected life of the radar to 2030.

**Rafael 'Iron Dome':** Rafael Advanced Defence Systems released in June 2008 at Eurosatory in Paris its 'Iron Dome' mobile defence solution employing 'Tamir' (based on the 'Python' AAM) interceptors, and intended to counter short-range rockets and 155mm artillery shell threats. The system's

main components include a tracking radar, a battle management & weapons control unit, and an interceptor with a special warhead that detonates threats from ranges up to 70km.

The 'Iron Dome' is complemented by 'David's Sling', another hit-to-kill missile defence system developed with Raytheon, to provide a multi-layered GBAMD solution.

'David's Sling' is intended for use against medium and long-range (250km) rockets, short-range ballistic missiles and cruise missiles. Successful tests of the 'Iron Dome' in March against Katyusha and other rockets were reported to have put the system on a path toward initial deployment in mid-2010 with the Israeli Defense Forces.

'David's Sling' will be now be operational by the beginning of 2012. An Israel Aerospace Industries initiative to combine both of these systems into a single new capability, code-named 'Steel Screen', has recently been cancelled.

Rafael also offers a quick reaction, low-level surface-to-air missile system known as the 'Spyder', which is designed to counter attacks by aircraft, helicopters, unmanned aerial vehicles and precision-guided munitions. It can be used to protect valuable assets as well as to provide defence for forces located in the combat area. The system incorporates the 'Derby' active radar radio frequency missile and 'Python 5' dual waveband imaging infra-



**NEW SOLUTIONS FOR GBAMD THREATS:** The US Army is upgrading its legacy AN/TPQ-36 target acquisition radars (far L) as a baseline to feed new ground-based air and missile defence systems capable of engaging rockets, artillery, mortars and even enemy tactical UAVs. An advanced targeting assisted laser system mounted on an 'Avenger' combat vehicle (L) offers more than GBAMD capabilities, and can neutralise IEDs and unexploded ordnance. Rheinmetall's new Air Defence Group has continued to support development of Oerlikon's 'Skyshield' C-RAM (R) which is now headed for German troops in Afghanistan, while Raytheon is offering a surface-launched version (far R) of the AMRAAM air-to-air missile already in-service with large numbers of western air forces.

THALES/RAYTHEON, BOEING, RHEINMETALL & ADBR PHOTOS

red (IIR) missile. Truck-mounted missile firing units are equipped with both IIR and RF missiles which can be carried in any combination (four missiles) on a rotatable launcher assembly. The 'Spyder' system has a 360-degree engagement capability during day and night, under all weather conditions. It also features lock-on-before launch and lock-on-after launch modes of operation.

The system's intercept envelope spans from less than 1km to 15km against targets flying at altitudes between 20m and 9,000m. A standard missile battery has up to six missile-firing units, and a command and control unit comprising the Elta EL/M 2106 ATAR 3D surveillance radar.

**IRIS-T SL/IRIS-T SLS:** German-based Diehl BGT Defence's IRIS-T SL (surface launched) system is based on the IRIS-T air-to-air missile and complies with the German Air Force's new requirements for a secondary missile for ground-based, medium-range air defence within the trilateral, medium extended air defence system (MEADS) program. The IRIS-T SL is equipped with a large solid-propellant rocket motor, a data link and a nose cone for drag reduction.

Via standardised plug & fight data interfaces, the IRIS-T SL system can be integrated into existing and future, networked air defence command and control systems. Compact carrier vehicles are said to provide high off-road mobility, and prospectively, easy air transport in either the A400M or C-17 heavy transports. IRIS-T SL is being developed within the TLVS/MEADS program and is planned to be in service from 2012.

While the IRIS-T SL is a medium-range air defence system, IRIS-T SLS is cited as a true short-range air defence system using the IRIS-T air-to-air missile without any changes. This is fired by means of an LAU-7 standard aircraft launcher, four of which are mounted onto an all-terrain launch vehicle.

**Rheinmetall 'Skyshield':** As of 1 January 2009, Oerlikon Con-

traves began trading under the new name of Rheinmetall Air Defence. The company now forms a component of the Rheinmetall Air Defence Group, comprising the Air Defence division of the Rheinmetall Defence Group, with a business portfolio ranging from stationary cannon-based systems to mobile guided missile-supported solutions, together with sensor technology and associated networking solutions.

Oerlikon's original 'Skyshield' C-RAM system typically consisted of a sensor/C4I module with radar and electro-optical sensors, as well as effectors deployed within the base perimeter. These comprised four high-performance 35mm automatic cannon for short- and very short-range air defence. Two guided missile launchers can also be integrated for engaging larger targets at longer ranges.

The sensor module, guns and launchers are all unmanned, making operation safer for crews as such assets would often be priority targets in enemy suppression campaigns. The command post can be deployed up to 500 metres away from the sensor module, whilst the entire system can operate in all weathers, is highly resistant to electronic countermeasures and can be networked with other C4I systems. Vehicle-mounted configurations are also possible.

In March 2007, Rheinmetall began developing a close-range protection system on behalf of the German Bundeswehr called Nachstbereich-Schutzsystem (NBS) C-RAM for defending forward operating bases, incorporating the 35/1000 'Millennium' revolver cannon and firing the Rheinmetall-developed 35mm 'Ahead' shell. Twelve months later, the NBS C-RAM system successfully underwent live-fire testing in Turkey. A fully functional NBS unit should be available by the third quarter of 2009.

**'Laser Centurion':** Reports emerging from the White Sands Missile Range in New Mexico have confirmed the testing of a new Raytheon-developed weapon system known as the 'Laser Centu-

tion', being developed as part of the Laser Area Defense Systems (LADS) program jointly funded by the US Navy and Army. The system combines proven radar and threat-detection technology with the latest in laser weapons.

The 'Laser Centurion' hopes to replace the 20mm cannon on the Navy's 'Phalanx' system, and the Army's 'Centurion' system. It will be able to engage targets like incoming mortars, rockets and missiles, and will be suitable for use in peacekeeping and anti-piracy missions against surface targets. The laser is said to have proven capable of rapidly penetrating armour plating even when not at full power, and system set-up is cited as "very easy".

One advantage of the system is that it will be able to engage targets without the drawbacks of limited ammunition. As the laser does not employ any kind of solid shot (like the cannon), it can be more widely deployed in defence of populated areas without the fear of projectiles falling back to earth and damaging property or injuring civilians, as often occurs with conventional air-defence guns.

The 'Laser Centurion' is said to be able to run equally well off land-based generators and power supplies or a ship's reactor.

**'Laser Avenger':** Boeing reported 26 January it had successfully demonstrated an advanced targeting assisted laser system mounted on an 'Avenger' combat vehicle that can shoot down a small, sensor/explosives-equipped unmanned aerial vehicle (UAV).

Having successfully tested in 2007 an earlier version of the 'Laser Avenger' to neutralise improvised explosive devices (IEDs) and unexploded ordnance (UXO), the latest Boeing-funded test tracked three small UAVs flying against a complex background of mountains and desert.

The laser system is said to have shot down one of the unmanned aerial vehicles from an operationally relevant range. The 'Laser Avenger' can fire its laser beam without creating missile exhaust or gun flashes that would reveal its position.

**HEL TD System:** Boeing completed 21 July 2008 the preliminary design of a rugged beam control system for the US Army's High Energy Laser Technology Demonstrator (HEL TD) program – whose objective is to demonstrate that a mobile, solid-state laser weapon system can effectively counter rocket, artillery and mortar projectiles.

If US Army contract options are exercised, Boeing expects to build, integrate and test the beam control system – equipped with a command and control system onboard an Army tactical military vehicle – as well as develop the system-engineering requirements for the entire High Energy Laser Technology Demonstrator system.

Northrop Grumman is also contesting the program, and similarly reported 19 August last year it had completed its HEL TD beam control preliminary design review ahead of schedule. It is now completing the design, assembly and integration of the beam control system, leading up to a test in 2010.

**JHPSSL Program:** Northrop Grumman Corporation announced 19 March it had produced the most powerful light ray yet created by an electric laser, measured at more than 105 kilowatts (kW). The demonstration milestone was achieved as part of the US military's Joint High Power Solid State Laser (JHPSSL) program.

The company had earlier reported (March 2008) reaching a JHPSSL Phase 3 power level of 15.3kW and a power level of 30kW in September. The 100-kilowatt threshold is considered to be the minimum strength for weapons-grade lasers.

Achievements included a turn-on time of less than one second, and continuous operating time of five minutes. The modular Joint High Power Solid State Laser design is considered to make the system a viable contender as a component of any ground-based air and missile defence requirement.