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Contents

MARCH 2020
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ASIAN MILITARY REVIEW




06

A pair of Royal Australian Air Force EA-18G Growlers of 6 Squadron ready for a mission during Exercise Pitch Black 2018. (ADF)



PUSHING BACK WITH OPVS

Offshore patrol vessels are increasingly being viewed as a solution to Economic Zone protection. *Tim Fish* reports.



10

A DEEPER GROWL

Mark Ayton discusses how the US Navy's electronic warfare EA-18G Growler is being substantially improved.



16

ASIA-PACIFIC UNMANNED AERIAL VEHICLE DIRECTORY 2020

JR Ng presents a country-by-country guide to military UAV ownership, development and future acquisition.



30

FOOT SLOGGER FIREPOWER

Stephen W Miller reviews up and coming automatic rifles and machine guns for combat troops.



34

BETTER THAN EVER?

Arguably Australia's Collins class submarines have come of age. *Dr Lee Willett* details the reasons why.



38

ALLIANCES DRIVE AUSTRALIAN DEFENCE SPENDING

Tim Fish outlines the driving forces behind Australian defence modernisation.



42

ANALYSTS COLUMN

Ben Ho discusses air defence in the context of cruise missiles and UAV threats.



Editorial

CHINA'S INFLUENCE(ZA) FREEZES BUSINESS AT SINGAPORE AIRSHOW

Index of Advertisers

AERONAUTICS	17
BARZAN HOLDINGS	5
DND	19
EUROSATORY	COVER 3
EW EUROPE	37
GENERAL ATOMICS	COVER 2
INDO DEFENCE	15
LAND FORCES	35
MAN ENERGY SOLUTIONS	9
ROTOCRAFT /	
UNMANNED SYSTEMS ASIA	COVER 4
SUBSCRIPTION	33

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This year's Singapore Airshow went ahead despite the rapidly looming threat of coronavirus (COVID-19). Ahead of the opening on Tuesday 11 February, Leck Chet Lam, managing director of organising company Experia Events revealed that 12 Chinese companies were no longer participating as exhibitors at the airshow, and that international Chinese visitors were also unable to attend.

The Pentagon, through a late decision to limit its official presence at the airshow following the Singapore Ministry of Health's 7 February declaration of a Code Orange health alert (heightened risk), in effect gave 'the green light' to defence companies to do the same or pull out, prompting giants Lockheed Martin, Raytheon, Northrop Grumman, Textron, CAE and others such as Italian OEM Leonardo to withdraw completely.

The 'word on the street' was that one of the reasons behind the US-based companies withdrawal was that they feared litigation from employees who could have travelled to the event and subsequently contracted the virus (at time of writing near the end of February no cases have been announced that have been linked to any exhibitor or participant at the event).

There was, however, another potential reason for the US Government to turn 'a cold shoulder' to the event. In the days before the start of the airshow the Singapore government announced that it had given its permission for the People's Liberation Army Air Force's August 1st aerobatics team (Ba Yi) to participate in the flying display for the first time. This action 'stole the thunder' from the participation of the US Marine Corps' F-35B Joint Strike Fighter and US Pacific Air Forces' F-22 Raptor, both of which were making their own flying debuts. It was particularly surprising as the Singaporean Defence Minister Ng Eng Hen told the nation's Parliament only the month before that the US Defense Security Cooperation Agency (DSCA) had given its approval for his country's acquisition of up to 12 Lockheed Martin F-35Bs at a cost of around \$2.75 billion.

In the end, although around 70 companies did not participate in the airshow (around eight percent of the total) this still left over 850 who were represented. The numbers of trade visitors were not there however, and there was little evidence of international defence delegations that usually appear at shows such as this.

It was however, an unavoidable and temporary brake on what will continue to be a leading defence event in Asia for years to come. Chinese acrobatic teams aside, Singapore is still a key linchpin in the region's defence environment, both as a manufacturer, customer and strategic partner, a factor wholly acknowledged by all Western leaning countries.

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Damen

The Vietnamese Coast Guard is bringing new ships into service in an effort to deter Chinese coercion following the HYSY981 incident.

PUSHING BACK WITH OPVS

China's maritime expansion has triggered a surge in interest for offshore patrol vessels to help police EEZs.

by **Tim Fish**

There are numerous offshore patrol vessels (OPVs) and patrol ships programmes activated by countries across the Indo-Pacific that are delivering new platforms that are set to improve maritime security across the region. However, these ships are being procured for very different reasons and they are operated by a myriad of different services from navies to coastguards or police forces, depending on local structures and departmental responsibilities.

OPVs are capable of providing maritime sovereignty and law enforcement in offshore areas and as such they can counter a range of trans-border challenges such as illegal fishing,

smuggling, piracy, armed robbery and trafficking among other activities, making them a useful constabulary vessel. Governments since the 1990s have recognised the importance of maritime territory and the economic value it has. Since then, OPVs have become a procurement priority for Asian maritime nations alongside more traditional war-fighting ships such as corvettes and frigates.

But Dr Collin Koh Swee Lean, Research Fellow at the S. Rajaratnam School of International Studies told *AMR* that depending on the government, there are varying levels of importance granted to maritime law enforcement agencies (MLEAs) and this differs between sub-

regions. 'We see more resources invested into MLEAs in Northeast Asia and to a lesser extent India in South Asia. But we still don't witness a more radical shift in funding priorities towards MLEAs in SE Asia,' he said.

Apart from the obvious law enforcement reasons for buying OPVs, there are other procurement drivers for these ships. Often countries simply want to replace older vessels, but some governments are keen to develop a naval shipbuilding industry and building OPVs is the easiest and least complex platform it can start with. By selecting a foreign design and partnering with an overseas shipbuilder, some governments are investing in the skills and facilities needed

to build these ships that should provide a more permanent local construction capability.

Thailand, Malaysia, Indonesia, Vietnam and the Philippines are all examples of countries that are building OPVs of various types and using transfers of technology with outside help to build up a naval shipbuilding base. In the future these countries will not only be able to build ships for their own navies or coastguards but also export them at a competitive price.

Territorial grab push-back

Some countries that have specific security concerns that are pushing forwards the acquisition of OPVs. The creation of the Chinese Coast Guard (CCG) in 2013 and the deployment of its vessels into disputed waters to bolster Beijing's claims has caused a series of crises in North East Asia and the South China Sea (SCS). The programme of island building largely by dredging and reefs to create a small land mass, has resulted in China establishing a set of bases that can be used overtly to support its fishing fleets and CCG vessels further into the SCS.

In North East Asia, Japan is seeking a fleet of large OPVs to improve deterrence beyond the 12nm Territorial Sea, particularly over the disputed Senkaku/Diaoyu islands. The Japan Coast Guard (JCG) is responding to continuous incursions by the CCG around Japan's Contiguous Zone and Territorial Sea. The JCG is expected to get three new patrol ships and the Japan Maritime Self Defence Force (JMSDF) is to start a programme for 12 vessels.

"This will free up the destroyers for other duties, especially peacetime prep for high-intensity ops. At present, the JMSDF is deploying its destroyers in support of the JCG presence in Extended Continental Shelf, revolving around the isles, to deter the PLA and also conduct ISR missions," Collin said.

For Taiwan the issue is more about replacing older assets in the Coast Guard Administration and procurement is underway for at least three OPV programmes. Collin explained that its priorities include the Senkaku/Diaoyu islands too, but also the SCS "by building up Taiwan's presence around Itu Aba" and the outlying islands off Fujian coast, such as Penghu and Matsu "where CGA routinely confronts Chinese illegal fishermen and sand dredgers."

In the SCS, China has claimed these

waters as its own under its nine-dash line policy but this overlaps with the maritime boundaries and Economic Exclusive Zones (EEZ) of other countries there. Since 2013 the CCG has been sending ships to the area and building permanent islands in the Spratly Islands and Parcel Islands that are close to the Philippines and Vietnam respectively. There are also disputes over Scarborough Shoal, which is also near the Philippines and even the Natuna Islands at the southern end of the South China Sea in between Malaysia and Indonesia.

For Vietnam, the Hai Yang Shi You 981 (HYSY981) incident in 2014 was one of the most serious disputes between the two countries for almost 30 years. HYSY981 is a Chinese oil rig that was moved into waters near the Parcel Island violating international agreement. Vietnam sent ships to prevent the platform from taking up a permanent position and conducting operations there and these vessels eventually clashed with the escorting Chinese ships resulting in collisions and injuries to sailors. An international outcry and anti-Chinese sentiments caused China to eventually withdraw the ship.

As China flexes its muscles, Collin said Vietnam is 'well aware' of its shortfalls in OPVs and is building ships for the Vietnam Coast Guard (VCG) and is also looking at buying larger ships. "Without offshore-capable assets such as OPVs to remain on station for long durations out to the EEZ limit, it's impossible for Vietnam to sustain in any protracted standoff with the Chinese in SCS," he said.

Another confrontation took place as recently as mid-2019 at Vanguard Bank - a set of reefs that make up the Western most part of the Spratly Islands within the 200nm limit of the Vietnamese EEZ. The Chinese survey ship Haiyang Dizhi 8 (HD8) escorted by as many as 20 ships entered waters in the vicinity of the reefs where Vietnam hosts its key DK1 oil rigs resulting in a stand-off between them and the VCG. Vietnam is likely to take China to international arbitration, something that the Philippines did successfully in 2016.

A dispute between the Philippines and China over maritime claims came to a head in July that year when a tribunal at the Permanent Court of Arbitration in The Hague, ruled in favour of Manila. This was largely ignored by China and despite friendly relations between the new President of the Philippines Rodrigo Duterte and Beijing, there is support for a



The green lines - known commonly as the nine-dash line - indicate the extent of the claims on the South China Sea by the People's Republic of China (CIA).

build-up of the Philippines Coast Guard (PCG). Although there is little chance of the PCG matching the Chinese capacity Collin said that if even it does achieve its aims with new vessels from France and possible local construction of an Austal design "at best, the PCG may hope for a bigger OPV capacity that can better allow it to project presence and assert its own claims in SCS." He added that the PCG still "wants to tap on this support to build its long-neglected capabilities. And it doesn't want the Philippine Navy to upstage it." This highlights an inter-service rivalry element in the region that is the same as that experienced between many other MLEAs.

In December 2019 a diplomatic incident with Indonesia was sparked after 60 Chinese fishing vessels entered the Natuna Sea near islands within its EEZ. The Indonesian Navy deployed patrol ships to the area and lodged a complaint with China whilst also sending ships to its maritime boundary with Vietnam, which has also conducted incursions of fishing boats into Indonesian waters.

However, Collin said the new OPVs for the Indonesian Coast Guard (BAKAMLA) are large enough in size to match those deployed by Vietnam and China but the build-up 'is painstakingly slow'. He added: "While each new OPV is good in itself there's just not enough built within a short time. Funding is still a concern. Whether Jakarta's recent talk following the standoff with China over Natuna about acquiring offshore-capable



Austal's 83m-long OPV proposal for the Philippines Navy patrol boat procurement programme. President Duterte has approved the acquisition of six ships for \$577 million.

assets for the TNI-AL and BAKAMLA will come to fruition remains a question mark."

Earlier in December prior to the Natuna Sea incident Malaysia applied to the UN Division for Ocean Affairs and Law of the Sea to extend its continental shelf claims. This signals a partial fight back by the SE Asian states in the SCS against Chinese incursions and although Malaysia can do little physically to prevent China from entering its seas due as it has so few ships, a concerted legal effort to uphold the UN Convention of the Law of the Sea (UNCLOS) will bolster resistance, especially if Vietnam follows suit.

Possessing too few ships has been a persistent problem for the SCS states when facing the coercive tactics of China. Malaysia has just four OPVs in the Malaysian Maritime Enforcement Agency (MMEA), which is not sufficient. The CCG maintains a permanent presence around the Luconia Shoals reef north of Sarawak, which it considers part of the Spratly Islands. Whilst the Royal Malaysian Navy (RMN) conducts patrols with its corvettes it could use more support and the MMEA is expected to get another three OPVs this year. Whether they will make any difference remains to be seen, but more ships means more regular patrols can be

carried out increasing its presence.

Malaysia also has other security concerns following a succession of incursions into the province of Sabah in Borneo by insurgent forces from the Philippines. The most serious incident was the Lahad Datu incident in 2013 when over 200 armed militants in the district there by boat to claim the territory. That such a large group was able to land and occupy the town of Tanduo for some weeks and that the situation was only resolved after heavy engagement by the Malaysian Armed Forces and several shootouts, showed how porous the maritime border was and how unprepared security forces were. Malaysia has since established the Eastern Sabah Security Command (ESSCOM) but there is still regular activity by Moro pirates and the terrorist group Abu Sayyaf in the area that include incidents of kidnapping.

The only SE Asian country not in dispute with China is Thailand, which does not see China as a threat. The Royal Thai Navy is buying new submarines and an amphibious ship from China and has purchased frigates and OPVs from Beijing in the past. But like the other SE Asian nations, Thailand is building its new OPVs locally to Western designs with technology transfer and development of construction facilities to enhance its industrial capacity.

Elsewhere, India has been expanding its OPV fleet following the terror attacks in Mumbai in 2008 that will serve both the coastguard and the navy. The ships will also improve maritime security in India's large EEZ. Pakistan is following suit to match India but also has many older ships that need replacing. Sri Lanka is getting new OPVs from China and India also to bolster maritime security in its large EEZ and harness the resources of its maritime territory. Collin said this has been a long time coming 'because of the earlier focus on defeating the LTTE insurgency, which placed greater emphasis on acquiring coastal and inshore fast interdiction tackle to support army operations and tackle the Sea Tigers (the LTTE naval wing).'

In Oceania, the Royal Australian Navy is embarking on a large OPV programme to replace older ships but also to increase capacity. Australia not only need to conduct routine maritime security and border management duties (such as Operation Sovereign Borders to counter refugee boats) but also conduct theatre security engagements with its neighbours.

Collin said that "a good bulk of offshore protection duties, for the energy sector, is performed by the RAN's frigates. Using frigates to do such constabulary duties isn't economical at all and diverts such precious assets away from other mission requirements." He added that as the Adelaide-class frigates are leaving service it puts pressure on the RAN, which also facing crewing difficulties so 'husbanding scarce manpower can be accomplished by deploying OPVs with leaner crews compared to frigates for peacetime constabulary duties.' This makes the introduction of a dozen OPVs a useful long-term solution to the challenges of maritime security.

The expansion of Chinese influence in NE Asia and the SCS using non-combatant platforms for presence and coercion is the primary driver for the focus on OPVs across the Indo-Pacific. Despite the rulings of the international court this situation is likely to continue for some time and the pressures on maritime security are only going to increase. Wealthier countries like India, Japan and Australia that also have a naval shipbuilding base are able to order, build and introduce new OPVs into service. However, the lack of funds and facilities means that for most states in the SCS the number of active OPVs remains woeful and despite current programmes their capabilities will remain limited. **AMR**



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An EA-18G Growler from Electronic Attack Squadron 141 (VAQ-141) 'Shadowhawks' lands on the flight deck aboard the aircraft carrier USS Ronald Reagan (CVN 76). Note the different side profiles of the underwing ALQ-99 pods compared to the centreline example.

A DEEPER GROWL

One of the most powerful weapon systems in America's arsenal, the EA-18G Growler, is about to get even better with the introduction of the Next Gen Jammer.

by Mark Ayton

Today, all Boeing EA-18G Growler aircraft are assigned to bases located around the Pacific. Naval Air Station Whidbey Island in Washington state is the EA-18G Growler master jet base. Whidbey is also home to Commander, Electronic Attack Wing, US Pacific Fleet, the parent wing for all Growler-equipped Electronic Attack Squadrons; a fleet replacement squadron, nine carrier-assigned squadrons and five land-based joint expeditionary squadrons. The latter are manned by both US Navy (USN) and US Air Force (USAF) personnel. One of the carrier-assigned squadrons is based at Marine Corps Air Station Iwakuni in Japan.

Both the carrier-assigned and land-based Growler squadrons regularly deployed around the Pacific theatre. Joint expeditionary squadrons deploy to Misawa Air Base in northern Japan, Kadena Air Base, Okinawa, Anderson Air Base, Guam and Australia. Squadrons assigned to Pacific Fleet carriers transit across the theatre on regular deployments to the Persian Gulf, and on short cruises to participate in major exercises such as *RIMPAC*, *Valiant Shield* and *Northern Edge*. These collective deployments make a much greater footprint around the Pacific theatre compared to those staged in the European and Central Command theatres.

However, the Growler's Pacific theatre footprint is not just down to the USN, as Australia also operates the EA-18G with a single Royal Australian Air Force (RAAF) squadron based at RAAF Base Amberley, Queensland. Despite its one-squadron force, the presence of Australian Growlers on the Pacific theatre's southern flank, based within deployable range of many areas of South East Asia represents a formidable capability in a politically tense part of the world.

Growler

Back in 2001, the US Department of Defense (DoD) tasked the Department

of the Navy to undertake an analysis of alternatives for a new-generation electronic attack aircraft.

The result of the study was the EA-18G Growler, a variant of the F/A-18F Super Hornet, built and configured as a stand-off and escort jammer for the USN. Now in its second decade of service, the EA-18G continues to be the only dedicated tactical electronic attack aircraft in the DoD's inventory.

Captain Jason Denney, the F/A-18 Hornet and EA-18G Growler programme manager with Naval Air Systems Command's PMA-265 said the aircraft has a fantastic ability to disrupt signals, deny communications, jam radars and provide crucial support and intelligence, not just to a Navy strike group, but deployed combatant commanders. "The Growler's ability to work with all other aircraft, not just those in the carrier air wing but within the DoD, makes it a critical node operating with deployed Air Force, Army and Marine Corps expeditionary units; interoperability is a large key performance parameter for the Growler."

The EA-18G's primary antennas and sensors are housed in two Northrop Grumman ALQ-218 wing-tip pods with additional antennas located on the forward and aft of the aircraft appropriately separated so the system correctly processes signals.

Threats can be detected throughout the RF spectrum measured in small elements. The signal is handed over to a secondary receiver which measures very fine and parametric measurements of the frequency and amplitude. Geo-location of the threat is calculated by interferometry; measuring differences in phase, the waveform angle relative to the aircraft's position in time.

Growler system software is embedded into the standard Super Hornet release but features a third level displaying all electronic attack options. Recognition of the aircraft's electronic attack systems and the ALQ-218 activates the third level. Aircrew use HOTAS (hands on throttle and stick) controls to view, operate from and switch between all three levels of display.

One control capability of the advanced crew station is interlinking of the forward (pilot) and aft cockpits (electronic warfare officer or EWO) that allow the two crew to operate the aircraft and its system with full co-ordination; the EWO uses four primary displays in the aft cockpit which



Royal Australian Air Force

Royal Australian Air Force Growlers from No.6 Squadron prepare for a mission during Exercise Pitch Black 2018.

are inter-linked to the front seat.

Bring back (the stores load an aircraft is permitted to land back on the carrier's flight deck with) is a design feature of all carrier-capable aircraft. Growlers only releasable stores (weapons) are AGM-88 HARM, AGM-88E AARGM and AIM-120 AMRAAM missiles; otherwise its full stores load has to return to the ship. During carrier suitability trials, VX-23 undertook gross-weight expansion testing to increase the Growler's bring-back capability to 48,000lb (21,773kg) including fuels, up from the Super Hornet's 44,000lb (19,958kg) load. This involved launch and recovery operations using a test aircraft loaded to its heaviest configuration.

Catapult shots had to ensure tow-bar, nose-bar, gear and hook point loads were within the required limits for launching the aircraft. Arrested landings with a gross weight of 48,000lb were conducted under various simulated conditions to test de-acceleration, high-sink rate landings, roll/yaw offset landings and different attitudes.

Tactical jamming systems

However, the EA-18G aircraft is only part of the Growler weapons system. The electronic attack mission is conducted by the EDO ALQ-99 tactical jamming

system in US Navy operation since 1971. Continual upgrades have enabled the ALQ-99 to remain relevant against potential threats from around the world. Different types of ALQ-99 pod are dedicated to notional wave bands and therefore target sets and what the attack solution should be. Over the past 35 years, the ALQ-99 has been upgraded in different ways; by either wave band, by radio frequency exciter or by universal exciter. Back in 2005 the ALQ-99 system hit its technology ceiling. Certain new target sets can be accommodated with small tweaks to the system, those of a communication or asymmetric warfare type, but for the latest surface-to-air missile systems, the ceiling was inhibitive. New architecture was required. An alternative of alternatives for a Next Generation Jammer (NGJ) was undertaken, and completed in April 2010. That November, a resources, requirements and review (R3) board sat at the Pentagon, which provided validation to build the system for use by the EA-18G. During 2010, technology and maturity contracts were awarded to Raytheon, Northrop Grumman, IIT with Boeing, and BAE Systems focussed on maturing the technology required for the context of the NGJ system.

Providing sufficient power and



Raytheon

This image of a ALQ-249 NGJ Mid-band pod shows the aft and forward arrays.

cooling for an electronic attack capability on a tactical size aircraft is a big challenge. There's a trade-off between power and range which is constrained by physics; the more power the more generation required, but the EA-18G does not generate a lot of excess power so power generation needs to be built into the pod. The ALQ-99 uses externally-mounted RAM air turbines, a pitched propeller that generates a lot of power. That's not an option for the NGJ because the power required by its solid state and active array technologies is too great for an externally-mounted RAM air turbine as used by the ALQ-99; instead the pod uses an internal RAM air turbine generator dubbed the RAT G.

Arrays also present unique challenges. An active electronically scanned array radar works best using a large flat plate, an arrangement that allows a good beam to be formed by focussing a lot of energy. Electronic attack is no different but for the requirement to have almost a 100 percent duty cycle active array for full-on jamming, which requires efficient beam formers and amplifiers. Use of gallium nitride circuits to enable close to 100 percent duty cycle jamming required this technology to be matured, such that development contracts were awarded to four companies in 2010. A follow-on contract for gallium nitride circuits was awarded to Raytheon in July 2013.

Next Generation Jammer

Under the Joint Electronics Type Designation System, the NGJ Mid-band is dubbed the ALQ-249; a high-powered, agile, electronic attack system capable of operating at stand-off ranges, attacking multiple targets simultaneously with

advanced jamming techniques designed for rapid upgrades with a modular, open systems architecture.

Equipped with agile, active electronically scanned arrays and an all-digital back end, the ALQ-249 conducts precise jamming assignments against advanced and emerging threats operating throughout a wide range of radio frequency bands.

Confronted with integrated air defence system radars, communications, and data links, the ALQ-249's ability to engage threat systems and conduct robust jamming at standoff distances is vital. Consequently, the ALQ-249 must provide sufficient effective isotropic radiated power (EIRP); the measured radiated (output) power of an antenna in a specific direction.

Once integrated on the EA-18G, the ALQ-249 will be capable of contributing to the full range of warfare from air strikes in anti-access/area denial environments to the type of irregular warfare encountered in Afghanistan.

The ALQ-249 pod is approximately 14ft (4.27m) long with a fuselage diameter close to 30 inches (760mm).

One outcome of the November 2010 R3 board was to return the NGJ programme into incremental capabilities.

- Increment 1 is the mid-band, which covers the most critical threat waveforms across a full spectrum of agile and adaptive communications, datalinks, and non-traditional radio frequency targets.

Increment 1 will be used to deny, degrade, or deceive use of the electromagnetic spectrum employing both reactive and pre-emptive jamming techniques and is currently

in the Engineering and Manufacturing Development (EMD) phase.

- Increment 2 is the low-band, which includes important threat waveforms and has an initial operating capability (IOC) targeted for after 2022.

- Increment 3 is the high-band with an IOC after 2024. This will be housed in a smaller pod carried on the outer wing stations 2 and 10.

Naval Air Systems Command currently describes Increment 2 and Increment 3 as planned future efforts.

April 2016 was an important month for the NGJ Mid-Band programme; it received Milestone B approval to enter EMD, and Raytheon was awarded a 56-month contract valued at \$1 billion for execution of the EMD phase. In accordance with the contract, Raytheon will deliver 15 engineering development model pods to be used for mission systems testing and qualification, and 14 aeromechanical pods for airworthiness certification.

On 27 April, 2017, the NGJ programme completed its critical design review which identified deficiencies that deemed a redesign of the pod structure, which caused schedule and cost breaches to the programme. Despite the structure redesign development, manufacturing, integration and testing of the antenna arrays, power generation system, software, common electronics unit continued, in accordance with the EA-18G H16 software integration schedule.

On 18 October, 2017, a memorandum of understanding was signed with Australia forming a joint program office and a cooperative development programme. The Royal Australian Air Force is the only other air arm currently operating the EA-18G Growler.

Testing

Naval Air System Command's anechoic chamber at Patuxent River is currently occupied by an EA-18G Growler aircraft fitted with the first set of two engineering development model mission system pods.

The aircraft and pods were first placed in the chamber last November. To date they have undertaken over 400 hours of testing with both pods radiating to check basic pod functionality and to capture electromagnetic interference data. The latter being the measurement of radiation data which is used to ensure the pod does not overheat or adversely affect the aircraft and the aircrew. Data captured in the chamber is also being used to gain

an interim flight clearance authorisation to operate a Growler aircraft fitted with a set of NGJ pods in non-standard configurations, flight envelopes, or conditions.

The chamber testing is now providing real data, as opposed to analysed data, for use in the mission system modelling process to begin validation of the system. Prior to that, extensive mission system modelling of the pod's application to electronic attack and jamming was based entirely on analysed data captured from ALQ-99 pods in operational scenarios.

Stores integration

Last summer, Raytheon delivered the first NGJ Mid-Band EMD pod to Patuxent River to begin initial stores integration. This includes verification of ground procedures, mass properties, aircraft installation, and built in test checks, all in preparation for chamber and flight testing.

Different types of tests require different configurations of pods such as fatigue, static, jettison and aeromechanical versions; the latter used for flying qualities and aircraft integration. Pods used for mission system testing are in full-up configuration with all of the sub-systems installed. Unsurprisingly mission system pods are expensive and are actually unnecessary for some elements of the flight test programme.

Prior to first flight, the NGJ pod is undergoing all of the standard tests required for stores integration. Static strength testing was completed in the early autumn of 2019. Once flights begin, a set of NGJ pods will undergo captive carriage tests; loads, environmental, flying qualities, performance, drag and structural integrity. Performance and jettison tests will follow as part of the employment phase.

Captain Orr described the forthcoming NGJ flight test programme as thorough and extensive, involving hundreds of missions. It will involve aero mechanical testing of the pod's physical integration on the aircraft; mission systems testing of the pod's performance, and ultimately carrier suitability testing.

Chamber testing will continue for quite some time as its focus changes to increased performance. Milestone C, the low-rate initial production decision, is anticipated at the end of FY2020. Flight testing is expected to start this spring and continue through most of 2021.

An operational test readiness review

should take place by early 2022. If the review is successful, the NGJ pod will enter operational test that year, followed by an initial operating capability declaration in FY2022.

Growler's continuous improvement

As part of the Growler's road map, the aircraft is continually improved primarily by the roughly biennial introduction of new operational flight program software drops. As a backdrop to the latest H14 software, the previous H12 release included another phase of multi-sensor integration improvements, enhanced ALQ-218 geolocation, communication countermeasures set improvements, display improvements (symbolism and crew-vehicle interface) to enhance air-to-surface, air-to-air and counter electronic attack sensor integration to manage aircrew workload, and additional capabilities to operate in ATC-controlled airspace.

The latest, H14, commenced operational test in October 2018, concluded earlier this year, and has just been released to the fleet to meet the latest operational requirements. Last March, Naval Air Systems Command staged numerous fire control missions in an electronic attack environment at the sea test range off the coast of California.

In July, live fire missile testing was undertaken to demonstrate the integration of the AIM-120 AMRAAM missile with the Super Hornet and Growler aircraft operating with the H14 software.

PMA-265 is now underway with the developmental test of the subsequent H16 software which will provide

- software and hardware upgrades to the ALQ-218 digital receiver
- an open architecture, multi-level secure processor known as the Distributed Tactical Processor-Network (DTP-N) reckoned to be 17-times more powerful than the original Growler system
- the Tactical Targeting Networking Technology (TTNT), a high throughput, low latency datalink called with satellite communications for advanced network connectivity.

Equipped with DTP-N and TTNT, a pair of Growlers will be able to fuse data acquired by on board and off board sensors to generate a common tactical picture of the battlespace and rapidly exchange that information with other assets. What does that achieve? It enhances targeting capabilities and improves air-to-air timelines and performance. This capability is scheduled to be implemented with several H-series software builds.

Back in August 2017, the Navy staged a series of fleet experiments called Netted Sensors 2017 conducted by the Navy Warfare Development Command involving, amongst others, F/A-18 Super Hornet and EA-18G Growler aircraft.

Focus of the experiments was sensor networking over the TTNT data link to enable distribution of information from around the maritime battlespace to all participating assets; aircraft, ships and shore stations.



An interesting perspective of electronic attack activity radiated from two ALQ-249 NGJ mid-band pods.



Naval Air Systems Command

An EA-18G Growler assigned to Air Test and Evaluation Squadron 23 loaded with a ALQ-249 Next Gen Jammer pod on station 3 (middle).

EA-18Gs were focused on working a common tactical picture, multi-ship electronic surveillance, Growler manned-unmanned teaming, and network-centric collaborative targeting (NCCT) technologies. What does this all mean? It means using joint data standards and interfaces to speed up sensor cueing and targeting through to launching strikes in multi-sensor geolocation events.

Captain Denney outlined other initiatives to deliver new capability to the fleet faster to outpace potential threats, to improve and sustain aircraft mission capability rates by using predictive maintenance in order to spend time performing effective and proactive maintenance rather than reactive maintenance.

One change already in effect and in support of the above is migration from multi-sensor integration to multi-system integration. This allows for insertion of new technologies and requirements to

keep pace with the fleet's demands; this will continue with H16.

Block II Growler and the number one mission

Ongoing work is defining the Block II capability development programme, which will include conformal fuel tanks, in pretty much the same configuration as those under development for the Block III Super Hornet. Similarly, the advanced crew station featuring a large area display and low-profile head-up display will initially deploy on the Block III Super Hornet and then the Block II Growler.

Growlers are not equipped with a cannon, but the internal space is not left empty, it's fitted out with an airborne electronic attack palette; this will be replaced with Block II to overcome obsolescence.

Given the relatively small fleet of aircraft, their ongoing utilisation rates, and an out-of-service date currently pitched

for the mid-2040s, PMA-265 is already conducting a service life assessment programme to assess utilisation and when a service life extension programme will need to start. Captain Denney explained that because of the Growler's utilisation, a service life extension programme will not start until after conversion to the Block II is complete. He said: "We are forecasting 2025 as the Block II IOC."

When asked whether the PMA-265 team will be able to stay ahead of fast developing emerging threats, Captain Denney said it was the team's number one mission: "Our motto is to support, to sustain and advance the fleet. That is what we do, whether that's getting the mission capability rate above 80 percent, or making sure the aircraft is able to fight and win against potential adversaries, that is why we make incremental improvements. We are developing the Block II Growler to exceed the capabilities of our potential adversaries." [AMR](#)



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A Royal Australian Air Force (RAAF) General Atomics Aeronautical Systems MQ-9B SkyGuardian.

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ASIA-PACIFIC UNMANNED AERIAL VEHICLE DIRECTORY 2020

Unmanned aerial vehicles (UAV) continue to proliferate in the Asia Pacific region, driven by increasing demand for persistent presence and surveillance from countries with large land and maritime domains to secure.

by JR Ng

For large and small regional stakeholders, UAVs are seen as an attractive proposition to reduce the strain on manpower and aircraft resources, not to mention getting good value from defence budgets.

Regional interest in larger UAV platforms - especially in the medium-altitude and high-altitude long endurance (MALE and HALE) classes - has clearly been observed in recent years with countries such as Australia, China, Japan, India, Indonesia, South Korea, and Taiwan all fielding such capabilities. This upward trend is indicative of the increasing maturity of such platforms and their associated technologies, as well as the growing confidence and desire of regional countries to incorporate these into their military forces.

According to US-based consultancy Market and Markets, the global UAV market was valued at estimated \$19.3 billion in 2019 and is projected to reach \$45.8 billion by 2025, at a compound annual growth rate of 15.5 percent from 2019 to 2025. The demand for UAVs in

the Asia Pacific accounts for over a third of the projected growth, second only to North America which accounts for nearly half of the total growth rate.

AUSTRALIA

The Australian Defence Force (ADF) has emerged as a leading regional UAV user, with its three services simultaneously pursuing a broad range of development and acquisition programmes that is noteworthy for being diverse, from pocket-sized 'nanocopters' to high-end MALE and HALE systems.

The Australian Army was experimenting with UAVs as early as the 1990s before introducing some of these capabilities during overseas deployments - including Afghanistan, East Timor, and Iraq - from 2005. The service is looking into expanding its use of such systems following more than a decade of successful UAV operations, with new capabilities expected to be introduced by the mid-2020s.

The Royal Australian Navy (RAN) has stood up a dedicated UAV unit known as 822X Squadron, which is also the fourth

operational squadron in the RAN's Fleet Air Arm. The unit oversees the service's fleet of Boeing Insitu's ScanEagle and Schiebel's S-100 Camcopter vertical take-off and landing (VTOL) UAVs.

The Royal Australian Air Force (RAAF) formerly operated four Israel Aerospace Industries (IAI) Heron 1 MALE UAVs leased from Canadian company MDA, while an Memorandum of Understanding (MoU) for logistics and training support was concluded with Canadian forces deployed in Afghanistan. In February 2019, Boeing and the Australian Department of Defence (DoD) announced a partnership to develop a large UAV concept demonstrator that will be capable of smart teaming with existing military aircraft, using artificial intelligence (AI) enabled technologies to fly independently or in support while maintaining safe separation between other aircraft.

Fielded Capabilities

Boeing-Insitu ScanEagle: Initial flight trials to assess the operability of the long-endurance ScanEagle UAV system aboard

the RAN's three Adelaide class FFG-7 frigates were completed aboard HMAS *Newcastle* in June 2016. The system is now in operational use aboard the Adelaide-class frigates and was deployed in June 2017 along with HMAS *Newcastle* as part of *Operation Manitou* in the Middle East, where its visual and ranging system (ViDAR) helped gather surveillance data. While on its deployment, the ScanEagle UAV was also involved in the RAN's first operational manned/unmanned teaming (MUM-T) with the frigate's Sikorsky MH-60R helicopter in September 2017. The Australian Army also leased army leased ScanEagles and completed 45,000 flying hours while deploying the system in Afghanistan before acquiring the Shadow 200 system.

Schiebel Camcopter S-100: The RAN selected the S-100 Camcopter under the Navy Minor Project 1942 tender request. Although the number of S-100 systems was not disclosed, the rotary UAV was to be used for operational training and development ahead of a future phase of Joint Project 129 that aims to select one

to two VTOL UAV platforms to conduct operations from the RAN's Future Frigates and offshore patrol vessels (OPVs). Delivery of the first S-100 systems powered by 55hp (41kW) Diamond gasoline piston engines occurred in mid-2017, with additional systems equipped with modified Rotron 600 HFE propulsion systems delivered in December 2017. Schiebel will update two of these vehicles with the internally developed S-2 HFE system, which is expected to be delivered to the RAN in the third quarter of 2019 for acceptance testing. The Australian Army is also operating the type under lease, and in December 2018 tested Elta Systems' ELK-7065 high frequency (HF) communications intelligence (COMINT) and direction-finding system and Overwatch Imaging's TK-5 Firewatch smart tactical mapping payload aboard one of its leased platforms.

AAI Unmanned Aircraft Systems/ Textron Systems RQ-7B Shadow: The acquisition of two complete RQ-7B Shadow 200 tactical UAV systems at a cost of \$133 million (AUD\$175m) for

the Australian Army was announced in August 2010 under Joint Project 129 Phase 2. The package comprised 18 air vehicles, four ground control systems, support systems, and initial training. It also included funding to deliver the UAVs to Australian troops in Afghanistan. The two systems were delivered by April 2012 and were operated by 20 Surveillance and Target Acquisition (STA) Regiment. By September 2013, the type had completed 10,000 flying hours in support of International Security Assistance Force (ISAF) troops before returning to Australia the following month. The army is presently seeking its replacement under the Land 129 Phase 3 programme with the aim of acquiring a new capability by around 2022.

AeroVironment RQ-12 Wasp AE: In June 2017 the Australian government announced a contract worth up to \$36.5 million for the delivery of hand-launched AeroVironment Wasp AE UAVs to fulfil the army's small unmanned aerial system (UAS) requirement under Project Land 129 Phase 4. The Army plans for every



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combat team to be equipped with the 1.2kg Wasp AE mini-UAV, which can operate for up to 50 minutes out to a range of 5km. The UAV is equipped with a pan-tilt-zoom Mantis i22 AE gimballed payload that delivers live, streaming colour and infrared (IR) video.

FLIR Systems PD-100 Black Hornet II:

The Australian Army outlined plans in 2017 for each combat platoon to be equipped with FLIR PD-100 Black Hornet II 'nano-UAVs'. Weighing approximately 18g, the hand-launched UAV features a tadpole-shaped fuselage design that is propelled by an electric motor driving a 120mm two-bladed main rotor and tail rotor. It can stay airborne for up to 25 minutes on a full charge, and can operate to a maximum range of 2km from the base station. Around 160 Black Hornet systems will be deployed across every combat platoon as a reconnaissance asset with deliveries commencing in early 2018 and expected to be completed by 2019.

Under Development/Consideration/Trials

Boeing Airpower Teaming System (BATS):

The 11.7m long BATS features a design range of around 3,700km and is expected to make its first flight in 2020, following its unveiling in mock-up form at the Australian International Airshow in March 2019. The DoD is investing \$28 million in the development programme. Boeing also stated that it will build three prototypes in Australia.

General Atomics Aeronautical Systems MQ-9B SkyGuardian:

The DoD downselected the MQ-9B SkyGuardian for its AIR 7003 requirement for an armed UAV capability, favouring the type over the MQ-9A Reaper. Following the shortlisting of the MQ-9B, a proposal for the acquisition will be put together for considering in the 2021-22 timeframe. It is understood that between 12-16 air vehicles – valued at \$880 million (A\$1.3 billion) – will be acquired for the RAAF to stand up its first armed MALE UAV capability.

Northrop Grumman MQ-4C Triton:

A HALE UAV capability for persistent long-range maritime patrol and other surveillance missions is being sought under Project AIR 7000 Phase 1B, with the latest Defence White Paper in 2016 stating that up to seven of these UAVs are expected to be acquired from the early

The Royal Australian Navy selected Schiebel's S-100 Camcopter under Navy Minor Project 1942. It will be used for operational training and development.



Schiebel

2020s. The DoD ultimately committed to six Tritons, with the first being contracted in June 2018 and the second in March 2019. The first air vehicle is also expected to enter service in mid-2023 and be fully operational by 2025. All six platforms are planned to be delivered by late 2025 and based at RAAF Base Edinburgh in South Australia. When in service, the Triton UAVs are expected to complement the RAAF's Boeing P-8A Poseidon maritime patrol aircraft, paving the way for the retirement of the service's ageing Lockheed Martin AP-3C Orions. The total value of the programme is expected to be worth approximately \$5 billion.

BANGLADESH

Although Bangladesh does not presently operate any military UAVs, the country's procurement agency – the Directorate General Defence Purchase (DGDP) – issued a tender notice in December 2017 to procure a MALE-class UAV for the Bangladesh Air Force (BAF). The DGDP said the UAV will be used for intelligence, surveillance, reconnaissance (ISR) and targeting operations under the military's Forces Goal 2030 modernisation plan.

The UAV is expected to have a maximum speed of 108 knots (200km/h) and maximum range of 1,000km, as well as a maximum ceiling of nearly 20,000 feet (6,000m). Also desired is a ground control station, avionics systems, sensors, datalinks, electro-optical and IR payloads, and the provision to carry weapons. Unconfirmed reports have suggested that the BAF has selected China's Wing Loong II strike-capable reconnaissance UAV, with an initial contract covering four air vehicles, a ground control station (GCS),

and associated training and logistical support. Delivery is said to be made in mid- to late-2019.

DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA (DPRK)

The DPRK's interest in UAVs can be traced back to the 1970s, although it was not until the late 1980s when a number of ASN-104/D-4 UAVs were acquired from China. During the 1990s a small number of Russian-made DR-3 Reys were received from Syria and Pchela-1T UAVs from Russia.

By the early 2000s North Korea possessed not only a growing inventory of UAVs but had begun to manufacture a UAV based on the ASN 104, known locally as the Panghyon I. The improved Panghyon II based on the ASN-105 followed several years later.

Reports also indicate that the DPRK is developing a long-endurance UAV, with Republic of Korea (RoK) officials revealing that "numerous test flights" by such prototypes have been detected since early 2016. In June 2017, a crashed 1.8m-long and 2.4m-wide UAV was discovered in the South Korean county of Inje, Gangwon province. South Korean officials subsequently revealed that the UAV had taken photographs of the deployment site of the US Army's Terminal High Altitude Area Defense (THAAD) system in Seongju prior to the crash, suggesting that the communist state has significantly improved the range of its UAVs.

Fielded Capabilities

Xi'an ASN Technical Group ASN-104/D-4: Development of the D-4 began in

March 1980 and was originally intended to be a low-altitude, low-speed UAV for civilian applications such as aerial survey and mapping. This was subsequently acquired by the People's Liberation Army (PLA) for tactical missions such as front-line reconnaissance and electronic jamming.

Panghyon I and II: Domestically manufactured versions of the X'ian ASN-104 (described above) and ASN-105 UAVs. The Panghyon II is essentially the same airframe but incorporates an extended range control system.

Yakovlev OKB Pchela-1T: Developed in the early 1990s to meet a tactical surveillance and electronic countermeasures requirement, the Pchela-1T adopts a pusher-propeller propulsion arrangement and carries a TV camera with zoom lens. It is believed that the DPRK acquired up to 10 of these UAVs.

Taiyuan Navigation Technologies Sky-09P: The Sky-09P is powered by a two-

blade propeller driven by a tractor engine mounted in the nose. It is now likely that the DPRK is locally manufacturing the type, following the acquisition of several of these UAVs in the 1990s.

MALAYSIA

The Malaysian Armed Forces (MAF) presently operates leased UAVs - the Boeing-Insitu ScanEagle and the indigenously developed Alliance Unmanned Developmental Research Aircraft (ALUDRA) Mk1 tactical UAV. The country is looking to expand its use of UAVs - particularly by the Royal Malaysian Air Force (RMAF) and Royal Malaysian Navy (RMN) as it seeks cost-effective measures to monitor developments in the South China Sea, Straits of Malacca, and the Sulu Sea near Sabah.

Korean Air Aerospace Division (KAL-ASD) agreed in April 2018 to transfer technologies and expertise to the Malaysian company DRB-HICOM Defence Technologies (Deftech). This would allow it to support local co-production of the Korean Unmanned

System (KUS)-FS MALE UAV, the KUS-FT tactical UAV, the KUS-VH vertical helicopter, the KUS-VT tiltrotor, and the KUS-HD hybrid multi-rotor UAV.

Deftech is also partnering with Turkish Aerospace Industries (TAI) to meet an anticipated RMAF requirement for wide area surveillance with its Anka MALE UAV, also with potential technology transfers in advanced aero composites and control technology.

In August 2018, the RMAF released its Capability 55 (CAP55) roadmap that outlines its modernisation plans up to 2055, which also highlighted the need for a MALE-class reconnaissance UAV. A request for information was issued in late December and called for responses by February 2019, indicating that the service has yet to firm up its requirements.

Fielded Capabilities

Boeing-Insitu ScanEagle: Malaysian company Unmanned Systems Technology (UST), a subsidiary of Composites Technology Research Malaysia (CTRM), is contracted to provide UAV surveillance covering sections of land and sea in and

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around Sabah. ScanEagle UAVs have been leased by the MAF Joint Force Headquarters to operate from its Kudat base.

Unmanned Systems Technology (UST) ALUDRA Mk1: Development of the ALUDRA Mk1 can be traced back to a number of earlier efforts by CTRM and SCS (SR-1 and SR-2; Nyamok) that commenced from 2003. At least 15 systems are believed to be operated under lease since 2006, with UST as main contractor.

Thales España Fulmar: The Malaysian Maritime Enforcement Agency (MMEA) acquired six Fulmar UAVs for its latest New Generation Patrol Craft (NGPC) in 2016. The Fulmar UAV is designed to support ISR roles and can carry an 8kg payload. The MMEA-specific model will carry one high-resolution video camera with automatic target tracking capabilities. The MMEA's Fulmar UAV is launched via a catapult launcher, situated just behind the ships' SMASH 30mm naval gun system. The UAV is recovered using an impact-absorbing net deployed on the deck space immediately behind the bridge.

Under Development/Consideration/Trials

Unmanned Systems Technology (UST) ALUDRA Mk2: The ALUDRA Mk2 is intended to be acquired by the MAF, although this requirement appears to have lapsed with the armed forces still operating the Mk1.

Deftech ALUDRA Camar: Deftech and Universiti Teknologi Malaysia (UTM) are jointly developing a 40kg-class surveillance UAV which is expected to be completed by 2019. The Camar is constructed from reinforced composites is 2.5m long with a 4m span. Deftech states that the Camar will be capable of flying for up to six hours with a control radius of approximately 80km

MYANMAR

The Myanmar Air Force (Tatmadaw Lay) is believed to be operating a squadron of Chinese-manufactured UAVs based at Meiktila Air Base in north-central Myanmar. Reports of UAVs being tested by the Tatmadaw in Rakhine State near the Bangladesh-Myanmar border surfaced in early 2015 before the outbreak of the Kokang conflict. It is also pursuing

indigenously developed systems, with one example armed with small unguided bombs showcased at its 71st anniversary parade in December 2018.

Fielded Capabilities

China Aerospace Science and Technology Corporation (CASC) Cai Hong/Rainbow (CH)-3: CASC's CH-3 UAV, developed by its China Academy of Aerospace Aerodynamics (CAAA) subsidiary, features a cranked wing design a span of 8m as well as forward canards. The UAV has a maximum take-off weight of around 650kg. It is powered by a rear-mounted piston engine driving a three-bladed pusher propeller and can carry a payload of up to 180kg. The company has stated that it can fly for up to 12 hours with a control radius of 200km via line-of-sight (LOS) datalinks. Between 10-12 CH-3 UAVs are believed to have been acquired by Myanmar.

NEW ZEALAND

The New Zealand Defence Force (NZDF) has expressed its desire for aerial ISR UAVs in its Future Land Operating Concept 2035 paper, which outlines potential challenges for its armed forces in the next decade and beyond.

A similar desire had also been highlighted by the NZDF in its latest 2016 Defence White Paper, which has proposed \$14 billion (NZ\$20 billion) out to around 2030 to enhance the capabilities of its various services, although both documents do not offer any specific timelines or preferred systems.

The Royal New Zealand Navy (RNZN) has also indicated an interest to field a maritime UAV aboard its Otago-class OPVs, which would greatly benefit from an organic high-speed surveillance capability for their extended maritime and economic exclusive zone (EEZ) patrols. However, no formal requirement has been raised to date.

In November 2018, NZDF chief Air Marshal Kevin Short noted in a televised interview that the service is seeking a new UAV capability by the mid-2020s.

Fielded Capabilities

Skycam UAV Kahu: The Kahu has been designed as a high performance, aerodynamically efficient mini-UAV that is equipped with an autopilot system designed by the New Zealand Defence Technology Agency. It is presently operated by the New Zealand Army and can carry a range of high performance

still, motion video and forward-looking infrared (FLIR) sensors, with a flight endurance of two hours and a range of 25km.

INDIA

India has been involved in UAV development for over two decades, with research and development (R&D) organisations such as the Aeronautical Development Establishment (ADE), Bharat Electronics Limited (BEL), Defence Research and Development Organisation (DRDO), Hindustan Aeronautics Limited (HAL), National Aerospace Laboratories (NAL), developing UAVs with ISR, targeting, and weapon guidance capabilities for a number of years.

The country has a growing UAV requirement for its military, paramilitary, border security forces, and commercial organisations across the platform size spectrum. Indigenous efforts have thus far resulted in a number of deployable mini- to tactical-class UAVs, although local industry has been struggling to develop larger platforms in the MALE and HALE class.

However, collaboration with foreign developers such as Israel's IAI as well as technology research institutes - which are also involved in R&D or part-manufacture of more advanced platforms - could finally provide the necessary breakthroughs in the development of larger multi-role UAVs. In March 2019, US DoD acquisition head Ellen Lord revealed that the US Air Force Research Laboratory is aiming to partner with DRDO to develop a small, air-launched UAV system that would likely be deployed via air mobility transports such as the Boeing C-17 and Lockheed Martin C-130J, which both countries operate.

Fielded Capabilities

IAI Heron 1/2: The Indian Air Force (IAF) is known to operate at least 20 Heron MALE UAVs for long endurance ISR mission, with the first examples delivered in 2001. Meanwhile, the Indian Army signed a \$218 million contract in February 2013 for additional Heron UAVs that were delivered from early 2014 to equip its artillery regiments situated along the disputed Sino-Indian border. The army earlier acquired 16 Heron UAVs in 2009. The Indian Navy (IN) is believed to operate at least 12 Heron UAVs, with a number of these located at its Porbandar facility on the west coast to monitor the waters off Karachi. However, a Heron

UAV crashed soon after take-off in March 2018. Taken together, the total number of these air vehicles in Indian military service likely exceeds 50 units.

IAI Searcher Mk II: All three services of the Indian armed forces have also been operators of the tactical-class Searcher II UAV since 2001. The MkII variant features extended-span wings and an AR 682 rotary engine that provide improved flight endurance over the earlier model. It is also configurable for tactical surveillance and communications relay and can carry multiple payloads simultaneously.

IAI Harop/Harpy: Although not specifically a UAV, the IAF has procured at least 10 units of the Harop loitering munition under a \$100 million deal in 2009, which were operational by 2013 to provide an all-in-one search, observe, track, and attack capability against fleeting targets of opportunity. The IAF also operates a number of the Harpy anti-radar attack munitions.

Under Consideration/Development/Trials

IAI Heron TP/TP-XP: In September 2015 India's Minister of Defence approved a \$400 million purchase of 10 Heron Turboprop (TP) MALE UAVs, with deliveries within 12-18 months of contract signing. However, these air vehicles have yet to materialise - likely due to India's entry into the Missile Technology Control Regime (MTCR). In February 2017, IAI announced a new export-version of the Heron TP called the Heron TP-XP. This export variant has a reduced payload of 450kg compared to the 1,000kg capacity of the original model to enable members of the MTCR to acquire it without violating the regime's obligations.

DRDO Rustom I/II: The DRDO's Rustom programme aims to produce an indigenously developed multirole MALE UAV to equip all three Indian military services. The platform is expected to undertake long-endurance missions, including communications relay, ISR, maritime patrol, as well as artillery fire direction and battle damage assessment (BDA). In 2012, the agency suggested that a strike capability involving the integration of the Helina missile - an air-launched variant of the Nag anti-tank guided missile currently under development - could be pursued at

some stage. Following its maiden flight in November 2016, Rustom II has been renamed the Tactical Air-Borne Platform for Surveillance-Beyond Horizon 201 (TAPAS BH 201) and is expected to be employed primarily as an ISR platform.

DRDO Nishant: Work on the catapult-launched Nishant multirole tactical UAV began in the mid-1990s with its maiden flight in 2008. Four of these systems were acquired by the Indian Army in 2011, although a series of crashes between 2013 and 2015 prompted the service to cease acquisition of the system. A conventional take-off and landing variant with a wheeled undercarriage, designated Panchi, was under development but this effort also appears to have ceased following the cancellation of the army's order.

General Atomics Aeronautical Systems Inc (GA-ASI) Predator B Guardian: Up to 22 units of the Guardian, an unarmed maritime variant of the MQ-9 Reaper MALE UAV system, worth \$3 billion could be acquired for the Indian Navy under the US Foreign Military Sales (FMS) programme. Capable of operating at a maximum altitude of over 49,200ft (15,000m), the turboprop powered Guardian is fitted with a Raytheon SeaVue multimode maritime radar under its belly that provides wide-area maritime ISR coverage for 27 hours.

HAL Unmanned Wingman: The Unmanned Wingman programme adopts a similar configuration with the US XQ-58A Valkyrie and is currently envisaged as a low-observable, multirole unmanned combat air vehicle with a flight endurance of up to 80 minutes and powered by the indigenously developed HAL PTAE 7 turbojet engine with a cruise speed of Mach 0.7, and a combat radius of up to 400km. The air vehicle can be directed by a combat aircraft at distances of up to 200km, with a possible candidate being the IAF's updated Jaguar MAX (Mothership for Augmented Xploitation). The company has said it aims to complete a prototype by 2022 and have a production-ready model ready by 2029.

INDONESIA

Indonesia has maintained a stated need for UAVs for several years in a bid to shore up defences across its huge territorial waters, which include around 17,000 islands. Attempts to procure and

indigenously develop UAV platforms for the Indonesian armed forces (Tentara Nasional Indonesia, TNI) have been hindered by a lack of industrial and technical capabilities as well as financial constraints.

The country's top defence officials have reiterated a requirement for armed MALE-class UAVs. PT Dirgantara Indonesia (PTDI) and Turkish Aerospace (TAI) indicated an interest in joint development - based on the Anka UAV - for the Indonesian Air Force (TNI-Angkatan Udara, TNI-AU) In January 2018 and again in August 2018. Officials have also outlined an interest to acquire armed UAVs from China, with an eye on technology transfer that could eventually enable PTDI to develop advanced UAV platforms and systems.

Fielded Capabilities

Aeronautics Defense Systems Aerostar: The TNI-AU operates an Israeli-made tactical UAV that features a stabilised, gimbal-mounted day/night electro-optic sensor, and a CommTact datalink. It is powered by a 38hp Zanzottera piston engine with a two-blade pusher propeller, enabling it to reach a service ceiling of 18,000ft (5,500m) and an operational radius of 200km with an endurance of 14 hours. This type is being operated by the service's Aviation Squadron 51 based near the city of Pontianak in West Kalimantan.

China Aerospace Science and Technology Corporation Cai Hong-4 (CH-4): The TNI-AU has taken delivery of at least two CH-4 armed UAVs, which have been equipped with satellite communications systems that enable these air vehicles to operate out to 2,000 km. Indonesia is understood to have signed for six CH-4 UAVs as well as associated technology transfer.

PT Dirgantara Indonesia (PTDI)/Agency for the Assessment and Application of Technology (BPPT) Wulung: The Wulung UAV programme, which began in 2004, originally sought to produce an indigenously developed UAV to perform a variety of civilian missions across the country's extensive archipelagic territory, from illegal fishing and logging surveillance to cloud-seeding missions and supporting firefighting activities. The TNI subsequently requested an improved variant with increased endurance and range for potential intelligence, surveillance, and reconnaissance (ISR)

missions. PTDI is understood to have delivered up to 11 Wulung UAVs to the TNI-AU by end of 2015.

Under Development/Consideration/Trials

UMS Skeldar Rajawali-330/F-330: The Indonesian Army (TNI-Angkatan Darat, TNI-AD) acquired three fixed-wing Rajawali-330 surveillance and reconnaissance UAVs and associated equipment under a 2015 contract. The air vehicle – which is equipped with an EO/IR camera, hyper-spectral camera, and a mapping camera with light detection and ranging (LIDAR) capabilities – is a derivative of the F-330 and is being co-developed under licence by Indonesian defence manufacturer PT Bhinneka Dwi Persada (BDP). Training was conducted from April 2016, with all three air vehicles believed to be delivered by mid-2016.

PDTI Elang Hitam (Black Eagle): PTDI revealed in December 2019 that it is leading the development of an indigenous armed MALE UAV called the Black Eagle, which features a 16m wingspan and a MTOW of 1,300kg. According to PTDI, the air vehicle will eventually be capable of 30-hour flights and carry up to 300kg of mission equipment and/or weapons. Flight trials are expected to commence in 2020.

PT Indo Pacific Communication & Defence (IPCD) Tactical UAV: The hand-launched Tactical UAV was first unveiled by IPCD at the 2014 Indo Defence exhibition in Jakarta. The air vehicle, which typically carries a high-definition

camera, is backpack transportable and is operated by a two-person team. It is believed that several of these examples were trialled by the Komando Pasukan Khusus (KOPASSUS/Special Forces Command) in mid-2014.

JAPAN

Although the Japan Self-Defense Force (JSDF) is widely seen as one of the most technologically advanced defence forces in the Asia Pacific, it is interesting to note that its present UAV capabilities have been for many years comparatively modest compared to regional peers such as China and South Korea.

However, since 2014 the country has outlined a series of initiatives to grow its indigenous UAV development capabilities, with the aim of introducing new and more capable air vehicles that can perform persistent ISR and early warning missions across its vast maritime domain and airspace.

Fielded Capabilities

Boeing-Insitu ScanEagle: The March 2011 earthquake and ensuing tsunami and nuclear crisis prompted the Japan Ground Self-Defense Force (JGSDF) to improve its humanitarian assistance and disaster relief (HADR) and ISR capabilities, awarding a contract with then Insitu Pacific to deliver a ScanEagle UAV via Mitsubishi Heavy Industries (MHI) for operational testing. The system was developed and tested by Insitu Pacific in collaboration with MHI to meet Japanese spectrum requirements and was delivered by May 2013.

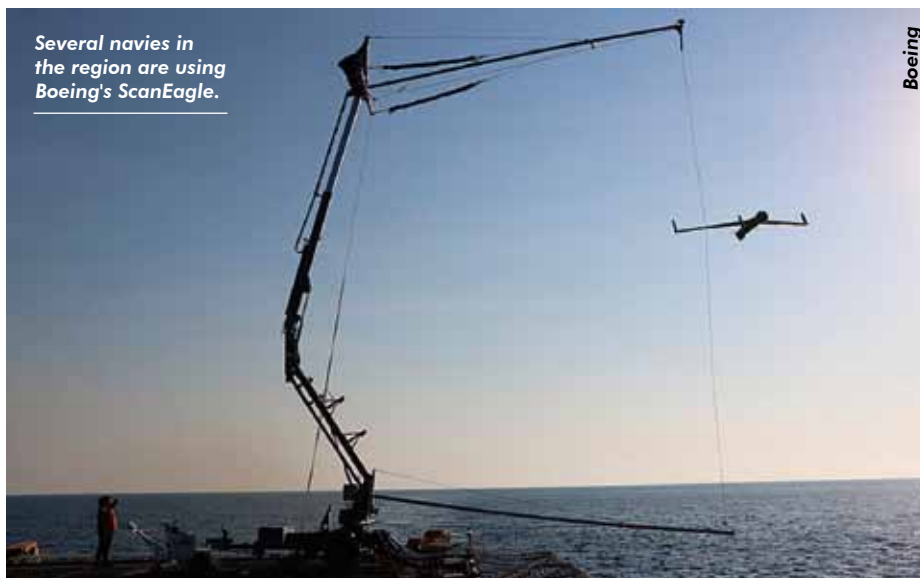
Subaru FFOS: Development of a rotary UAV for the JGSDF for target acquisition, artillery fire-control, and BDA commenced in 1991. Known as the Forward-Flying Observation System (FFOS), a prototype performed its maiden flight in December 1993 and trialled for the Technical Research and Development Institute (TRDI) until 1997. The FFOS carries a daylight TV or FLIR sensor mounted under the fuselage and can also be equipped with a laser rangefinder.

Yamaha R-MAX Mk IIG: A rotary UAV first developed as the R-50 from 1983 for commercial agriculture and entered service in 1991. The more advanced R-MAX featuring an improved engine, flight stability, and safety functions was introduced in late 1997. An evolved version, G-1, was introduced in October 2005 and certified in January 2008. This was followed by a military variant, the MkIIG, which entered service with the JGSDF and deployed for peacekeeping missions in Iraq in 2005.

Fuji Heavy Industries (now Subaru) TACOM: The Fuji TACOM (TAYouto COgata Mujinki, or Small Multirole UAV) is a unique air-launched UAV that was used by the JASDF to evaluate autonomous high-speed flight and manoeuvring techniques. Although primarily a test platform, the TACOM could potentially undertake a range of missions including surveillance and reconnaissance.

Under Development/Consideration/Trials

Northrop Grumman RQ-4 Global Hawk: In December 2013, the Japanese MoD confirmed plans to purchase three RQ-4 Global Hawk HALE UAVs, and announced its firm decision in January 2015. This was followed by a US Defense Security Cooperation Agency (DSCA) announcement in November detailing the request and potential sale of three RQ-4 Block 30i (international) air vehicles to Japan at an estimated cost of \$1.2 billion. In October 2017, Northrop Grumman signed a \$130 million contract to acquire long-lead materials for three Global Hawk Block 30s, two ground control elements, as well as spares and site survey. Japan firmed up its order in November 2018, awarding a \$490 million contract to the company for the three air vehicles. These will be equipped with the Raytheon Enhanced Integrated Sensor



Several navies in the region are using Boeing's ScanEagle.

Suite (EISS) – which comprises EO/IR, synthetic aperture radar, and ground moving target indicator systems – and to be delivered by 1 September 2022. The Japanese government is also selecting a base for the UAVs, which is anticipated to be Misawa Air Base in northern Japan.

PAKISTAN

Pakistan has attempted to acquire Western made UAVs since the early 2000s, but it was not until 2006 before it acquired the German-made Luna and Italian Falco UAVs. Concerted efforts to develop its indigenous UAV production capabilities have also borne fruit, with a number of domestically produced systems already in service with the Pakistan armed forces.

Fielded Capabilities

Advanced Computer Engineering Services (ACES) Uqab II: The Uqab II is a tactical short-range UAV system developed from the Eagle Eye and has an operational range of 150km and a ceiling of 10,000ft (3,000m). It is fitted with a pan-tilt-zoom camera and can downlink digital video in real time. The Uqab UAVs have GPS-based navigation and tracking systems that can be pre-programmed and altered during flight. They can also operate under manual control and use conventional take-off and landing.

Boeing-Insitu ScanEagle: Pakistan has acquired an unspecified number of ScanEagle UAVs under a \$15 million FMS contract awarded in September 2015. The contract, which emerged after nearly seven years since the country expressed its interest in the air vehicle, was handled via the US Naval Air Systems Command and is believed to cover up to 30 systems if all options were fully exercised. Deliveries of the ScanEagles commenced from the third quarter of 2016 to the Pakistan Navy.

CASC CH-3: At least 20 CH-3 UAV systems are believed to have been delivered to Pakistan in 2011. See earlier entry for air vehicle details.

EMT Luna: The fixed-wing Luna is a short-range battlefield reconnaissance, surveillance, and target acquisition UAV with a flight endurance of approximately six hours and an operational radius of 100km. Potential payloads include a daylight CCD camera with zoom, a thermal imager, or a miniature single aperture radar. At least three systems have been acquired for the Pakistan Army.

Leonardo Falco: Originally developed by Selex ES/Finmeccanica, the long range Falco UAV comprises a fuselage module that supports a fixed tricycle undercarriage, shoulder-mounted gull wings and a rear-mounted pusher engine. The company states that the air vehicle has an operational radius of 200km and a 14 hour endurance, although this can be further extended via command handover between ground control stations (GCS). Deliveries of the Falco to the Pakistan Air Force is believed to have been completed in 2008 with service entry in 2009.

Global Industry and Defence Solutions (GIDS) Burraq: Claimed to be a fully indigenous development by the state-owned National Engineering and Scientific Commission (NESCOM), the Burraq appears to be heavily inspired by the Chinese-made CH-3 tactical UAV with its canard and swept-wing configuration and pusher-propeller propulsion arrangement. The Burraq entered service with the Pakistan Air Force in November 2013 and is equipped with two underwing hard points, which can be used to launch a variety of munitions including Barq laser-guided missiles.

Global Industry and Defence Solutions (GIDS) Shahpar: Adopting a similar airframe configuration with the Burraq, the Shahpar is optimised for ISR missions and does not feature an offensive capability. It is presently equipped with a four-stroke Rotax 912 ULS engine that provides up to seven hours with an operating radius of 250km while carrying a 50kg payload, although the company is planning to upgrade the air vehicle with a new and more powerful engine.

Under Development/Consideration/Trials

Pakistan Aeronautical Complex (PAC) ZF-1 Viper: Promotional material of the ZF-1 Viper stealthy unmanned combat air vehicle (UCAV) concept emerged in May 2019, depicting a blended wing design with a 18m wingspan and a 16,000kg MTOW, which is expected to achieve a maximum speed of 533kts (988km/h) and a service ceiling in excess of 30,000ft (9,100m), while carrying a 300kg payload up to a range of 500km. The concept is aimed at performing deep penetration and suppression of enemy air defences, as well as reconnaissance and electronic warfare. The effort is part of Pakistan's 'Project Azm' which seeks to develop next-generation military aviation capabilities.

PEOPLE'S REPUBLIC OF CHINA

Chinese industry has introduced scores of unmanned systems over the past decade, mainly produced by state-owned defence primes such as the Aviation Industry Corporation of China (AVIC) and China Aerospace Science and Technology Corporation (CASC), although the number of private firms involved in military and dual-use UAV development has also increased significantly. Indeed, the US DoD believes that the country could manufacture as many as 41,800 UAVs worth over \$10 billion by 2023.

The DoD also believes that the development and acquisition of longer-range UAVs will increase the People's Liberation Army's (PLA's) ability to conduct long-range reconnaissance and strike operations, with notable developments such as the Wing Loong (Pterodactyl) and Xianglong (Soaring Dragon). Although information about the capabilities of in-service systems remains shrouded in secrecy, these programmes represent major advances in Chinese technology.

Fielded Capabilities

CASC CH-1: The short-range general-purpose CH-1 entered production for the PLA's artillery forces from around 2003. The tactical UAV carries a 20kg payload comprising a range of electro-optical sensors appropriate for its intended missions, which include artillery fire direction, battlefield damage assessment, as well as reconnaissance and surveillance within a radius of 100km.

CASC CH-2: The CH-2 medium-range general UAV is essentially a larger and night operations-capable air vehicle based on the CH-1 design and was produced from 2005. The newer platform improves on almost every aspect of its predecessor, including an increased operating radius of 200km and an endurance of eight hours. An increased payload capacity of 30kg enables the air vehicle to take on a greater variety of roles, such as data communications relay.

AVIC Wing Loong-1/Gongji-1: Developed by AVIC's Chengdu Aircraft Design and Research Institute (CADI) subsidiary, the Wing Loong-1 is a MALE-class UAV that has a wingspan of 14m and shares a close physical semblance to the US-made RQ-1 Predator. The air vehicle – which is identified as the Gongji-1 (GJ-1) in People's Liberation Army Air Force



A PLAAF Wing Loong-2 MALE UAV, otherwise known as the Gongji-2 (GJ-2).

(PLAAF) service – has a payload capacity of 200kg and can carry munitions, such as the indigenous HJ-10 anti-armour missile, CS/BBE2 50kg high-explosive bomb, and LS-6-50 small-diameter bomb.

AVIC Wing Loong-2/Gongji-2: The PLAAF revealed in November 2018 that it has fielded the Wing Loong-2 MALE UAV with the in-service designation of Gongji-2 (GJ-2). Performance is believed to remain largely unchanged from the export Wing Loong-2 platform, although the GJ-2 can be differentiated with its lack of wingtip devices.

Wuzhen-8 (WZ-8) and Gongji-11 (GJ-11): The PLA made a surprise unveil of two hitherto unknown special mission UAVs at a military parade commemorating the 70th anniversary of China’s founding. Although no official information has been released, the WZ-8 is believed to be powered by two solid-state rocket engines and designed to be launched by a host aircraft such as the H-6 bomber. In contrast, the GJ-11 is believed to be derived from AVIC’s Lijian (Sharp Sword)UCAV development albeit improved with a blended fuselage that features enclosed exhaust nozzles. Close-up imagery indicates that the air vehicle is equipped with two internal payload bays.

Beijing University of Aeronautics and Astronautics (BUAA)/ Harbin Aircraft Industry Group (HAIG) BZK-005: The existence of the multirole BZK-005 MALE UAV was first made known in 2006 in a promotional video. Equipped with a

satellite communications (SATCOM) datalink and carrying up to 150kg of stores and equipment, the air vehicle can stay airborne for up to 40 hours and is specifically designed for long-range reconnaissance missions. It is believed to be in People’s Liberation Army Navy Air Force (PLANAF) service, and this was proven in April 2018 when the Japanese Air Self-Defense Force (JASDF) announced that it had photographed a BZK-005 flying over the East China Sea to the north of Taiwan.

Guizhou Aviation Industry Group Xianglong (Soaring Dragon): The Xianglong is believed to be the primary HALE UAV operated by the PLAAF for high-end ISR missions and is often compared to the US-made RQ-4 Global Hawk.

Xi’an ASN Technical Group ASN-206: Development of the short-range tactical ASN-206, which reportedly incorporated technical assistance from Israeli firm Tadiran Spectralink, began in December 1994 with serial production believed to have occurred from 1996. The ASN-206 has a payload capacity of 50kg and has an operational radius of 150km and flight endurance of up to eight hours.

Xi’an ASN Technical Group ASN-207: The ASN-207 was revealed in 2002 and is essentially a larger and more capable version of the ASN-206, featuring a 100kg stores carrying ability, a 600km operational radius, and a 16 hour endurance.

Xi’an ASN Technical Group ASN-209: The ASN-209 multirole tactical UAV, which appears to be derived from the earlier ASN-206/207 design, is believed to have been acquired by the PLA Navy (PLAN), with several examples reportedly sighted during a major naval exercise between Hainan and the Spratly Islands during July 2011 as a shore-based surveillance platform and communications relay.

China Aerospace Science and Industry Corporation (CASIC) WJ-600: The WJ-600 is a high-speed, armed reconnaissance UAV that adopts a form factor that is comparable to that of a cruise missile and is available with a turbojet (WJ-600) or turbofan (WJ-600A) engine. It is believed to have been acquired by the PLAAF, although it has yet to be seen in operation despite multiple public appearances at defence exhibitions around the world. However, the existence of operational WJ-600s was proven when at least two examples were displayed during Turkmenistan’s Independence Day parade in October 2016.

Export-oriented systems

AVIC Wing Loong II: Unveiled in its production-ready form at the 2016 Airshow China Exhibition, the Wing Loong II has an overall length of 11m and wingspan of 20.5m. The air vehicle has a stated internal payload capacity of 200kg, with provision for up to 480kg of external stores, and can operate for up to 20 hours. It reportedly made its maiden flight on 27 February 2017, with AVIC announcing that it had secured an unidentified international customer on the same day.

Beihang Unmanned Aircraft System Technology TYW-1: The export-oriented TYW-1 is thought to be a strike-capable MALE UAV that is based on the in-service BZK-005. It reportedly features a 370kg payload capacity and is equipped with four underwing hard points, with a flight endurance of up to 40 hours.

CASC CH-3: The CH-3 has found regional success with Myanmar and Pakistan acquiring a number of these systems for armed reconnaissance missions. The company has also developed civilian variants for applications such as geological survey and low-level aerial mapping. Advanced flight control technologies resulting from these efforts

have also benefited its military systems.

CASC CH-4: Inspired by the US-made RQ-1 Predator, development of the MALE-class CH-4 UAV commenced in 2009, with the first production-ready example rolled out in 2014. Glass fibre-based composite materials are used extensively to reduce the overall weight of the air vehicle as well as its radar cross-section (RCS). Two variants are currently offered: the CH-4A, which is configured principally for reconnaissance missions with a flight endurance of 30 hours; and the strike-oriented CH-4B, which can carry a 345kg weapons payload but has a shorter flight endurance of 14 hours. At least 30 CH-4s – valued at \$700 million – have been exported worldwide since 2014.

CASC CH-5: Also unveiled in its production-ready form at Airshow China 2016, the CH-5 features a lightweight all-composite airframe that measures 11.3m long with a wingspan of 21m and bears a striking resemblance to the US MQ-9 Reaper UAV. The company claims it can carry a maximum payload of 1,200kg. The air vehicle has a stated flight endurance of over 40 hours, although a heavy fuel variant with an extended endurance of 60 hours is under development. The company has specified an operating radius of 250km via line-of-sight control, although this can be extended to 2,000km when a SATCOM datalink is fitted.

Under Development/Consideration/Trials

AVIC Wing Loong I-D: State media reported in January 2018 that AVIC is developing the Wing Loong I-D, an improved version of its Wing Loong I

UAV. It will feature a wider wingspan of 17.6m and be able to carry up to 400kg of external stores. The company has stated that it aims to have the I-D variant production-ready by the end of 2018.

AVIC AV500W: Under development by AVIC's China Helicopter Research and Development Institute (CHRDI), the AV500W is a modified version of the civilian model AV500 VTOL UAV with a more robust structure and improved performance. The AV500W is stated to have a payload capacity of 160kg. This typically comprises a chin-mounted, stabilised electro-optical infrared sensor turret as well as internally carried payloads such as a synthetic aperture radar (SAR) or communications relay systems. Weapons can also be carried on its stub wings.

CASC CH-4C: CASC is developing an improved variant of its widely exported CH-4 MALE UAV with an updated electronic architecture that will enable it to carry more powerful mission payloads. Designated the CH-4C, it has been seen carrying what appears to be an electronic warfare (EW) or signals intelligence (SIGINT) pod during flight trials in early 2018.

Tengoen Technology TB001 'Twin Tailed Scorpion': A new starter in China's UAV industry, Tengoen took the opportunity at the 14th China-Association of Southeast Asian Nations Exposition in Nanning in September 2017 to unveil its twin-engine, twin-boom TB001 armed reconnaissance UAV. The TB001 has a stated maximum range of 6,000km and an endurance of 35 hours,

and is equipped with two hard points under each wing. State media reported that the prototype air vehicle performed its maiden flight just days after its public unveiling in Nanning.

PHILIPPINES

Despite engaged in decades of counterinsurgency (COIN) operations, the modernisation of the Armed Forces of the Philippines (AFP) has been hampered by a lack of funding and ineffective policy. The Department of National Defense (DND) has in recent years made significant efforts to boost AFP capability and transform it from a COIN-oriented force into one that can undertake the full spectrum of military operations, which has seen its services benefit from a number of new acquisitions. The AFP initially adapted hobby drones for tactical ISR support but has recently taken delivery of US-made military systems.

Fielded Capabilities

AeroVironment RQ-11B Raven: The Philippine Army has taken delivery of the RQ-11B Raven system comprising three UAVs as part of a United States-supported counterterrorism support programme. According to a US embassy announcement in February 2017, the army will also receive operations and maintenance training.

Boeing-Insitu ScanEagle: The Philippines was revealed to have acquired the ScanEagle UAV in a US Navy Naval Air Systems Command (NAVAIR) solicitation published in June 2017. In September 2017, the US Department of State announced that the Philippines is to receive a ScanEagle system comprising six UAVs by 2019. This was handed over to the Philippine Air Force during a ceremony held at Villamor Air Base in Pasay City in March 2018. The system is operated by 300 Air Intelligence and Security Wing (AISW) out of Antonio Bautista Air Base in Palawan.

Elbit Systems Hermes 450: The Hermes 450 is a tactical-class UAV with a MTOW of 550kg and a 10.5m wingspan that can be operated via a single-person GCS. An unspecified number of these air vehicles were acquired under a \$153 million package announced in October 2019.

Elbit Systems Hermes 900: The Hermes 900 is the first MALE-class UAV platform to be acquired by the Philippines, featuring



Reports indicate that a new version of the CASC CH-4 MALE UAV, which will be known as the CH4C, is being developed.

a MTOW of approximately 1,200kg and a 15m wingspan. An unspecified number of these air vehicles were acquired under a \$153 million package announced in October 2019.

Elbit Sytems Skylark 3: The Skylark 3 is a tactical ISR platform that is launched via a pneumatic launcher. An unspecified number of these air vehicles were acquired under a \$153 million package announced in October 2019.

Elbit Sytems Skylark I-LEX: The hand-launched I-LEX is a stealthy, battalion-level ISR UAV acquired under a \$153 million package announced in October 2019. According to the company, the type is designed for tactical surveillance and is almost inaudible at altitudes of 330 feet (100m) or higher.

Elbit Sytems Thor quadrotor UAV: The Thor is a quadrotor VTOL UAV that is designed for military and homeland security missions. The Philippines acquired 1,000 Thor UAVs under a \$153 million package announced in October 2019.

Philippine Army Research and Development Center (PARDC) Raptor: Publicly unveiled at an AFP open house event in Camp Aguinaldo in December 2013, the Raptor is a fixed wing drone based on the airframe of a commercially available remote-controlled aircraft. It has an endurance of around three hours and carries a video camera that provides real-time imagery and video out to an operating radius of 3km. The Raptor was first deployed during the Zamboanga City crisis in September 2013.

Philippine Army Research and Development Center (PARDC) Knight Falcon: Similar to the Raptor, the Knight Falcon is a fixed wing UAV that was adapted from a commercial airframe, although it is larger and features a longer range of around 7km.

REPUBLIC OF KOREA

The Republic of Korea (RoK) is one of a handful of Asia Pacific countries that possess advanced aerospace industries and are pursuing wide ranging unmanned aircraft system development programmes. At present, the RoK's military forces rely on a mix of indigenously developed systems – with the majority of these operating at the tactical level and below – from established international manufacturers at the MALE-class and above, such as IAI's Heron I and Northrop Grumman RQ-4 Block 30 Global Hawk.

Present domestic development efforts largely centre on MALE-class platforms for the Republic of Korea Air Force (RoKAF) and Republic of Korea Army (RoKA), the introduction of an unmanned combat air vehicle (UCAV) capability, as well as vertical take-off and landing (VTOL), and tiltrotor platforms.

UAVs are also expected to be an important element of the so-called 'Kill Chain' integrated surveillance and strike system for detecting and neutralising hostile missile launches from the DPRK.

Beyond serving the needs of its armed forces, the country aspires to be one of the leading manufacturers and exporters of world-class UAV systems, with key government agencies and industry primes such as the Agency for Defense Development (ADD), Korea

Aerospace Research Institute (KARI), Korea Aerospace Industries (KAI), and Korean Air Aerospace Division (KAL-ASD) spearheading efforts to advance its UAV technology base.

Fielded Capabilities

KAL-ASD Korean Unmanned System-FT (KUS-FT)/RQ-102: KAL-ASD, a unit of the South Korean national airline specialising in military systems, secured a contract from the Defense Acquisition Program Administration (DAPA) in 2016 to manufacture the KUS-FT tactical UAV system for the RoKA. The company will deliver 16 complete systems – each comprising four UAVs – by the end of 2020. The RQ-101 is designed for short take-off and landing operations, and can stay aloft for 24 hours. It is equipped with automatic target tracking capability with an effective range of up to 10km.

Daewoo/KAI RQ-101 'Night Intruder 300': The RQ-101 is the RoKA's first tactical-class UAV platform, which adopts a fixed-wing configuration and offers a 120km operating radius with line-of-sight control or up to 360km with ground relay stations. It has a payload capacity of 45kg which is dedicated to high-definition day and infrared sensors as well as a SAR device. Deliveries are understood to have been completed by the end of 2004.

Elbit Systems Skylark II: Elbit's Skylark II is a larger and more capable version of the hand-launched Skylark I with an endurance of six hours and an operational radius of approximately 59km. The system typically comprises up to two air vehicles, associated payloads, and a truck-mounted rail launcher and GCS.

Foosung Group/UCON Systems

Remoeye: The RoKA signed a contract with Foosung Group for its RemoEye 002B mini-UAV in 2013, with deliveries of 120 systems – each comprising four air vehicles – commencing in the third quarter of 2015. The RemoEye 002B is hand-launched and recovered with an air-bag cushion system. The electrically powered air vehicle has an range and endurance of 10km and 60 minutes, and is equipped with a nose-mounted, stabilised electro-optical infrared payload with pan and tilt scanning.

IAI Heron 1: IAI announced in December 2014 that the South Korean Defense Acquisition Program Administration



The Philippine armed forces are using Elbit's Hermes 900 MALE UAV.

Elbit

(DAPA) selected its Heron 1 MALE UAV for the RoK armed forces' corps-level UAV requirement. An unspecified number of these air vehicles are understood to be operated by the RoKA. At least one of these air vehicles have been reported performing reconnaissance missions over the Demilitarised Zone (DMZ).

Under Development/Consideration/Trials

KAI Next Corps Reconnaissance UAV II, Tactical UAV, and unmanned combat air vehicle (UCAV): KAI is developing a range of next-generation UAV platforms positioned to meet the future requirements of the RoK armed forces. Detailed information on these developments have yet to be released.

KAL-ASD KUS-FC: Very little is known about the stealth-optimised, turbojet-powered KUS-FC UCAV. The company has stated a wingspan of approximately 16m and a flight endurance of six hours at the ADEX 2017 exhibition in Seoul, but has withheld further information.

KAL-ASD KUS-FS: Previously known as the Medium-Altitude UAV, the KUS-FS MALE UAV is being developed for the RoKAF and is in the same class as the US MQ-9 Reaper UAV. The multirole air vehicle is expected to perform missions such as communications relay, electronic warfare (EW), ISR, as well as signals intelligence (SIGINT). Images showing a prototype in flight reveal that it is also equipped with two hard points under each wing, indicating a potential strike capability. Development of the air vehicle expected to be completed by end of 2018, which will then be transferred to the RoKAF for operational testing and evaluation.

KAL-ASD KUS-VH: KAL-ASD is developing a rotary-wing unmanned platform based on the MD-500 light attack helicopter. Flight endurance is extended to four hours with the installation of a large fuel tank in place of the rear passenger seats. If successfully developed, the KUS-VH could potentially support manned/unmanned-teaming operations with the RoKA's AH-64E Apache Guardians, which already feature the ability to command UAVs.

KAL-ASD KUS-VT: An unmanned tiltrotor aircraft developed jointly with the Korea Aerospace Research Institute



JR Ng

At the recent Singapore Airshow ST Engineering unveiled its Veloce family of fixed-wing VTOL UAVs. Shown here is the Veloce 15.

(KARI) and based on the TR-60 system. The KUS-VT can carry a 30kg payload and has an operational radius of 200km with an endurance of six hours. It is expected to perform autonomous VTOL and shipboard operations.

Northrop Grumman RQ-4 Global Hawk: The RoK has acquired four RQ-4 Block 30 Global Hawks along with two GCS systems and two spare engines under a \$657 million FMS contract, which will equip a RoKAF ISR unit. Two aircraft are scheduled to be delivered in 2018, with a further two in 2019.

REPUBLIC OF CHINA (TAIWAN)

The Republic of China Air Force (RoCAF) has been reluctant to adopt unmanned technologies, with no UAVs known to be currently in service. The country's largest and most capable UAV, the tactical-class Chung Shyang II, is operated by the Republic of China Army (RoCA).

The country's UAV development efforts are being spearheaded by the National Chung-Shan Institute of Science and Technology (NCSIST).

Fielded Capabilities

NCSIST Cardinal II: The Cardinal II is a small hand-launched UAV that is understood to be in RoCA and Republic of China Navy (RoCN) service. The air vehicle is powered by an electric motor and can stay aloft for up to 60 minutes, and is recovered via parachute-assisted landing. An electro-optic camera enables it to capture ISR imagery.

NCSIST Chung Shyang II: Also known as the Albatross, the Chung Shyang II is a reconnaissance platform that is presently in RoCA service. Around 32 UAVs were acquired for the army under a \$120 million contract inked in 2010. The package included eight complete control suites, each comprising a command post, GCS, launch and recovery system,

remote video terminal, and other support equipment. Three of these air vehicles reportedly malfunctioned and were lost during routine operations and training in 2012, 2013, and 2016. Further work is underway to improve reliability and performance.

Under Development/Consideration/Trials

NCSIST Teng Yun: The prototype of a new MALE-class UAV was revealed at the 2015 Taipei Aerospace & Defense Technology Exhibition (TADTE), which appears to be modelled after the US RQ-1 Predator platform with proposed mission sets including communications relay, persistent ISR operations, as well as coastal patrol and civilian research missions. An updated prototype with underwing hard points was subsequently rolled out at TADTE 2017. In December 2017, President Tsai Ing-Wen announced that the air vehicle, now designated Teng Yun (Cloud Rider), would enter production.

SINGAPORE

Singapore has been described by some observers as an 'enthusiastic user' of UAVs. The country first began unmanned aircraft operations with the army-operated Tadiran Mastiff tactical UAV in 1979, but has since acquired newer and more capable platforms that are now operated by the Republic of Singapore Air Force's (RSAF) UAV Command, which was inaugurated in 2007 and now oversees all major military UAV operation. With a perennial shortfall in manpower, the Singapore Armed Forces (SAF) see technology as a critical force multiplier with the ongoing modernisation effort focusing deeply on the integration of command and control, ISR, and precision strike. In that regard, UAVs are seen as a key enabler for the SAF's transformational initiatives.

The IAI Heron 1 is the RSAF's primary long-range UAV.



JR Ng

Fielded Capabilities

Boeing-Insitu ScanEagle: The Republic of Singapore Navy (RSN) operates the ScanEagle UAV as part of the upgrade and life extension of its six Victory-class missile corvettes, providing these vessels with an organic airborne ISR capability. The air vehicle is launched via a pneumatic launch catapult installed on the aft deck. A Skyhook recovery system is fitted just astern of the superstructure to snare the returning vehicle in mid-air.

Elbit Systems Hermes 450: The RSAF has operationalised a number of Hermes 450 tactical UAVs in March 2015, which were first delivered in 2007. The RSAF's Hermes 450 UAVs are operated by 116 Squadron, which is based at the western Tengah Air Base. The air vehicle carries a 150kg payload, although the service opted for a belly-mounted turret with high-definition colour daylight TV and IR cameras, as well as a laser designator.

IAI Heron 1: The RSAF's primary long-range UAV is the MALE-class Heron 1 UAV, which was introduced in May 2012 and replaces the ageing IAI Searcher tactical UAV. The service's Heron 1 UAVs were declared fully operational in March 2017, and are operated by the 119 and 138 Squadrons. It has opted for a MAN 4x4 truck-based mobile GCS configuration for general UAV and mission payload operation, with two modular workstations that handle critical mission planning, control, command, and processing functions.

ST Engineering Skyblade II: The Skyblade II is described as a short-range

mini-UAV. The 5kg air vehicle is hand-launched and parachute-recovered and is powered by a hybrid propulsion system and has an endurance of one hour and operating radius of up to 8km. It is equipped with an automatic 'return-home' function and can be programmed to autonomously fly user-defined flight paths via waypoint-setting and also features three pre-determined loiter patterns.

ST Engineering Skyblade III: At least six Singapore Army units have been equipped with the Skyblade III mini-UAV since 2010. The Skyblade III is a 5kg, man-portable UAV can be transported in two backpacks weighing 20kg each. It can be readied for flight within 20 minutes and launched by hand, flying for up to one hour out to a range of 8km.

Under Development/Consideration/Trials

DSO National Laboratories V15: The V15 is Singapore's first locally developed fixed-wing surveillance UAV with a VTOL capability. Unveiled in November 2017, the V15 is equipped with a day/night camera and is designed specifically for use in urban environments where conventional UAV take-off and recovery is a challenge. The V15 has a three hour endurance and has also demonstrated an ability to take-off and land on a moving unmanned ground vehicle.

Schiebel S-100 Camcopter: The RSN has reportedly conducted shipborne trials for the rotary-wing S-100 Camcopter aboard one of its latest Independence-class Littoral Mission Vessels. It is understood

that the service is yet to commit to a buy, and is also exploring other similar UAVs before it selects the appropriate platform.

ST Engineering Stinger: The Stinger Unmanned Aerial Multi-Rotor Gunship is envisioned to be a semi-autonomous, company-level reconnaissance and fire-support platform. Although still in early development, the company is aiming for an endurance of over 30 minutes when carrying high-definition daylight and thermal imaging cameras, a fire-control system (FCS), and a 5.56mm calibre Ultimex 100 Mk8 light machine gun.

ST Engineering Veloce 15 (V15) and Veloce 60 (V60): The land systems division of ST Engineering unveiled the Veloce family of fixed-wing VTOL UAVs that are designed to offer the tactical advantages of VTOL with high-speed conventional flight. The V15 and V60 have respective MTOWs of 16-17kg and 50-70kg and are designed to be quickly transported and assembled.

SRI LANKA

Since the end of the Sri Lankan Civil War, the country's armed forces have been tasked with an increasing spectrum of missions, including air defence, strike, and cyber warfare, but is primarily geared towards providing tactical air support during COIN and naval interdiction operations. To this end, the Sri Lankan Air Force (SLAF) maintains a range of UAVs that have supported the ground forces for more than a decade.

Fielded Capabilities

IAI Searcher: Operated by SLAF's 111 UAV Squadron, the long-endurance Searcher UAV is believed to have conducted 265 sorties in support of ground troops during the civil war with the Liberation Tigers of Tamil Eelam from 1983 to 2009.

EMIT Aviation Consult Ltd Blue Horizon II: An unspecified number of the long-endurance Blue Horizon II tactical UAVs - which have a flight endurance of 24 hours and an operational radius of up to 150km via a datalink - have been acquired after a 2009 request from the Sri Lanka government. These are believed to be operated by the SLAF's 112 UAV Squadron.

THAILAND

Thailand's requirement for improved

intelligence gathering has increased in recent years, with a concomitant growth in indigenous UAV research and development capability. Earlier efforts to manufacture locally made systems have largely revolved around highly affordable but technically rudimentary products from private- and military-owned firms with foreign assistance from countries such as Israel.

However, increasingly sophisticated and capable UAVs are beginning to emerge in recent years, following a Ministry of Defence initiative that was introduced in 2009 to reduce dependency on foreign UAV technologies and imports. Today, the ministry's Defence Technology Institute (DTI) is spearheading efforts to grow its indigenous UAV production capabilities and spur innovation within the local defence industry.

Fielded Capabilities

Aeronautics Defense Systems Aerostar: The Royal Thai Air Force (RTAF) fielded its first UAV, the tactical-class Aerostar as part of the military's wider effort to introduce surveillance and reconnaissance UAVs into service to support its fighting forces. Local media reported that a new unit, 404 Squadron, was created at Takhli to operate the

AeroVironment RQ-11 Raven: The Royal Thai Army is believed to have acquired around 12 of these hand-launched mini-UAVs in 2010 for tactical ISR missions.

RTAF Research and Development Centre for Space and Aeronautical Science and Technology Tigershark II: Designed around 2015, the medium-range Tigershark II tactical UAV is stated to have an operating range of up to 150km while carrying a 30kg payload. Ministry of Defence reportedly awarded a \$18 million contract in 2016 to procure parts for up to 17 Tigershark II UAVs. Local firm AVIA Satcom reportedly responsible for systems integration and testing, while G-Force Composites is constructing the airframe.

Under Development/Consideration/Trials

R V Connex Sky Scout: A smaller tactical UAV with a similar airframe configuration is also being developed by local firm R V Connex for DTI. The Sky Scout tactical UAV has a 10 m wingspan is capable of carrying a 10kg payload with a flight endurance of up to six hours.



The RTAF's indigenously developed U1-M tactical UAV.

It is said to have accumulated over 200 hours in flight testing.

R V Connex U1-M: The RTAF has fielded the indigenously developed U1-M tactical UAV, which is understood to be based on technologies derived from the earlier Tigershark II and Sky Scout developments. The company is also integrating lightweight air-to-surface missiles to the air vehicle, with a potential candidate being the Thales Lightweight Multirole Missile.

Royal Thai Navy (RTN) Naval Research and Development Office Tarem: Unveiled at the 2017 Thailand Defence & Security Exhibition in Bangkok, the multi-rotor Tarem tactical UAV is being developed by the Thai Naval Research and Development Office for communication and surveillance missions. It is also equipped with a stabilised mount that can accommodate a 9mm calibre automatic pistol.

Top Engineering Group Falcon V: The Falcon V is a fixed-wing surveillance UAV with a VTOL capability that is being developed under a DTI contract. It can carry a 5kg payload.

VIETNAM

There has been an observable emphasis on UAV development in line with a requirement to boost the ISR capabilities of the Vietnamese armed forces. The country is understood to have begun developing UAV technologies such as flight control and navigation systems, operating software and airframe design,

since 2011. Moreover, programmes led by the state-owned Vietnam Aerospace Association (VASA) has ostensibly resulted in cooperation with Russia's Irkut and Sweden's Unmanned Systems Group (UMS) to develop and produce tactical UAVs based on the Irkut-200 and UMS Magic Eye 1 UAVs, although it appears that the momentum has since stalled with little known progress on development.

Fielded Capabilities

Viettel Group Patrol VT: The military-owned telecommunications firm Viettel Group publicly showcased its indigenous Patrol VT tactical UAV in 2014. The air vehicle, which is developed by the company's Flight Instrument Centre, is stated to be capable of operating out to 50km and carries an optical infrared camera that provides real-time transmission of high-definition imagery.

Under Development/Consideration/Trials

Academy of Science and Industry/Ministry of Public Security HS-6L: Vietnamese media have reported the existence of the HALE-class HS-6L, which has a twin-boom airframe and a wingspan of 22m. Stated performance include a range of up to 4,000km and a 35 hour flight endurance. The air vehicle is thought to be destined for military patrols over the South China Sea, where Vietnam maintains several claims. A prototype was reportedly completed by November 2015 with flight testing occurring during the second quarter of 2016. [AMIR](#)



USMC

The fire team is an element of the infantry rifle squad that typically includes an automatic weapon (Automatic rifle or light machine gun), several rifleman, and a team leader. This is the most basic infantry combat unit. Here a US Marine fire team conducts live firing.

FOOT SLOGGER FIREPOWER

A review of some of the latest firepower becoming available to riflemen and those firing automatic weapons in today's infantry.

by Stephen W. Miller

Weapons of the combat infantry small unit must address tasks ranging from suppression of enemy in dug-in positions by automatic riflemen and machine gunners to the dedicated marksman's precise engagement of individual targets and the arms of each rifleman. Developments in small arms and recent initiatives by a number of the world's militaries suggest it is timely to examine the direction of each of these classes of squad and platoon arms.

Rifles and machine guns

The heart of the dismounted ground defence has been and continues to be the machine gun and automatic rifle. The former are given priority in being positioned to provide flanking an enfilade fires covering the most likely avenues of attack by the enemy. The latter then are placed to cover secondary approaches

and to protect the machine guns. Similarly the machine gun is critical to the friendly attack. Here it provides the base of fire which will keep the defenders 'heads-down' reducing their ability to effectively engage the attack. Rifleman with automatic weapons moving with the attack force supplements these suppressive fires. They will also take up the machine gunners task when they must shift their fires so as friendlies sweep over the objective.

Given the need to place sustained fires on either an enemy defensive positions or on their attacking assault these weapons need to reliably deliver continuous fires without stoppage or failure. The challenge has been how to assure this while also reducing the carry weight of the weapon to make it more manageable. In fact, there is considerable debate regarding the most appropriate automatic weapon for the squad. The question is whether this should be an automatic rifle

(AR) as represented by the renowned Browning Automatic Rifle (BAR), the light machinegun (LMG) such as the FN Minimi/M249, or a medium or general purpose machine gun (GPMG) like the Russian PK. The challenge is in achieving the characteristics seen desirable for a weapon to be used within the constraints of the front line small infantry unit.

GPMGs

The GPMG have proved to reliably provide well aimed sustained fires, although their weight discourages its adoption by the small unit. However, industry initiatives have sought to overcome this. Russian infantry still employ the PKM or Modernizirovanniy Pulemyot Kalashnikova (PK Machinegun Modernised) first introduced in the 1960s. It is also widely exported and produced under license gaining particular mention by US soldiers in Afghanistan on its ability to engage at ranges of up to 1000m. This is further facilitated by its use of a 1P29 optical sight. The PK is readily fit to a tripod mount which enhances its accuracy over the bipod. Using an operating mechanism similar to the AK, at 16.53lb (7.5kg) with bipod and using 7.62x54R ammunition it is not particularly light but has proved to be reliable even in the extreme conditions. This is reflected in its fielding by over eight-five armies.

The FN MAG58 designated M240 by the US, is another widely used GPMG. It has also been the subject of a number of improvement efforts. One by Barrett Firearms Manufacturing has resulted in the M240LW (Lightweight). Bill Geissele, president of Geissele Automatics, who has technical rights, explained: "The 7.62mm 240LW/LWS is improved in every performance aspect: it is lighter, more reliable, easier to load, easier to maintain, more ergonomic and more controllable making it a machine gun for the 21st century." The new M240LW is lighter at weights 21lbs (9.55kg) and shorter at 44in (112cm).

The issue with the GPMG at squad level is that it was designed as a crew served weapon which even at reduced weight remains requires a trade-off in personnel that may not be acceptable with a squad size of eight or less.

LMGs

The light machine gun traces its origin to the Great War and the German introduction of Stormtrooper tactics. These small units required a fast firing but light weapon



The US Army is evaluating three candidates for its Next Generation Squad Weapon. One of them being offered by Textron uses a unique CT Cased Telescoped ammunition that is lighter and shorter than conventional cartridges. The LMG version (shown) uses belted ammunition with polymer links.

they could carry with the assault force. The ability of today's LMG to achieve the desired portability has been significantly enhanced by the introduction of smaller calibre ammunition such as the 5.56x45mm NATO and the Russian 5.45x39. Their lower recoil permits lighter weapon designs while smaller cartridge size allows for carrying more rounds. The trade-off is reduced lethality and accuracy at longer ranges. The US military in 1984 fielded the M249, an adaptation of the FN Minimi which is used over 50 countries. Minimi is widely used by Asian-Pacific armies with the weapon licence manufactured by Sumitomo Heavy Industries for the Japanese Self Defence Forces, by Thales Australia as the F89 for the Australian Army and as the Pindad SM-3 in Indonesia. In addition, the Republic of China (Taiwan) uses a local design, the T75 Light machine gun produced by the 205th Armoury which is based on the FN weapon.

An FN Herstal spokesperson explained that its latest Mk3 version "offers improvements based on operational experience and user feedback over the past 10-15 years." New features include the ability to convert to either 5.56x45mm or 7.62x51mm rounds, a five position adjustable stock, picatinny rails, and a three position adjustable bipod. The Mk3 features can be incorporated into existing weapons as an upgrade.

Taking a similar path the Republic of Korea's Agency for Defence Development designed its 5.56mm K3 LMG manufactured by S&T Motiv

(Daewoo Precision Industries) to replace the M60 machine gun. Fielded in 1989 it is substantially lighter at 15.10lb (6.68kg) with the flexibility of feeding from a 30 round magazine and 200-round disintegrating M27 belt. It too has an integrated bipod but also fits to a tripod for more accurate firing. The largest user outside Korea is the Philippine Army which acquired 6,540 units in 2008 although it is also used by Indonesia's the Komando Pasukan special forces. The company introduced its Para version in 2015 which at 31.7in (805mm) is shorter

when collapsed and lighter at 13.89lb (6.3kg).

A new machine gun, the K12, is being developed which draws on the K3 design it is, however, 7.62mm. This calibre is being driven by the Army's need to replace its ageing M60 GPMG inventory used on vehicles and helicopters as well as the desire to have return to the longer range and power of the 7.62 in at least some infantry roles. Currently at 26.4lbs (12kg) it falls outside the LMG category but it does have a unique feature in that it incorporates not only a pistol grip but also a rear spade grip and metal sliding stock in each weapon. This allows the same design to be used in a variety of mountings. The Indian Army reportedly visited S&T Motiv in May 2019 and may be considering the K12 as a candidate for its next machinegun.

Singapore's ST-Engineering has made improvements to its Ultimax 100 in the new Mark 8 model. Already known for having the lightest recoil and exceptional accuracy in a 5.56mm calibre machine gun due to its patented constant recoil feature the Mk 8 adds both automatic and semi-automatic fire modes, as well as a quick-change barrel. At 11lbs (5kg) it is easily operated by a single soldier. An ST-Engineering spokesperson shared that: "Ultimax's features like its removable and retractable stock with height adjustments, inclusion of picatinny rails and ability to use M16 type box magazines, 100 rounds C-MAG and ULTIMAX 100 drum



Kalashnikov has developed a new light machine gun, the RPK-16, using the same 5.45x39mm ammunition as the AK-74 assault rifle. It can use both a high capacity drum and standard AK magazines. In testing now it is intended to replace the PK.

magazines offer flexibility in a variety of roles” Ultimix is used by 25 countries.

The Russian military is also considering a new squad machine gun the RPK-16. First shown in 2017, it a new iteration of the iconic Kalashnikov light machine gun using the same 5.45×39 cartridge as the AK-74. It has an interchangeable barrel with both a full-length and a short barrel offered. Its stock not only folds but is telescoping and can be adjusted. The bipod is detachable bipod; it has rails for scopes and other equipment, and can be fit with a suppressor. The gun has a 96 round high capacity magazine but can also use any existing AK-style magazines. The bipod is no longer an integral part of the machine gun and it can be attached and detached freely. The weapon according to Kalashnikov is undergoing field tests but it may have been fielded in limited numbers to Spetnaz.

Common Squad Weapons

The Peoples Republic of China (PRC) had largely employed either the Type 67or Type 80 GPMG, either locally designed or adapted and using 7.62×54R ammunition. However, in 1997 the QBZ-95 Infantry Weapons Family appeared. Designed and manufactured by Norino it is a bullpup-style weapon that fires a new 5.8×42mm DBP87 cartridge. The family consists of an assault rifle, a carbine and the QBB-95 Light Support Weapon (LSW). The LSW is intended as the squad automatic weapon variant and adds a bipod, a longer, a heavier barrel and 80-round drum magazine, though it

S&T Motiv in the Republic of Korea is presenting the K12 machine gun in 7.62mm as a complement to the 5.56 mm K3 design. The requirement is driven by the Army’s need to replace its aging M60 GPMGs that remain in use.



can also use the standard 30-round box magazine. These features begin to blur the difference between the LMG and AR. An improved version, the QBB-95-1, has since been fielded addressing several reliability and ergonomic issues as well as, firing a heavier 5.8×42mm DBP10 round. This places the PRC military in the forefront in providing a level of weapon and ammunition commonality with its advantages within the squad.

The US Marines have moved to a similar squad commonality though it might be said in their case it was ‘backed into’. Their initial push was to find an alternate to the M249 LMG for the squad automatic rifleman (AR). Following evaluation of a number of candidates they selected the Heckler & Koch HK416 a magazine feed automatic rifle. The weapon is already adopted by the German, French, Norwegian and other forces. With the Marine’s adaption’s it was designated the M27. It met the Marines requirement for a more accurate AR offering 2 Minute of Angle (MOA) accuracy vs. 12 of the M249 meaning a round would strike within 50mm of the

point of aim at 100m. Subsequently the Marines determined to field the M27 to all members of the infantry squad, thus, providing an AR capability to every infantryman. Its further adoption of a more accurate M27 version, the M38, with better optics as the Squad Designated Marksman Rifle rounded out the Marine’s squad commonality.

Currently the US Army is seeking a Next Generation Squad Weapon which is built around a new 6.8mm cartridge intended to have better accuracy at longer ranges and to be effective against personal body armour. Three candidates have been selected and are competing. Sig Sauer, Textron, and General Dynamics each will offer a replacement for the M249 SAW and assault rifle to substitute for the M4. Of the candidates two former employ belted ammunition as a LMG while the later is a magazine fed AR design. Army programme officials indicate they plan to select a final design from a single company in early 2022 and begin fielding in 2023.

Squad Automatic Weapon direction

The number of programmes defining a new standard for the squad automatic weapon suggests continued recognition of its key role in small unit combat. Each seeks to concurrently reduce the automatic rifleman’s load, while increasing effective range and lethality. In addition, weapons like the M27/HK416 particularly enhance the unit’s tactical flexibility by essentially providing every squad member the ability to assume the AR role on direction. When combined with new ammunition and the introduction of more advanced optics, miniaturised range finding and ballistic computation the capabilities of these weapons is approaching that of previously found in the Company level GPMG. This introduction holds the potential to have significant implications for the infantry combat unit, its future organisation and employment. [AMR](#)



The Peoples Liberation Army (PLA) has fielded its QBZ-95 family of squad weapons which includes the QBB-95 Light Support Weapon. The latter is designed with a heavy barrel for sustained automatic fires. It uses an 80-round drum magazine but also accepts the standard 30-round box magazine. The latest model QBB-95-1 fires a heavier 5.8×42mm DBP10 round that offers improved performance at range.

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BETTER THAN EVER?

The Royal Australian Navy's six Collins-class diesel-electric submarines are delivering improved operational output, just as Australia's requirement for anti-submarine warfare (ASW) appears to be increasing.

by Dr Lee Willett

In August 2019, the Royal Australian Navy (RAN) Collins-class diesel-electric submarine (SSK) HMAS *Farncomb* completed a five-month deployment across the Indo-Pacific region. The deployment included participation in several high-profile exercises. These included the Australia-United States bilateral *Talisman Sabre* exercise, which took place off Australia's east coast between June and August, and the US-led *Pacific Vanguard* exercise in May-June where, alongside the US, Japanese, and South Korean navies, the boat worked through various maritime task group scenarios.

In 2019, another Collins-class submarine HMAS *Collins* was engaged in another high-profile deployment, as part of the task group based around the RAN's lead landing helicopter dock (LHD) amphibious assault ship HMAS *Canberra* for the 'Indo-Pacific Endeavour 2019' deployment. *Collins'* activities during

this deployment included participation in the French Navy-led multinational exercise *La Perouse*, in the Bay of Bengal in May and June: participants included the French Navy aircraft carrier FS *Charles de Gaulle*, and ships from the Japan Maritime Self-Defense Force (JMSDF).

Navies tend not to talk much about submarine operations. However, the level of operational output currently being generated by the Collins-class boats, as demonstrated by these two deployments, underlines how far the class has come in terms of delivering improved output. Certainly, the programme appears to have moved on somewhat from what was a difficult period in terms of acquisition and initial operations.

The level of output also is highlighting the enduring importance of a submarine capability for Australia just as the country is doubling the number of boats in its fleet, with the purchase of 12 Attack-class SSKs (which it is hoped will replace the Collins

boats from 2035 and beyond).

Speaking at the Undersea Defence Technology conference in Stockholm in May 2019, Commodore Michael Houghton – Director General Future Submarines in the Australian Department of Defence said that, alongside the focus on technology in delivering required operational outcomes, “one of the things ... [is] the need for presence, and with presence means availability of platforms”. The presence of high-end technology onboard a platform is no use for a navy if the platform itself is unavailable, he explained. This is where the Collins boats' increased operational availability is adding much value to the outputs the RAN can generate in the critical underwater domain, including in terms of generating anti-submarine warfare (ASW) effect.

According to the RAN website, as of January 2020 four of the Collins boats – HMA Submarines *Collins*, *Dechaineux*, *Farncomb*, and *Sheean* – appear to be available for operations. HMAS Rankin and HMAS Waller are listed specifically as being in short- and longer-term maintenance respectively.

Notwithstanding the fact that precise details regarding submarine operational availability is not something navies routinely reveal, having four boats available from a flotilla of six prospectively is a high level of availability. It also supports the provision of robust operational presence in the underwater domain at a critical strategic time in the Indo-Pacific maritime arena.

Strategic environment

The RAN operates across the Indo-Pacific theatre, from the littoral waters around Australia, across the Southeast Asian region, up into the North Pacific, and also across the Indian Ocean to the Gulf. These various waters all contain a complex mix of shallow and deep waters, and different environmental conditions that challenge even the most capable submarine and submariner.

Perhaps more notably, the Pacific Ocean region in particular was arguably the first theatre in which, going back a decade or more, state-based naval competition – especially in the underwater domain – began to re-emerge. Such competition is now evident across the entire Indo-Pacific arena.

Broadly, the Indo-Pacific theatre is “a very dynamic environment where there is competition for influence”, said Cdre

Houghton.

Alongside generating presence and contributing to maritime domain awareness, the primary operational task for an SSK like a Collins-class boat is ASW – especially in terms of its contribution to high-end operations.

Even at the lower end of the operational scale, however, ASW still plays a key role. As with most countries around the world, Australia remains dependent on maritime trade that moves along sea lines of communication (SLOCs). Across Australia’s theatre of strategic national interest, such SLOCs pass through key maritime choke points such as the Straits of Hormuz in the Gulf, and the Malacca, Sunda, and Lombok Straits in Southeast Asia. Cdre Houghton noted that keeping SLOCs open is a key role for submarines. Simple presence is key here.

“In terms of Australia’s ASW requirement, the major driver is the regional proliferation of submarines,” Dr Sidharth Kaushal, research fellow in sea power at the Royal United Services Institute (RUSI) in London, told AMR.

“The proliferation of submarines does complicate the security of Australia’s SLOCs in the medium to long term.”

In ASW terms, the RAN faces the twin requirement of providing coverage across the Indo-Pacific theatre, with other navies increasingly active underwater in areas of critical Australian strategic interest, and of providing ASW coverage for the RAN’s emerging and increasingly active task group capability. These task groups are based around different combinations of high-value assets such as the two Canberra-class LHDs and the three Hobart-class, air warfare-focused guided-missile destroyers. Such is the RAN’s growing task group capability that, during ‘Talisman Sabre’, its two LHDs – *Canberra* and sister ship HMAS *Adelaide* – operated together for the first time.

Working in partnership with other navies is a central element of how the RAN helps provide this ASW coverage.

In the future, the Attack-class SSKs and the Hunter-class frigates (which will begin arriving in service in the late 2020s)

will take on the ASW burden, but until then a large part of this burden sits with the Collins boats.

Collins capability

Homeported at Fleet Base West in Western Australia, the six Collins boats are strategically well positioned there to meet what the RAN states is a requirement for defence capability that includes a two-ocean surveillance role.

They are also well equipped to meet this requirement. The principal ASW capabilities of the 78m, 3,400-tonne (dived displacement) Collins boats are the sonar and torpedoes.

The boats are fitted with the Thomson Sintra Scylla sonar bow/flank, active/passive sonar array and the Thales SHORTAS retractable, passive sonar. In March 2019, *Waller* became the first boat to receive the new Thales modular cylindrical bow sonar array, under the Collins Sonar Capability Assurance Programme (CSCAP) within the wider SEA 1439 programme. Kaushal said the new sonar fit “provides the



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The Collins-class submarines are looking at a prolonged period of life extension until the new Attack-class SSKs arrive in the mid-to-late 2030s.

submarines with a step change in situational awareness, which has ramifications for their role in ASW”.

The torpedo capability is provided by the Raytheon Mk 48 Mod 7AT CBASS, an active/passive homing weapon that delivers a 300kg warhead at speeds of up to 55 knots. The boats can carry 22 weapons in total, with these fired out of six 533mm torpedo tubes in the boats’ forward end..

Operation of such sonar and torpedo capabilities is supported and integrated by the Raytheon AN-BYG 1 tactical weapon control system.

One of the most important elements of the Collins capability is its displacement, a size that supports the boats’ ability to deploy at the distances and for the durations Australia requires. According to the RAN, the Collins boats have a range of 9,000 nautical miles while dived and snorting.

Stressing the strategic contribution the boats make to Australian defence capability, the RAN’s Chief of Navy Vice Admiral Michael Noonan said in a letter to *The Australian* newspaper on 12 December 2019, that the Collins boats provide “a world-class submarine capability” that is “an essential part of Australia’s naval capability”. In particular, he pointed to the Collins boats’ role as “a powerful instrument for deterring conflict and a potent weapon should conflict occur”.

Under the Chief of Navy’s ‘Plan Pelorus’, designed to provide guidance and reference for the navy to enable it to maintain bearing in delivering its mission of fighting and winning at sea, the RAN’s headmark aim is that by 2022 it will be “ready to conduct sustained operations as

part of the joint force”. Several elements listed under the headmark reflect neatly what a submarine capability brings here in particular. These include lethality, integration with joint and combined forces, persistence to enable the maintenance of “long-term presence away from ... home ports”, and the ability to engage with close partners across the Indo-Pacific region.

“The Collins-class [boats] are highly capable and very quiet SSKs, with excellent (and being kept up-to-date) sensor and weapon systems,” James Goldrick, a retired RAN rear admiral and currently a fellow at the Lowy Institute, told AMR. The boats “are obviously very effective ASW units in a wide variety of situations and locations,” he continued, adding. “It is intended they remain so.”

In its most recent defence white paper, published in 2016, Australia underlined its intent to ensure the Collins boats continue to be operationally relevant through a programme of “priority capability enhancements, obsolescence management, and fleet sustainment ... This will include upgrades to the Collins-class communications and sensor capabilities.”

The white paper also noted the improvements in Collins availability, pointing to previous times when as many as three boats might have been in longer-term maintenance at once.

ASW focus

Across the navy, Goldrick assessed, “There is a renewed emphasis on ASW at all levels, and the RAN is seeking to strengthen its technical and operational capabilities.”

More broadly, Goldrick continued, “ASW has to be considered as a *theatre* problem, not as a task group or even single unit one.” While individual navies are developing improved platforms and are integrating these more coherently into task groups, what consideration of ASW as a theatre issue means is there needs to be increasing development too of multinational co-operation in ASW, for example. Goldrick pointed to the importance of such co-operation, including the sharing of surveillance information, as key to building future ASW capability.

Certainly, the RAN and its partner navies such as the US Navy (USN), UK Royal Navy (RN), and JMSDF are already doing this, building different bilateral and multilateral ASW links between

them. Once again, this has been evident in recent exercises, such as *Ocean Explorer* and *Lungfish*.

Ocean Explorer, part of the RAN’s ‘Ocean’ exercise series, trains high-end, blue-water warfighting capability.

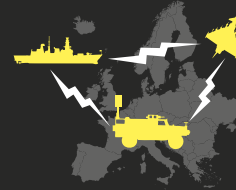
At the time of this activity, the RAN’s *Navy News* publication quoted Commodore Tim Brown, director general Submarines, as saying the Collins boats “[in 2018] spent more than 600 days at sea, which was the highest tempo ever achieved by the Collins class”. The RAN’s aim for 2019 was something closer to 700 days, AMR understands..

In written evidence submitted in November 2019 to a Senate Reference Committee inquiry on Australia’s sovereign shipbuilding capability, the Department of Defence (DoD) stated that, over the previous two-and-a-half years, “Operational availability of the Collins-class submarines [was] at the highest levels ever achieved, exceeding international benchmarks.” Writing in *Navy News* in December 2019, Vice Admiral Noonan said the RAN was “continuing to achieve record days of availability for Collins-class submarines”.

The DoD submission also noted that work to improve boat availability was enabling the introduction of “capability enhancements ... during routine docking activities”, with such enhancements “including the installation of new bow and flank sonar arrays as well as improved communications and electronic warfare capabilities”. “These upgrades and ongoing updates across the Collins fleet will ensure we retain a potent and agile submarine capability as we introduce the Attack-class submarine from the early 2030s,” the DoD added.

As well as focusing on current operational challenges, Australia clearly today is already planning for the long-term sustainability of its submarine programme and the ASW capability it brings, even looking beyond the Attack-class boats. In the 2016 defence white paper, the government stated that “To ensure no capability gap and the ability to progress development of a replacement submarine in the 2050s, the government has decided to implement a rolling acquisition programme for Australia’s submarine fleet. A rolling acquisition programme will ensure that Australia is able to maintain a fleet of 12 regionally superior submarines as submarine and anti-submarine technologies develop over the coming decades.” **AMR**

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A digital impression of Naval Group Australia's Shortfin Barracuda attach-class submarine.

NGA

ALLIANCES DRIVE AUSTRALIAN DEFENCE SPENDING

Australian defence modernisation is moving ahead across a broad front with a 'build in Australia' impetus behind many major projects.

by **Tim Fish**

Australia's defence modernisation programme is following the route set out for it under the government's last Defence White Paper published in 2016. It committed to spending two percent of Gross Domestic Product (GDP) on defence by 2020-21 and a total of \$129 billion (AD\$195 billion) over 10 years.

Its analysis of the global strategic environment for the next 20 years out to 2035 has informed its equipment procurement programmes and while it anticipates increased prosperity across the Indo-Pacific region through to 2050 it acknowledges that the relationship between China and the US will be key to maintaining peace.

The White Paper stated that: "A strong and deep alliance is at the core of Australia's security and defence planning" and that the US "will continue to be Australia's most important strategic partner." Therefore it committed to "broaden and deepen" the relationship and support its role in underpinning

security in the region.

Australia's procurement decisions have largely been taken with this alliance structure in mind and it has forged ahead with a wholesale modernisation of the Royal Australian Air Force (RAAF), Australian Army and Royal Australian Navy (RAN). Australian Defence has embarked on some large and expensive programmes that, when brought to fruition, will give the Australian Defence Force (ADF) the most modern and capable platforms available.

The White Paper also committed Australia to the "most ambitious plan to regenerate the RAN since the Second World War." But here, the Department of Defence has been more than ambitious as it wants most of its new platforms to be built in Australia rather than imported from overseas. This means it has devoted huge sums towards developing its domestic naval shipbuilding industry to undertake this task. Its largest ever acquisition project SEA 1000 Future Submarine is projected to cost an estimated \$53 billion (A\$80 billion) and

it will replace the RAN's existing six Collins-class submarines with 12 new Attack-class boats.

The new SSKs will be built at a new manufacturing facility at ASC in Osborne North near Adelaide, South Australia. The prime contractor is French shipbuilder Naval Group, which is providing a new design called Shortfin Barracuda that is an adaptation of its Barracuda design used to build the French Navy's new Suffren-class SSNs. But it could be that Defence has been over-ambitious.

In a report by the Australian National Audit Office on Future Submarine published in January 2020, it highlighted an overall programme delay of nine months in achieving the original pre-set milestones and a further five-week delay since the project was re-baselined with revised milestone dates. This has been down to a failure of communication between Naval Group and Defence and what seems to be a lack of understanding about what the company is expected to provide at each project stage.

After some extensive bartering a



Lürssen

Lürssen Australia will deliver 12 OPVs meeting the RAN's requirement for its SEA 1180 Offshore Patrol Vessel (OPV) project.

Strategic Partnership Agreement (SPA) was belatedly signed in February 2019 setting out the long-term relationship between them. Marcus Hellyer, senior analyst at the Australian Strategic Policy Institute (ASPI) told *AMR*: "It may be that now they are working together under the SPA things will improve." However, he added: "The construction schedule and IOC [Initial Operational Capability] schedule is still rather opaque (i.e. start of construction in 2022-23 really means 2024). IOC seems to have slid over the past few years to 2034."

The project has other areas of risk. The extent to which Australian industry is able to provide what is required in the supply chain is also in doubt and the project does not have much scope for error. If there are significant overall delays in excess of three years then it could affect the RAN's submarine capability.

The RAN is also set to receive nine new frigates under the \$23 billion (A\$35 billion) SEA 5000 Hunter-class frigate programme that will replace the existing ANZAC-class. Construction will take place at a new facility in ASC South, adjacent to the new submarine shipyard in Osborne. Prime contractor BAE Systems is expected to deliver the frigates from 2029 built to its Type 26 design and it has been granted temporary ownership of the ASC South shipyard for the duration of the contract. Prototyping will commence this year including the procurement of long-lead items and steel cutting for the first ship is expected in late-2022.

AVOIDING BOOM AND BUST

The reason the programme is drawn

out over a long time period is that Defence wants to establish a continuous shipbuilding programme that will see a steady stream of naval vessels built at ASC once the Hunter-class are completed in the 2040s. The intention is to avoid a boom-and-bust cycle where orders and work dries up causing the loss of personnel with skills and experience to other sectors whilst facilities and equipment lays dormant.

However, this has raised criticism as Hellyer believes that new ships and submarines are needed sooner than this. He told *AMR* that a long procurement

programme will mean the RAN will not get its first new frigate for another 10 years and its first new submarine not for 15 years. Final ship and boat deliveries will not take place until the 2040s and 2050s respectively, and by then technology and the strategic environment is likely to have changed. Hellyer's concerns is that Defence has overcommitted itself with SEA1000 and SEA5000 taking up so much of the budget and leaves little room to change.

The RAN is also getting 12 new Arafura-class Offshore Patrol Vessels (OPVs). The first two are being built at ASC before production shifts to Civmec's facility in Henderson, Western Australia. Luerssen is prime contractor and the ships are being built under a Joint Venture with Civmec to its OPV80 design for nearly \$2 billion (A\$3 billion). ASC has already started construction of the first two OPVs and Civmec is due to start cutting steel for the third this year at a new facility in WA.

Outside of the big three programmes the RAN is expecting to receive two new auxiliary oiler replenishment (AOR) vessels under Project SEA 1654 phase 3 Maritime Operational Support Capability (MOSC). Built by Spanish shipyard Navantia for \$424 million (A\$642 million), the vessels *Supply* and *Stalwart* are due to arrive in June this year and May 2021 for handover to the RAN. The programme is running about a year late due to logistical support issues.



Defence

An F-35A Joint Strike Fighter aircraft from No. 3 Squadron about to conduct night flying at RAAF Base Williamtown as part of pilot familiarisation training.



Defence

A decision needs to be made whether the RAAF should buy more F-35As or upgrade their existing F/A-18F Block II Super Hornet aircraft to the Block III standard.

LIGHTNING ARRIVES

Meanwhile the RAAF is in the process of receiving 72 new F-35A Lightning II Joint Strike Fighters under Project AIR 6000 phase 2A/B. Lockheed Martin is delivering the planes under a Foreign Military Sales (FMS) agreement. So far the RAAF has just 20 fighters. Pilots and maintainers are undertaking training at Luke Air Force Base in the US and Defence has announced that 34 pilots and 16 instructors have been certified. It means that training can begin in Australia. The final aircraft is due to be handed over in 2023 when the programme will achieve Full Operational Capability (FOC) and they will be split into three squadrons of 24 aircraft.

Defence told AMR: “After their arrival at RAAF Base Williamtown, the aircraft will be used in a Verification and Validation (V&V) program during 2019-2020. The V&V programme is an important milestone in the lead-up to the declaration of Initial Operating Capability (IOC) in December 2020.” Lockheed Martin has stated there should be 33 aircraft in Australia by then to reach IOC and the first fighter squadron of operational F-35 will be created within the next three years.

“The first operational squadron – No. 3

Squadron – will be proficient in air combat, strike and offensive air support, and ready to deploy in support of Australia’s national interests,” Defence said.

The question for the RAAF is whether it should proceed with Phase 2C, the acquisition of more aircraft to develop a fourth squadron of F-35As. However, there is debate within the service if it would not be better served to instead opt for upgrading their existing F/A-18F Block II Super Hornet aircraft to the Block III standard. Malcolm Davis, a senior analyst at ASPI, told AMR that “the issue is still under consideration” and he believes the Super Hornet upgrade option has its merits.

“The F/A-18Fs still have a lot of life in their airframes, and there is no reason for them to be replaced. Certainly upgrading them to Block III would make a great deal of sense, and save a great deal of money in comparison to buying an extra batch of F-35As,” he said. An upgrade of 24 Super Hornets and 11 EA-18G Growler aircraft to an advanced model is estimated to cost a total of \$568 million rather than \$2.8 billion for 28 additional F-35As. But it is not just about money, the F-35A’s stealth characteristics are thought to be less than effective and the F/A-18s have a larger weapons payload capacity. However,

there is nothing official from Defence and there is still some time before a decision has to be made therefore the debate within the RAAF is set to continue.

An original 12 Growler aircraft were delivered in July 2017 under Project AIR 5349 Phase 3 but in January 2018 the engine of one plane failed on the runway at Nellis AFB in the US and the damage was beyond repair. The RAAF originally wanted to replace the aircraft but compensation from neither the suppliers (General Electric and Boeing) or the US Navy has been forthcoming and so the Growler fleet will remain at 11 aircraft. The initial operating capability (IOC) for the Growler was mid-2018 and this was pushed back to April 2019.

Defence told AMR that IOC was delayed “to ensure sufficient maturity for training and support systems” and that “The US Navy continues to pursue remediation from the Engine Manufacturer General Electric. Defences continue to engage with the US Navy over the engine claim.”

It added that one less aircraft “has an effect on aircraft availability but does not affect the Growler capability to achieve its Airborne Electronic Attack mission. Final Material Release is still planned for 2022.”

Another major capability upgrade is the acquisition of 12 P-8A Poseidon maritime patrol aircraft under AIR7000 Phase 2 that will replace the RAAF’s



Defence

Australia’s first Boxer vehicle received by the Army on 24 September 2019 at Enoggera Barracks, Brisbane that will replace the ageing ASLAV. The vehicles will also come with 223 Mission Modules.

existing AP-3C Orion aircraft. The final aircraft was delivered to RAAF Base Edinburgh in December 2019 and some P-8s already in-service have completed a deployment with Operation *Manitou*, which is Australia's contribution to international security efforts in the Middle East. Meanwhile the P-8As are being supplemented by a new Unmanned Aerial Systems (UAS) capability under Phase 1 of AIR 7000 with the acquisition of six Northrop Grumman MQ-4C Triton systems. Valued at Anearly \$1 billion, the aircraft will enter service from 2023-25.

The Army is progressing with its flagship procurement programme Land 400. Under the Phase 2 Combat Reconnaissance Vehicle (CRV) element worth about \$3.4 billion (A\$5.2 billion) it is replacing its existing ASLAV vehicles with the Boxer 8x8. Defence made the choice of Boxer to meet its CRV requirements in March 2018 and prime contractor Rheinmetall will deliver 211 vehicles. The first 25 are being built in Germany with construction of the rest taking place at a new facility near Brisbane, Queensland. Defence wanted the initial batch from Germany because the facility in Australia would not have been up and running until 2022 and it will deliver the remaining platforms through to 2026. Rheinmetall handed over the first German-built unit in September 2019 and of these initial vehicles, 12



A Boeing P-8A aircraft from No. 11 Squadron undertaking a search and rescue exercise in the Spencer Gulf, South Australia.

are reconnaissance vehicles and 13 are multipurpose variants. It means that the Army can begin training earlier.

Under Phase 3 worth about \$6.6-10 billion (A\$10-15 billion), the Army will get 450 new Infantry Fighting Vehicles (IFVs) that will replace its ageing M113 Armoured Personnel Carriers. Known as the Mounted Close Combat (MCC) capability, the competition to provide the new vehicle has been narrowed with two companies remaining: Rheinmetall offering the KF41 Lynx and South Korea's Hanwha Defense Systems offering the AS21 Redback. These beat rival offerings from BAE Systems with the CV90 and General Dynamics with a variant of the Ajax. Rheinmetall and Hanwha have been awarded Risk Mitigation Activity (RMA) contracts that will allow them to ensure their vehicles meet the MCC requirements. This RMA is expected to last about two years with a Gate 2 approval due in 2022 and an IOC slated for 2024-25.

DERISK REQUIRED

With large acquisition programmes underway for the land, sea and air domains, there are significant challenges ahead for Australia. Davis said that the priorities for Defence are to de-risk

the major projects "particularly Future Submarine, and address the slow delivery of capability". He is concerned that the first boat won't enter service until 2034 at the earliest.

Davis also said that Australia needs to "think seriously" about options to meet an air strike capability gap in the ADF and whether this should be met with manned aircraft, long-range missiles or Unmanned Combat Air Vehicles "and how we might better utilise forward basing".

The role of unmanned systems along with Artificial Intelligence (AI) and autonomy could be key capabilities for the military in the future and these are only just starting to play a larger role. Defence needs a strategy to exploit these technologies better and analyse how they could change the whole structure of military forces.

Overall with the increasing amount of commitments on the horizon, changing technologies and rapid rise of China, Davis believes Defence needs to think about whether the size of the ADF "is right for the worsening strategic outlook we face" - and by extension - "to what extent do we need to increase defence spending to levels above that suggested in the Defence 2016 White Paper." **AMR**

AIR-DEFENCE CHALLENGES IN THE NEW DECADE

By Ben Ho

Air defence is coming to the fore of Western military planning after being neglected in the 20-plus years of permissive campaigns since the end of the Cold War. The low-threat operating environment in Afghanistan and Iraq lulled defence chieftains into a false sense of security, but the increasing use of low-observable, massed capabilities in the form of cruise missiles and/or unmanned aerial vehicles (UAVs) are making them sit up.

The threat posed by cruise missiles is well-established and yet they have been able to circumvent modern air defences time and again. These legacy weapons usually fly on a nap-of-the-earth profile to evade ground-based sensors, and this challenge is exacerbated by the stealthy features incorporated by some of them. To illustrate, the Russian KH-101 travels at a terrain-hugging attitude of 30 metres and its composition of radar-absorbing material makes it hard to detect. And because cruise missiles fly at such low levels, the detection time for air defences is rather short. Against a notional terrain-hugging KH-101, the response time for the defender may be a matter of just minutes. In such circumstances, not being on the highest alert makes interception of the weapon an uphill task.

Moreover, modern cruise missiles have surgical precision given that many of them incorporate inertial navigation system and/or satellite-based navigation for guidance. Indeed, the KH-101/102's accuracy is such that its circular error probability is reportedly six metres. With more cruise missiles being capable of supersonic speeds and perhaps in the not-so-distant future, hypersonic speeds, anti-air warfare managers will have their

work cut for them in the coming decade.

UAVs are the up-and-coming threat air-defence planners are grappling with. These platforms have been largely used in the intelligence, surveillance, and reconnaissance (ISR) role until the first decade of the 21st Century, where they took on limited strike missions in permissive environments. The democratisation of technology and the availability of commercial off-the-shelf drones mean that non-state actors are embracing the UAV as an asymmetric weapon against their more powerful state foes. Think the Islamic State in Iraq and Syria and its fleet of weaponised drones toting "shuttlecock bomblets".

Various observers have contended that such makeshift armed UAVs are of meagre tactical utility owing to their limited payload and navigation capability. However, events in recent years have rendered this argument problematic. To illustrate, in January 2018, Russia's Khmeimim Air Base in Syria came under attack from a drone swarm, which was the first of its kind in history. Photographs taken of the aftermath show rudders of fighter planes being torn, in essence rendering these aircraft 'mission kills'. Not a bad deal indeed to trade improvised drones wrapped in plastic sheet and with parts held together by tape for mission-killed multi-million-dollar combat jets.

Traditional air defences are not particularly well-equipped to deal with UAV swarms. Firstly, the air defences of most advanced nations are designed largely to deal with higher-end threats like conventional aircraft and ballistic missiles. Like cruise missiles, drones are hard to detect owing to their small size and concomitantly minuscule radar cross-



section. Moreover, it simply does not make economic sense to launch expensive surface-to-air missiles (SAM) against such makeshift drones. In any case, most SAM batteries lack the magazine capacity to effectively intercept UAV swarms numbering in the dozens.

A more ominous challenge for air defences would be an integrated drone-and-cruise missile operation such as the September 2019 strike on the Abqaiq and Khurais oil facilities in Saudi Arabia. Despite the lavish amounts the kingdom spent on its air defences, none of the 25 drones and cruise missiles used during the attack were intercepted. Arguably it heralded the dawn of a challenging new era in air defence in the 2020s.

An Abqaiq-Khurais 2.0 in the coming decade could see a larger-scale and fully-networked strike involving not just 'kamikaze' drones and cruise missiles, but also more combat-capable drones launching their own ordnance. To compound matters, their approach to the target could be coordinated from different vectors to overwhelm the defender. These weapons could also be preconfigured to approach the target where they are least expected. Or perhaps to increase deniability in this day and age where 'grey-zone' operations are par the course. While the defender is currently playing catch-up, it is still not too late if the challenge is duly recognised and if authorities could muster the political (and financial) capital to tackle these threats head-on. [AMR](#)

**This column was adapted from a presentation of the same title given to officers and senior enlistees of the Republic of Singapore Air Force's Air Defence and Operations Command on 6 February 2020*

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