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Schiebel's Camcopter S-100 is helping to drive forwards the UAV mission sets being developed by the Australian Defence Forces.



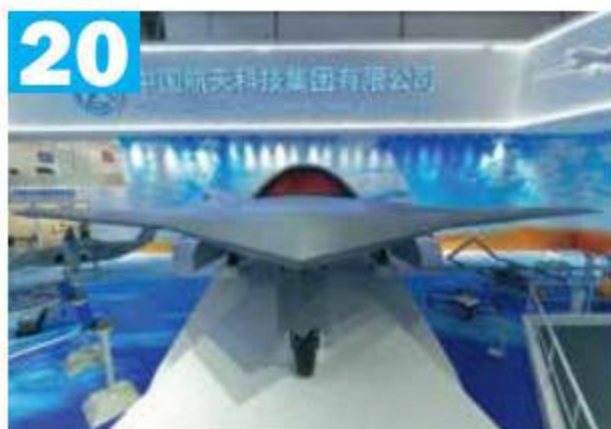
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What is being done to make next generation rotorcraft substantially different? *Andrew Drwiega* explains.



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All Other Countries

Jakhongir Djalmatov, Media Transasia Limited
Tel: +66 2204 2370, Mobile: +66 81 6455654
Email: joha@mediatransasia.com

Roman Durksen, Media Transasia Limited
Tel: +66 2204 2370, Mobile: +66 83 6037989
E-Mail: roman@mediatransasia.com

Editorial



PREVENTING THE INEVITABLE?

The People's Republic of China (PRC) has no intention of adhering to western "rules based order or values," particularly as it is increasingly seeing an opportunity to extend its power in terms of dominating Asian - and beyond. The aim is to usurp the power-broker role played by the United States, and dominate its neighbours politically, backed by the rapid territorial expansion of its economic zones all supported by a large, modernised and highly capable military.

The Belt and Road initiative has been the 'carrot' offering many nations the implied benefit of better infrastructure and economic gains, with financial pressure over debt not being met as the 'stick' to gain concessions.

In the disputes over islands situated in the South China Sea (SCS), the 'stick' is taking a semi-clandestine form - 'fishing boats' crewed by militia who have no intention of fishing.

China is now well on the way to achieving its objective of securing the SCS through its bogus and legally rejected claim to all of the area within the Nine Dash Line. While the occasional passage of United States warships conducting Freedom of Navigations Operation (FONOPS) is something of an irritant to China, there is no ever present hard power in the area capable of preventing China from achieving its objective.

While many European countries have historic ties to countries in the region - France to Vietnam, the Netherlands to Indonesia, the United Kingdom to Malaysia, Singapore and Brunei - the power still vested in those links has long since diminished. The US is also out of the immediate region, with bases in Japan, Okinawa and Guam.

The Philippines, a country with islands to lose to China, has done little to press on from the verdict reached by the Permanent Court of Arbitration (PCA) in the Hague which ruled in 2016 "that China's claims of historic rights within the nine-dash line, which Beijing uses to demarcate its claims in the South China Sea, were without legal foundation." Not only has China rejected this ruling outright, but the Philippine President Rodrigo Duterte reportedly barred his own ministerial cabinet from even discussing the issue on Monday 17 May, and has said that he would throw the Hague's ruling "in the waste basket."

This stance, against the advice of many in his government including his defence and foreign ministers, has all the traits of appeasement. It also ignores the presence of hundreds of Chinese militia-operated 'fishing boats' that harass civilians and fishermen within the SCS, including those from Vietnam. Indonesia has also suffered similar incursions into its own Economic Exclusion Zone and has sunk a number of transgressors, but all without any forceful rebuke to Beijing.

The revival of the Quadrilateral Security Dialogue (the QUAD) between India, Australia, the United States and Japan is aimed at curbing China's growing power in the Indo-Pacific region. A joint statement issued in 2021 declared that the members held "a shared vision for a free and open Indo-Pacific" and specifically a rules-based maritime order preserved in the East and South China Seas. This will need the buy-in of many of the regional sovereign nations to make it really effective, many were rocked by the "America first" policies of President Trump, leaving a significant amount of trust to be regained.

Andrew Drwiega, Editor-in-Chief

Editor-in-Chief: Andrew Drwiega

Tel: +44 1494 765245, E-mail: andrew@mediatransasia.com

Publishing Office:

Chairman: J.S. Uberoi

Media Transasia Limited, 1603, 16/F,
Island Place Tower, 510 King's Road, Hong Kong

Operations Office:

President: Egasith Chotpakditrakul

Chief Financial Officer: Gaurav Kumar

General Manager: Jakhongir Djalmatov

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Digital Manager: David Siriphonphutakun

Art Director: Rachata Sharma

Media Transasia Ltd. 75/8, 14th Floor, Ocean Tower II, Soi Sukhumvit 19,
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MILITARY ROTORCRAFT DEVELOPMENT - NO MORE 'STOVEPIPES'

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by Andrew Drwiega

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Sikorsky/Lockheed Martin



Sikorsky/Lockheed Martin states that its digital backbone will reduce risk, cost, and increase efficiency for its Defiant X and Raider X Future Vertical Lift rotorcraft.

The main manufacturers of military rotorcraft in the United States and Europe are at various stages of substantially transforming the performance of their designs for what will be their future platforms. The driving force behind this is the adoption of digital technology and improved manufacturing techniques and materials.

But it is also the product of the last 20 years of counter-insurgency campaigns, where many helicopters were proven to be unsuitable for operations in 'hot and high' conditions, particularly those experienced in Afghanistan.

However, the rule is never prepare for the conflict that has just gone. With the chance of peer-to-peer or near-peer conflict now resurfacing, there are more elements to consider above range, speed, endurance and improved maintenance, although these remain key attributes that virtually all military rotorcraft need to have.

More than ever the rotorcraft must be part of the military network, whether gathering intelligence, surveillance and reconnaissance (ISR), acting as a communications node or delivering kinetic effects to the standard airborne logistical transport asset.

To do this, they must be able to share voice and data in real time. They must also be able to operate close to, or in, the opponent's anti-access aerial denial (A2AD) zone - particularly those with a kinetic role.

FLRAA/FARA

US Army Aviation Future Long Range Assault Aircraft (FLRAA) and Future Attack Reconnaissance Aircraft (FARA) are due to be fielded around 2030. The main US rotorcraft manufacturers of Bell, Boeing and Sikorsky/Lockheed Martin are the primes with a variety of compound and tiltrotor designs.

The two contenders for FLRAA are Bell's V-280 Valor tiltrotor and Sikorsky/Boeing's Defiant X coaxial, both of which emerged out of the US Army's Joint Multirole Technology Demonstrator (JMR-TD) project. Both Bell and Sikorsky are again in competition over FARA. Bell is offering its 360 Invictus while Sikorsky its Raider X.

Teaming with industry is one of the crucial aspects of any development programme, with recognised organisations bring their particular technology experience. Bell's team Invictus include Astronics, Collins Aerospace (part of Raytheon), GE Aviation, ITT-Enidine, L3Harris, Parker Lord, Mecaer Aviation, MOOG, and TRU Simulation + Training. While some of the



Bell is integrating the Modular Open System Approach (MOSA) with both its FLRAA Bell V-280 Valor and FARA Bell 360 Invictus developments. The Open Architecture Digital Backbone allows both the integration of currently fielded mission system equipment as well as new technology.

same companies are also part of Team Valor, others companies include Eaton, GKN Aerospace, IAI, Lockheed Martin (also of course a key player in Sikorsky's competitive platforms), Rolls Royce and Spirit Aerosystems.

In August 2020, Bell opened a new Manufacturing Technology Center (MTC) at its Fort Worth headquarters. The drive to find solutions and to develop technologies and processes in line with the DoD's ongoing upgrade requirements for its FVL aircraft is the reason for this development. Although the down select of both the FLRAA and FARA is over a year away, the MTC will focus on the refinement of core technologies including rotor and drive systems, critical infrastructure and final assembly. Incidentally, this will almost certainly also be extremely useful to the company in its development of its civilian rotorcraft range.

Glenn Isbell, vice president, Rapid Prototyping & Manufacturing Innovation said that 'future factories' such as the MTC would allow industry partners and teams to work more in harmony with each other throughout the development and sustainment of any platform. With the backbone of future platforms centred around digital connectivity and integration, system architecture can be built and tested by industry before ever getting close to the aircraft for which they are intended.

"These future factories working together with our teammates and suppliers, will be designed to enable high-quality, high-rate production of the Bell V-280 Valor, Bell 360 Invictus and other future aircraft."

The MOSA challenge

Modular Open Systems Approach (MOSA), formerly known as modular systems architecture, has been adopted by the US Army to allow the flexible integration of major systems and their component parts, and between systems

and their host platforms.

MOSA will be central to all of the new US Army Future Vertical Lift contenders, so that army aviation can benefit from accelerated integration of capabilities, significantly reducing non compatible architectures.

An enduring block to rapid platform development and systems upgrade on military rotorcraft was due to the fact that rotorcraft operators have been tied into proprietary technology which traditionally has meant waiting for the development of expensive upgrades over which the operator had little or no control. This meant that there was very little flexibility to control cost or through life upgrades to the platform.

"MOSA will let us align the strategies for standards and interfaces said Colonel David Phillips, project manager, FLARA US Army. During the same conference, Matt Sipe with the MOSA Transformation Office at PEO Aviation said MOSA represented "a tailored approach for addressing and resolving challenges", adding that they didn't want to be reliant on "any particular vendor's box."

Sipe said that one of the key advantages of MOSA was that with rapidly developing technology it allowed the US Army's rotorcraft "to stay modern and stay relative." Meeting the threat offered by technologically advanced peers meant continually adapting to the battlefield: "we need to maintain the high ground."

In order to achieve this standardisation and drive to eliminate proprietary 'stovepipe' development, MOSA will focus on nine Lines of Effort (LoEs): governance and policy; architecture and standards; software development; collaborative digital environment; MOSA conformance centre; qualification and material release; affordability and savings; contracting efficiencies; and strategic communications. The end result should be to ensure that future

fleets are affordable, sustainable, and upgradeable as the Army encounters threats that change and evolve.

Europe's NGR

NATO'S Next Generation Rotorcraft Capabilities (NGRC) Team of Experts (TOE), after years of building analysis and deliberations are backing a proposal for a new medium multi-role helicopter that will be developed by industry with a proposed delivery date of around 2035.

The conclusion was reached when analysis of rotorcraft currently in service revealed that close to 1,000 medium helicopters across NATO forces would reach their out of service date date between 2030 and 2050.

To date, the NGRC TOE has deliberately not focused on a type of platform that might be suitable, such as rotor configuration, number of engines and internal size, although an airframe weight of between 17,600lb and 33,100lb (8,000kg - 15,000kg) has been loosely suggested.

The NGRC is one of NATO's high visibility projects, listed as a high end

NATO MEDIUM ROTORCRAFT EXPECTED OUT OF SERVICE DATES

- 100 Mil Mi-8/17 in 2030-35
- 191 Aérospatiale SA 330 Puma in 2030-40
- 167 Sikorsky S-70/UH-60 in 2030-40
- 143 Leonardo AW101 in 2035-40
- 331 NHIndustries NH90 in 2040-45

acquisition requirement alongside the Multi Role Tanker Transport Capability (MRTT-C), Maritime Multi Mission Aircraft (M3A), Maritime Unmanned Systems (MUS), Modular Solution for Ground Based Air Defence Capabilities (Modular GBAD) and Rapidly Deployable Mobile Counter Rockets,

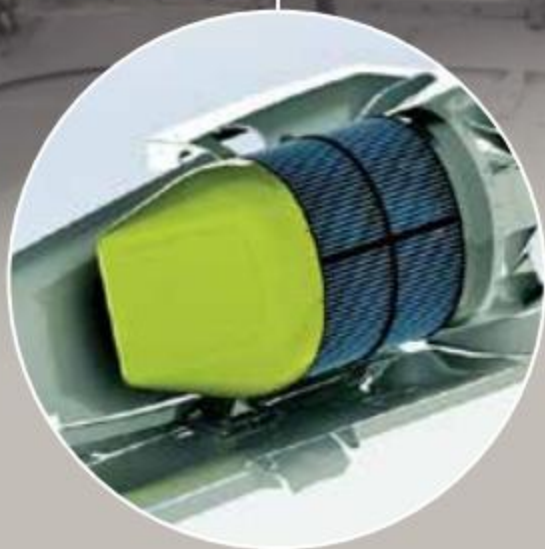


Sikorsky/LM's digital design and manufacturing is aimed at lowering acquisition costs while allowing rapid and affordable upgrades over time.

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The Defence Ministers of France, Germany, Greece, Italy and the United Kingdom have signed a Letter of Intent (LOI) binding them to a national commitment to develop a new medium multi-role helicopter through NATO's NGRC Project.

Artillery and Mortar (C-RAM).

Lieutenant Commander, Andrew White, Royal Navy, Capability Air Manoeuvre with UK armed forces and also Secretary for the TOE during a discussion on the subject hosted by the Royal Aeronautical Society's Rotorcraft Group in January that studies have shown that a medium helicopter is usually the most cost efficient platform across the majority of missions. In terms of practicality it is also very transportable either as a tactical or strategic asset.

But why now? Lt Cdr White pointed out that it has traditionally taken around 20 years to develop a new rotorcraft. The first NATO advisory group meetings on NH-90s occurred in 1981 but first aircraft deliveries did not take place until 25 years later. He said that multinational projects could be particularly difficult, but with NGRC and its focus on developing the concept first, difficulties could be avoided in the long term.

"The fundamentals of how to control a rotorcraft haven't really changed, however advanced inceptors, fly-by-wire technology, and active control allow decrease in weight, increase in responsiveness and agility," said White. "Also the modular open systems approach is absolutely fundamental to the future and is the driving force behind many programmes and products and is absolutely key."

Artificial intelligence and machine learning into an onboard or remote crew is also getting to be a fundamental requirement for a new generation of rotorcraft. There is also potential to consider self-protection and kinetic firepower. "One point we have briefly

looked at is directed energy weapons however it is an open area that we are keen to export," said White.

New materials and manufacturing mean, stronger, lighter and more robust aircraft in the future. Greater situational awareness will also increase aircraft survivability added White.

In October 2020, a Letter of Intent (LoI) was signed by the Defence Ministers from France, Germany, Greece, Italy & UK which meant that work could begin on defining a Statement of Requirements which would lead to the more precise defining of what the NGRC would be and what it could deliver. As various national requirements will undoubtedly emerge, it is believed that this early identification of the concept of the NGRC, combined with a MOSA like framework to build upon will avoid the difficulties and delays that were inherent in the NHI NH-90 programme. The Defence Ministers are scheduled to return in 2022 to sign a Memorandum of Understanding which would initiate the concept phase.

The NATO Industry Advisory Group (NIAG) has also been examining the capabilities, sustainability and acquisition processes behind the NGR. This takes in through life costs, modularity and conditions based maintenance so that the aircraft are interoperable, sustainable perhaps most importantly affordable not only at their acquisition, but through their operational lifetime (supporting changing mission requirement) through to their out of service data.

Paul Kennard, director at Ascalon Defence Consultancy with experience founded in the Royal Air Force

(RAF) as a Support Helicopter pilot and air platform / future technology requirements manager, observes that, in his opinion, the fundamental requirement for an NGR will be significant increases in speed, altitude and radius of action - in fact similar to the attributes desired by US Army aviation.

However, he points out that there are many different aspects to the requirements future rotorcraft will have to satisfy, particularly in the heightened threat and ever more congested environment of near peer conflict. This is where platform modularity (backed by a MOSA type structure) will be important.

Kennard underscores the need for several vital mission systems: certified Degraded Visual Environment (DVE) systems (for white/brown out conditions and low light), cyber hardening and enhanced Electronic Warfare survivability (particularly when operating near or in an Anti Access/Area Denial (A2/AD) environment), and the ability to conduct manned and unmanned teaming (MUM-T).

Optionally piloted rotorcraft have been tested for some years, and could be used for very dangerous insertions or simply 'ash and trash' missions along benign flight paths where crews could be rested for more important tasks. This would increase the number of task missions that could be flown in a 24 hour period, perhaps reducing the actual number of aircraft needed in theatre, as long as health and usage monitoring could allow the maintenance crews to keep the aircraft compatible with the number of flight hours.

Lars Ericsson of the NATO Joint Capability Group Vertical Lift and Army APEO Aviation for Engineering and Technology concludes by underlining the unqualified benefits MOSA will bring: "it gives us rapid upgradability with dramatic reduction in cost and fielding. We need to keep pace with [technological] improvements and buy into capabilities that fit the MOSA framework."

International militaries will not be able to avoid the success of programmes such as FLRAA, FARA and NGR. Joint and combined international operations will rely on partner countries being able to operate in coordination with highly capable next generation rotorcraft, and need to start planning now for their own transformation to the next level of capability. **AMR**

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French/Swedish 155mm Bonus Mk II PGM as it would appear in flight

SMART MUNITIONS INCREASE MARKET SHARE

Top attack munitions are now widely developed for different artillery calibers with varied ranges.

by Christopher F Foss

While aviation assets now employ precision guided munitions (PGM) and smart munitions on an increasing scale, the land sector has been more cautious as their target sets are different.

A key role of artillery is still to provide suppressive fire against opposition forces using high-explosive (HE) projectiles, with secondary natures including smoke and illumination.

To engage hard targets such as armoured fighting vehicles (AFV) cargo rounds were developed and deployed. These carry a large number of small

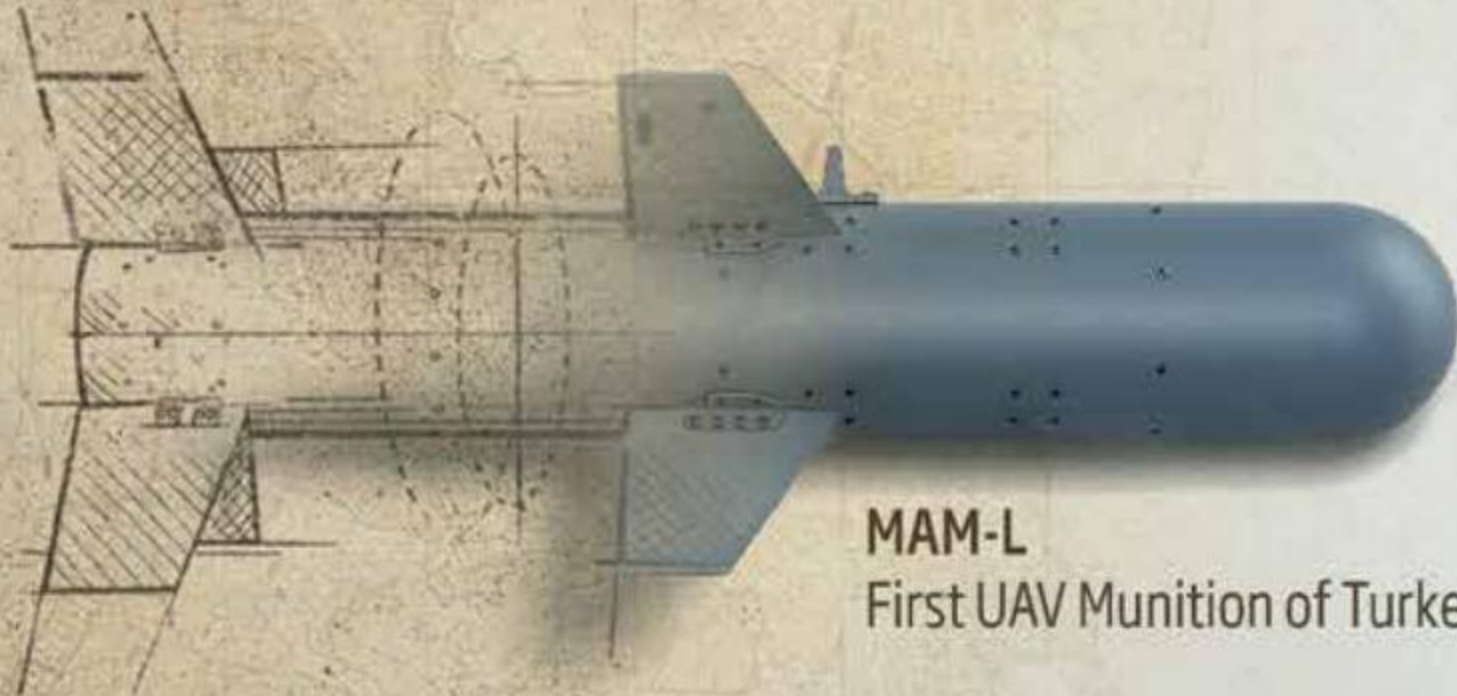
sub-munitions fitted with a small high-explosive anti-tank (HEAT) warhead to penetrate the vulnerable, lighter armoured upper surfaces of AFVs. These sub-munitions can have a high dud rate and therefore limit the manoeuvre of follow up forces as well as potentially causing later casualties to civilians.

For these reasons such munitions are banned under the Convention on Cluster Munition (CCM) and the Cluster Munition Coalition (CMC) agreements and have therefore been phased out of service with most countries, although they are still deployed by such countries such as China and Russia.

As with all artillery projectiles, the key requirement is target acquisition, especially at long ranges and PGM are expensive and would normally be used against high value targets.

To counter AFVs, more advanced 155mm top attack weapons have been developed and deployed with market leaders in Europe, including the GIWS SMArt 155 and the Bofors/Nexter BONUS.

SMArt is a joint development between the German companies of Diehl Defence and Rheinmetall Weapons & Munitions with export sales being made to Australia, Greece and Switzerland.



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Some 12,000 have been manufactured. SMArt 155 carries two top attack sub-munitions, each having a heavy metal explosively formed penetrator (EFP) warhead.

Manufacturing was completed sometime ago but the production line is to be restarted to enable German Army stocks to be replenished as well as allowing the potential needs of export customers to be met. These will be essentially the same as the original SMArt 155 but obsolete sub-systems will be replaced. The maximum range when fired from a German Army PzH 2000 155mm/52 calibre self-propelled howitzer (SPH) is 27.5 kilometres (17 miles).

The BAE Systems Bofors/Nexter Bonus was originally developed to meet the requirements of France and Sweden with production lines being established in both countries and with export sales made to Finland, Norway and the Kingdom of Saudi Arabia. The latest version is the Bonus Mk II and carries two sub-munitions which are parachute retarded at the rate of 45 metres per second (147 feet) and have a search area of 32,000 square metres (334,400sq ft) each.

Maximum range when fired from a 155mm/52 calibre weapon is quoted as 35km (21.7 miles) and when fired from a 155mm/39 calibre weapon is 27km (16.7 miles).

Late in 2018 the US Army placed a contract through the NATO Support and Procurement Agency for the Bonus Mk II with deliveries from the Swedish production line now well under way. A

second contract was placed in early 2020

The US Army did deploy the 155mm M712 Copperhead Cannon Launched Guided Projectile (CLGP) and this Laser Guided Projectile (LGP) fitted with a HE warhead was used in action in the Middle East, but these have time expired.

The US currently deploys the Raytheon Excalibur 155mm M982 PGM fired from its deployed 155mm/39 cal M777A2 lightweight towed howitzer and the 155mm/39 cal M109A6/A7 SPH. Details of the platform, target and GPS specific data are entered into the projectile's mission computer through an Enhanced Inductive Fuze Setter (EIFZ).

Excalibur uses a jam resistant inertial GPS receiver to update the inertial navigation system (INS) to provide precision in-flight guidance and according to the US Army "dramatically improving accuracy to less than 2m (6.5ft) miss distance, regardless of range." It has three fuze options which depend on the target being engage and these are point detonation (PD), PD delay and height of burst.

The current production model is the M982 Excalibur Increment Ib which has a number of improvements including hardware and software updates to improve GPS jamming resistance as well as allowing user defined trajectories for target engagement.

Another development is the Excalibur Shaped Trajectory (EST) which was successfully demonstrated in 2018 and eliminates targets in hard to reach locations by selecting the projectile's



German Rheinmetall 120mm DM11 air-bursting high-explosive round complete (left) and as it would appear in flight with fins extended (right)

terminal or final phase attack angle.

The maximum range of M982 Excalibur depends on the weapon and charge but for a 155mm/39 calibre artillery system it is 39.3km (24.4 miles) with a Modular Artillery Charge System (MACS) while minimum range is being quoted as 8.7km (5.4 miles).

By early 2020 production of the Excalibur has reached over 14,000 units of which some 1,400 have been used in combat. In addition to the US Army and Marines, export customers include Australia, Canada, India, Jordan, Netherlands and Sweden.

Other weapons that are compatible with the 155mm Excalibur are BAE Systems Archer (Sweden) and AS90 (UK), Nexter's CAESAR (France), Denel's G6 (South Africa), Hanwha's K9 Thunder (Korea), Rock Island M198 (USA) and KMW's PzH 2000 (Germany).

In mid-2018, Nexter revealed that it was developing the Katana family of 155mm PGM using internal research and development funding. The Katana has sets of control surfaces positioned on its ogive as well as four fins at the rear which unfold after launch. The guidance system consists of an inertial measurement unit/global position system (IMS/GPS) with a



The German Rheinmetall DM11 round has been designed to neutralise battlefield targets such as fortifications and walls

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Northrop Grumman 120mm XM1147 Advanced Multi-Purpose round in flight clearly showing fins extended at the rear of the projectile

maximum range of up to 60km (37 miles) with a circular error probability (CEP) of 10m (32ft).

During trials carried out in Sweden late in 2020 a CAESAR 155mm/52 calibre SP artillery system fired a 155mm Katana during which all of the Canard Actuation Systems (CAS) were successfully tested. The next phase will be for a complete coordinate guided and coordinate controlled firings sometime in 2021.

Leonardo of Italy has been working on the Vulcano 155mm Ballistic Extended Range (BER) artillery projectile for some time and this unguided projectile has been type classified by the Italian Army.

Leonardo is working with the Diehl Defence of Germany for a semi-active laser (SAL) version of Vulcano having a range of up to 80km (50 miles) when fired from a 155mm/52 calibre artillery system. This has an insensitive HE warhead with pre-fragmented tungsten splinters.

Russian Rounds

The Russian KBP Instrument Design Bureau has developed a complete family of LGP, propelling charge as well as their guidance systems.

The 152mm 2K25 Krasnopol guided weapon system (GWS) uses the 152mm 3OF39 LGP with a maximum range of 20km (12.4 miles), fitted with a HE fragmentation (HE-F) warhead and is claimed to have a high probability against stationary and moving targets of up to 80 percent.

This is used in conjunction with the latest Malakhit automated artillery fire control system as well as laser designators/

rangefinders including the ID22/ID26, LTsD-3M1 and the French DHY-307.

While the Russian Army and many other countries have large numbers of 152mm artillery weapons, NATO and other countries have 155mm artillery systems and the KBP Instrument Design Bureau has developed 155mm versions.

The first of these is called the 155mm KM-1 Krasnopol GWS and includes the K155 SAL LGP with a maximum range of 20km (12.4 miles) and is also fitted with a HE-F warhead.

The latest is the 155mm KM-1M Krasnopol-M2 which includes the K115M SAL LGP and has range increased

to 25km (15.5 miles) and also has a HE-F warhead.

For use with 122mm artillery systems such as the widely deployed D-30 (towed) and 2S1 (SP) artillery systems, the KBP Instrument Design Bureau has developed the 122mm KM-3 Kitolov-2M GWS which includes the actual K122 LGP and propelling charge which has a maximum range of 13.5km (8.3 miles).

China invests in PGM

China has invested in PGM with all of these being marketed by China North Industries Corporation (NORINCO) to potential export customers with the 155mm versions being exported to a number of countries and recently used in North Africa.

These include the GP 155 with a maximum range of 20km (13.5 miles) and the more recent GP155A with range increased to 25km (15.5 miles) with both of these being of the LGP type and have a HE warhead.

To enable targets to be engaged at longer range the GP155B has been developed and this features both the Chinese Beidou satellite positioning system and GPS with NORINCO quoting a maximum range of 35km (21.7 miles).

For 122mm artillery systems NORINCO is marketing the GP122 with a maximum range of up to 14km (8.7 miles).

These Chinese LGP can be used with their Laser Target Designator



Christopher F Foss

The Ukraine has developed a number of guided projectiles including the 120mm and 125mm tank launched and the Kvitnyk artillery projectile

NEW CAPABILITIES EXTEND NAVAL POWER BEYOND THE HORIZON



IAI's maritime domain multidimensional portfolio

The sea has always been a playground for the nations using naval power to exert influence. In the past, projecting naval forces to the high seas was sufficient to demonstrate a nation's military might. Today, national interests also focus on littoral areas and inner seas, where vessels operate closer to mainland, where battlespace becomes congested, complicated and even more challenging. The situation exacerbates in arenas where the enemy maintains anti-access and area denial (A2AD) capabilities, in the form of long-range air defenses, coastal anti-ship missiles, and sea mines. Such threats are hindering the movement of naval forces and risking merchant shipping, threatening the sea lanes.

A Challenging Arena

To adjust, navies are called to dominate the maritime arena by maintaining continuous, complete situational awareness and control of their surroundings. Such dominance covers the sea, air, land, and subsea domains, for the naval force would have no second chance when facing an immediate hostile activity unprepared.

Based on a rich technological heritage, delivering naval combat-proven offensive and defensive weapons, sensors, combat management, and information systems, Israel Aerospace Industries (IAI) have cooperated with the world's navies, fielding the latest defense solutions keeping naval fleets and maritime security forces ready for new challenges.

Maintaining Maritime Domain Awareness

IAI offers Navies a comprehensive sensors suite they need to secure their coastal waters and littorals and Economic Exclusion Zone (EEZ). Such systems suite range from satellites to aerial maritime patrols by aircraft and UAVs to coastal radars, including Over-the-horizon (OTH) and coastal radars, Signal Intelligence (SIGINT), and electro-optical observations. Through the integration of different assets, customers establish maritime domain awareness (MDA).

These systems rely on multiple sources of information, from commercial, open-sources such as AIS and vessel traffic monitoring, wide-area scanning using space-based synthetic aperture radars (SAR), over the horizon, and surface radar scans, electronic surveillance, communications interception, and tracks by imaging sensors. By employing sensor

fusion, artificial intelligence, machine learning, and decision support algorithms, IAI's MDA information systems streamline the operator's workflow, thus buying more time for decision making and cost effective resource allocation.

Integrated Combat Suite

Naval vessels follow a similar path by integrating the sensors and weapons onboard with IAI's Naval Combat Suite. IAI's open architecture CMS integrates these capabilities across weapons, platforms, and entire task forces enabling net-centric operations.

IAI's Barak-MX naval air defense system reflects this capability. Employing Area Defense to intercept aircraft, missiles, or drones at a range up to 150 km, Barak MX family of weapons extends the defensive coverage across the entire task force by combining multiple vessels carrying Barak-MX into an integrated defense network. Users can also network their offensive weapons across a task force to achieve scalable and optimized effects. These capabilities could include a range of IAI-made weapons, including long-range missiles, loitering weapons, or precision-guided missiles.

Leveraging cutting-edge technologies and innovation, and backed by decades of experience developing and fielding integrated naval suites, sensors, and combat systems, IAI's innovative naval systems enable navies find and decisively defeat the enemy under the most challenging conditions.





Christopher F Foss

The Turkish company of Roketsan is developing the Tanok 120mm tank launched guided projectile for use with their Altay MBT

Rangefinder OL1 and OL2 plus radio communications equipment, fire control system (FCS) and fire control calculator (FCC) and programme setter.

Tank launched precision projectiles

The main advantage of tank launched guided projectiles is they can engage threat targets well beyond the effective range of the main armament of the main battle tank (MBT).

The US Army did have the M60A2 MBT and the M551 Sheridan light tank armed with a 152mm gun/missile launcher, but both of these have now been phased out of service.

The now Northrop Grumman (then ATK) and Raytheon were developing the Mid-Range Munition (MRM) which would have been fired from the 120mm main armament of the M1A1/M1A2 Abrams MBT and the Mounted Combat System (MCS) which was part of the Future Combat System (FCS), but this

programme and MRM was cancelled.

Following a competition, Northrop Grumman, Armament Systems, was down selected to continue development of the 120mm Advanced Multi-Purpose Round (AMP) XM1147 which can be fired from the 120mm M256 main gun of the MA2 Abrams MBT fitted with the Ammunition Data Link (ADL).

This HE round can be programmed for one of three modes including point detonate, point detonate delay or airburst but also has a default in which the round functions in PD mode when not set through the ADL.

It has a muzzle velocity of 1,150m/s and a typical target range of 2km (1.2 miles) and trials have shown it will punch a hole in an eight inch (20cm) dual reinforced concrete wall at zero degrees impact. When fielded it will replace currently fielded HE rounds including the M830A1 HEAT, M908 HE counter obstacle round and the M1028 canister.

In December 2020 the AMP XM1147 had received Milestone C which cleared it for production release with first being Low Rate Initial Production (LRIP).

Northrop Grumman, Armament Systems of the US have already stated that "the company is also evaluating a 105mm AMP concept with internal research and development funding for the Stryker Mobile Gun System and the potential of the US Army fielding a 105mm armed Mobile Protected Firepower platforms, currently being tested for deployment by the Infantry Brigade Combat Teams (IBCT)

The new 105mm AMP cartridge will combine the capability of three currently inventoried rounds which are M456 HEAT, M393 high-explosive plastic (HEP) and M1040 canister, into one round to greatly enhance the capability and effectiveness of our mobile system by allowing a single round to expand lethality in their limited vehicle ammunition stowage.

The on-going investment of 120mm ammunition development is considerable especially in AB HE ammunition such as the German Rheinmetall Weapons & Munitions DM11 HE round which can be programmed in the weapon and is already in quantity production and service with a number of countries.

In mid-April 2021 Rheinmetall stated: "The DM11 is in service with four countries. Three more countries are interested in procuring the DM11 in conjunction with upgrade programmes or new purchases of the 120mm smoothbore technology."

The US Marines purchased DM11 for use with their M1A1 Abrams MBTs under the designation of the MK324, but these have now been phased out of service.

The 120mm DM11 can be fired from 120mm L44 and L55 smooth bore tank guns and consists of a warhead with a programmable fuze as well as ballistic cowl, tailfin assembly, drive band, combustible casing with propelling charge and a new design of stub case

which contains the primer and an integrated data cable from programming.

The Russian Army has deployed 125mm gun launched LGP for its MBTs with these having a maximum range of 5,000m (3 miles). First versions were fitted with a single HEAT warhead but more recent ones have been fitted with a tandem warhead to neutralise targets fitted with ERA.

The main drawback of these is that the gunner must keep his sight on the target until missile impact which at longer ranges can take up to 17 seconds, by which time the target could have moved and taken cover.

NORINCO is also marketing tank launched LGP with the 105mm one designated the GP2 and the 125mm one GP7. GP2 is a one piece round and has a maximum range of 5,000m while GP7 is in two parts like the Russian tank launched LGP and has a similar range and are fitted with a tandem HEAT warhead to defeat targets fitted with ERA.

The State Kyiv Design Bureau Luch

in the Ukraine has developed a complete family of gun launched LGP with calibres of 125mm, 115mm, 105mm and 100mm with the 105mm version being successfully fired from a 105mm rifled gun installed in a John Cockerill Defense two person turret.

France was working on a 120mm Metric Precision Munition for its Leclerc MBTs but work is now being concentrated on a 120mm laser guided mortar round under leadership of Thales.

Israel Aerospace Industries has developed the Laser Homing Anti-Tank (LAHAT) projectile which would have a range of at least 8,000m (4.9 miles) with both 105mm and 120mm versions developed.

Roketsan, the missile systems house of Turkey, is developing the Tanok 120mm LGP for use with the Altay MBT now in production for the Turkish Land Forces Command. This is stated to have direct and top attack modes and have a maximum range of up to 6km (3.7 miles) and is fitted with a tandem HEAT warhead. **AMR**



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400 - 1 500 N

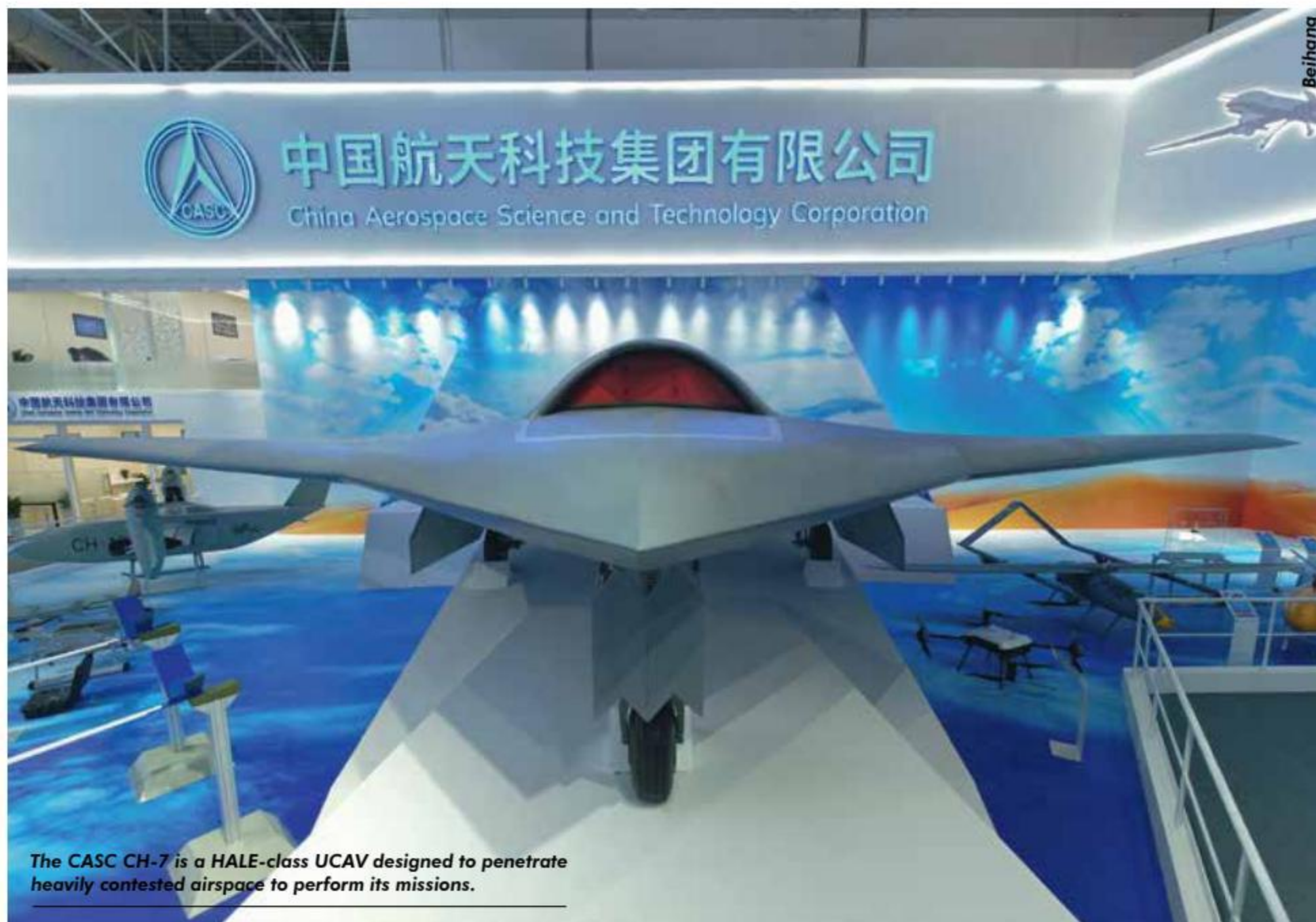
Outer diameter

147 - 272 mm

Electrical output

150 - 2 300 W





INDO PACIFIC UAV DIRECTORY 2021

The development of unmanned aerial vehicles is growing apace, especially in China. New longer range ISR platforms are also on the procurement list of several nations.

by JR NG

Regional military forces continue to develop and field unmanned aerial vehicles (UAVs) as part of ongoing modernisation efforts, with an eye on applications – such as border/maritime patrol and surveillance – where extended range and loiter performance is desired.

While contemporary tactical and medium-altitude long endurance

(MALE)-class UAVs have traditionally served in the intelligence, surveillance, and reconnaissance (ISR) roles, there is an emerging interest in developing more capable systems that can undertake higher-end missions such as air-to-air combat, electronic warfare, and long-range strike.

Indeed, market forecaster Teal Group estimates in its 2020/2021 study that global military UAV

research spending could be worth up to \$64.5 billion over the decade on the back of new technologies. In addition, the company noted that the next generation of systems is being developed at a time when the UAV market is expanding rapidly due to liberalised US export regulations, affordable and accessible Chinese exports and a growing demand for armed UAVs.



The Boeing Airpower Teaming System (ATS), also known as the Loyal Wingman, took its first flight on 27 February 2021.

AUSTRALIA

The Australian Defence Force (ADF) is aggressively pursuing unmanned and autonomous aircraft development, with its three services simultaneously managing broad range of development and acquisition programmes from pocket-sized 'nanocopters' to high-end medium-altitude long endurance (MALE) and high-altitude long endurance (HALE) platforms, and even 'loyal wingman' combat systems.

Unmanned systems will also be a core element of the Royal Australian Air Force's (RAAF's) Plan Jericho, an ambitious project which seeks to transform the service using future high technology systems.

Fielded Capabilities

Boeing-Insitu ScanEagle: In operational use aboard the Royal Australian Navy's (RAN's) Adelaide-class frigates and equipped with Sentient Vision Systems' visual detection and ranging (ViDAR) equipment for on-demand maritime intelligence, surveillance, and reconnaissance (ISR). Also known to have been integrated aboard the lead Leeuwin-class hydrographic survey ship HMAS Leeuwin.

Schiebel Camcopter S-100: Used by

the RAN for operational training and development ahead of a future phase of Joint Project 129 that aims to inform the selection of a vertical take-off and landing (VTOL) UAV platform for its future Arafura-class offshore patrol vessels (OPVs) and Hunter-class frigates.

AeroVironment RQ-12 Wasp AE: Acquired for the Australian Army's Project Land 129 Phase 4 small UAV requirement. Australia announced a contract for an unspecified number of Wasp AE mini-UAVs, which can operate for up to 50 minutes out to a range of five kilometres (three miles), with the aim of equipping every combat team.

FLIR Systems PD-100 Black Hornet II: In service with the Australian Army. The palm-sized Black Hornet systems are being used as platoon-level reconnaissance assets.

Under Development/Consideration/Trials

Boeing Airpower Teaming System (BATS): The 38 feet (11.7 metres) long BATS features a design range of around 3,700km (2,300 miles). Australia is investing \$22 million (A\$28 million) in the development programme with

Boeing building three prototypes in Australia. The company announced in late February that first prototype had performed its maiden flight in Woomera.

General Atomics Aeronautical Systems MQ-9B SkyGuardian: The DoD downselected the MQ-9B SkyGuardian for its AIR 7003 requirement for an armed UAV capability. In April 2021, the US State Department approved a potential \$1.65 billion Foreign Military Sale (FMS) of up to 12 weapons-ready MQ-9B systems, along with a sensors and weapons package and related equipment and services.

Northrop Grumman MQ-4C Triton: Six Tritons UAVs were acquired in separate deals between 2018 and 2019. These are expected to enter service in mid-2023 and fully operationalised by 2025 and will support the RAAF's Boeing P-8A Poseidon patrol aircraft in long-range maritime surveillance.

DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA (DPRK)

North Korea earlier acquired several types of Chinese and Russian-made UAVs, but has since started local manufacture of the Chinese ASN-104



Thales

Thales' Fulmar UAS is in service with the Malaysian Maritime Enforcement Agency.

design, known locally as the Panghyon I, as well as the improved Panghyon II based on the ASN-105. Reports also indicate that the DPRK is developing a long-endurance UAV, with South Korean officials claiming that "numerous test flights" by such prototypes have been detected since early 2016.

Fielded Capabilities

Xi'an ASN Technical Group ASN-104/D-4: In service with the People's Liberation Army (PLA) and DPRK army 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.

Fielded Capabilities

Boeing-Insitu ScanEagle: The RMN will

eventually operate 12 ScanEagle UAVs transferred under the US Maritime Security Initiative (MSI) programme. In April 2021, it stood up a new unit, Squadron 601, to operate the new systems. Six air vehicles have already been delivered, with the remaining systems expected by the end of 2021.

Unmanned Systems Technology (UST)

ALUDRA Mk1: The ALUDRA Mk1 leverages on earlier development on the SR-1 and SR-2 UAVs from the early 2000s. 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 MMEA-specific model will carry a high-resolution video camera with automatic target tracking capabilities.

Under Development/Consideration/Trials

Unmanned Systems Technology (UST)
ALUDRA Mk2: The ALUDRA Mk2 is



The CASC Cai Hong/Rainbow CH-3 is believed to be in service with the Myanmar armed forces.

intended to be acquired by the MAF, although this requirement appears to have lapsed with the armed forces still operating the Mk1.

MYANMAR

The Myanmar armed forces (Tatmadaw) is believed to be operating a range of Chinese, Israeli, and Russian-made UAVs, with several examples being highlighted in the coup that it launched against the

civilian government in February 2021 as well as ongoing military action against rebel groups along its borders.

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. Between 10-12 CH-3 UAVs are believed

to have been acquired by Myanmar. An example was seen overflying Mandalay city to monitor protest activity in late March.

Elbit Systems Skylark I-LEX: It is believed that Israel supplied a number of hand-launched I-LEX UAVs to Myanmar following an official visit to Israel around 2015. However, Israel has reportedly ceased to provide further UAVs and associated support over human rights concerns since 2018.

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DOMINATOR XP
Medium Altitude Long Endurance UAS

ORBITER 3
Small Tactical UAS

ORBITER 1K
Loitering Munition UAS

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Hindustan Aeronautics (HAL) CATS Warrior will be India's first autonomous wingman.

Spetsialny Tekhnologicheskii Tsent (STT) Orlan-10: Russia will reportedly supply an unspecified number of Orlan-10E reconnaissance UAVs to Myanmar as part of a broader deal that also includes Pantsir-S1 surface-to-air missile and radar systems. An identified UAV with a comparable profile was also seen being used to monitor civilians in March.

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 (15 miles).

INDIA

India has been involved in UAV development for over two decades, with research and development (R&D) organisations and defence companies such as 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 decades.

Fielded Capabilities

IAI Heron: The Indian Air Force (IAF) is known to operate at least 20 Heron MALE UAVs for long endurance ISR missions, with the first examples delivered in 2001 and additional aircraft acquired since to equip army regiments situated along the disputed Sino-Indian border. 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. Taken together, the total number of Mk I and Mk II Herons 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 Mk 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.

Under Consideration/Development/Trials

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).

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.

HAL Combat Air Teaming System (CATS) Warrior: The CATS Warrior is a concept that adopts a similar configuration with the US XQ-58A Valkyrie and is currently envisaged as a low-observable, multirole unmanned combat air vehicle that can be commanded from a Tejas light combat aircraft. The concept was unveiled at Aero India 2021.

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.

Fielded Capabilities



Japan is to acquire three Northrop Grumman RQ-4 Global Hawks.

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. 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 Indonesian Air Force has taken delivery of at least four CH-4 armed UAVs, which have been equipped with satellite communications systems that enable these air vehicles to operate out to 2,000km (1,243 miles). 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.

Under Development/Consideration/ Trials

PDTI Elang Hitam (Black Eagle): PDTI revealed in December 2019 that it is leading the development of an indigenous armed MALE UAV called

the Black Eagle, which features a 52ft (16m) wingspan and a MTOW of 2,866lb (1,300kg). According to PDTI, the air vehicle will eventually be capable of 30-hour flights and carry up to 661lb (300kg) of mission equipment and/or weapons.

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

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 MkII, which entered service with the JSDF ground units.

Under Development/Consideration/ Trials

THE TELESCOPIC MAST SYSTEM



MILMAST

www.milmast.com

Northrop Grumman RQ-4 Global Hawk: Japan has acquired three confirmed plans to purchase three RQ-4 Global Hawk Block 30i (international) Global Hawk HALE UAVs at an estimated cost of \$1.2 billion. These will be equipped with the Raytheon Enhanced Integrated Sensor Suite (EISS) and expected to be delivered by 1 September 2022. The first Japanese Global Hawk performed its maiden flight from the company's Palmdale facility on 15 April.

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 (3,048m). The Uqab UAVs have GPS-based navigation and tracking systems that can be pre-programmed and altered during flight.

Boeing-Insitu ScanEagle: Pakistan has acquired an unspecified number of ScanEagle UAVs under a \$15 million FMS contract awarded in September 2015. Deliveries of the ScanEagles commenced from the third quarter of 2016 to the Pakistan Navy.

CASC CH-3: At least 20 Chinese-made CH-3 UAV systems are believed to have been delivered to Pakistan in 2011. See CH-3 entry in People's Republic of China section.

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 (62 miles). 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. 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. 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.

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 35,274lb (16,000kg) MTOW, which is expected to achieve a maximum speed of 533kts (988km/h) and a service ceiling in excess of 30,000ft (9,144m), while carrying a 661lb (300kg) payload up to a range of 500km (310 miles). 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 CASC, although the number of private firms involved in military and dual-use UAV development has also increased significantly. However, many of China's military UAV programmes continue to be shrouded in secrecy.

Fielded Capabilities

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 shares a close physical semblance to the US-made RQ-1 Predator. The air vehicle – which is designated the Gongji-1 (GJ-1) in People's Liberation Army Air Force (PLAAF) service – has a payload capacity of 440lb (200kg) and can carry munitions, such as the indigenous HJ-10 anti-armour missile, CS/BBE2 110lb (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 multirole BZK-005 MALE UAV 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 announced that it had photographed a BZK-005 flying over the East China Sea to the north of Taiwan.

AVIC Guizhou WZ-7 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.

Export-oriented systems

AVIC Wing Loong II: Unveiled at Airshow China 2016, the Wing Loong II has an overall length of 36ft (11m) and wingspan of 67ft (20.5m). The air vehicle has a stated internal payload capacity of 440lb (200kg), with provision for up to 1,058lb (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 a strike-capable MALE UAV that is based on the in-service BZK-005. It features a 816lb (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 is a tactical-class UAV with a MTOW of 1,433lb (650kg) and can be armed with up to two air-to-surface munitions. It features a distinctive cranked arrow 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.

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 760lb (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 37ft (11.3m) long with a wingspan of 69ft (21m) and bears a striking resemblance to the US MQ-9 Reaper UAV. The company claims it can carry a maximum payload of 2,645lb (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 (155 miles) via line-of-sight control, although this can be extended to 2,000km (1,242 miles) when a SATCOM datalink is fitted.

Under Development/Consideration/Trials

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. Armed versions of the AV500 have been tested by the PLA Ground Force.

CASC CH-7: CASC is developing a HALE-class UCAV with a MTOW of 28,660lb (13,000kg). Broadly comparable in terms of shape with the Northrop Grumman X-47B, the CH-7 is designed

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US Air Force photo by Senior Airman Luke Milano





AVIC

AVIC's Wing Loong-1/Gongji-1 is a MALU-class UAS and can carry munitions such as the HJ-10 anti-armour missile and a range of bombs.

to penetrate heavily contested airspace to perform ISR or strike missions.

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 (3,728 miles) 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

The Armed Forces of the Philippines (AFP) and the Department of National Defense (DND) have in recent years made significant efforts to boost AFP capability. The AFP initially adapted commercial drones for tactical ISR support but has since fielded Israeli- and

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.

Boeing-Insitu ScanEagle: The Philippine Air Force (PAF) received several ScanEagle UAVs from the US, which were handed over in ceremony held at Villamor Air Base in Pasay City in March 2018. These are operated by 300 Air Intelligence and Security Wing (AISW) out of Antonio Bautista Air Base in Palawan.

Elbit Sytems Hermes 450: The Hermes 450 is a tactical-class UAV with a MTOW of 1,212lb (550kg) and a 34ft (10.5m) wingspan. An unspecified number of these air vehicles were acquired under a \$153 million package announced in October 2019.

Elbit Sytems Hermes 900: The Hermes 900 is the first MALE-class UAV platform to be acquired by the Philippines, featuring a MTOW of approximately 2,645lb (1,200kg) and a 49ft (15m) wingspan. Nine of these air vehicles were acquired under a \$153 million package announced in October 2019. All nine systems are believed to have been delivered by the end of 2020.

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 328ft (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.

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. 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.

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-7 (KUS-7) /RQ-102: KAL-ASD is believed to have delivered 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 (six miles).

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 (36 miles). 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



At Singapore Airshow ST Engineering unveiled its Veloce family of fixed-wing VTOL UAVs including the Veloce 15 and Veloce 60.

air vehicles – commencing in the third quarter of 2015. The electrically powered air vehicle has an range and endurance of 10km (six miles) 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 its Heron 1 was selected 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

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 52ft (16m) and a flight endurance of six hours at the ADEX 2017 exhibition in Seoul, but has withheld further information.

KAL-ASD KUS-FS: Also known as the Medium-Altitude UAV (MUAV), 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).

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 (KARI) and based on the TR-60 system. The KUS-VT can carry a 66lb (30kg) payload and has an operational radius of 200km (124 miles) 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. All four aircraft have been delivered by September 2020.

REPUBLIC OF CHINA (TAIWAN)

The Republic of China Air Force (RoCAF)



DRDO

DRDO's Rustom programme aims to develop a multirole MALE UAV to equip all three Indian military services.

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 Abatross/Chung Shyang II, is operated by the Republic of China Navy (RoCN). The country's UAV development efforts are led 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 Republic of China Army (RoCA) and RoCN service. The air vehicle is powered by an electric motor and can stay aloft for up to 60 minutes.

NCSIST Albatross/Chung Shyang II: Around 32 Albatross UAVs were acquired for the army under a \$120 million contract inked in 2010. The type received performance and reliability upgrades following the loss of three air vehicles from 2013-2015, and was subsequently transferred to RoCN service.

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. An updated and more robust prototype was subsequently rolled out at TADTE 2019. At least three Teng Yun prototypes were constructed, with one of these destroyed in a crash in February 2021.

SINGAPORE

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 considered a key enabler for the SAF's transformational initiatives.

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 Republic of Singapore Air Force (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.

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.



The R V Connex U-1 in service with the Royal Thai Air Force derived from earlier Tigershark II and Sky Scout developments.

ST Engineering Skyblade II/III: The Skyblade II is described as a short-range mini-UAV. The 11lb (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 (five miles). The Skyblade III is a 11lb (5kg), man-portable UAV can be transported in two backpacks weighing 44lb (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.

ST Engineering Stinger: The Stinger

Unmanned Aerial Multi-Rotor Gunship is envisioned to be a semi-autonomous, company-level reconnaissance and fire-support platform. 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 35-37lb (16-17kg) and 110-154lb (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



The Viettel Group Patrol VT is in service with Vietnam's armed forces.

and development capability. The state-run Defence Technology Institute (DTI) is spearheading efforts to grow its indigenous UAV production capabilities and spur innovation within the local defence industry, with technical assistance from countries including China and Israel.

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/U-1: Designed around 2015, the medium-range Tigershark II tactical UAV is stated to have an operating range of up to 150km (93 miles) while carrying a 66lb (30kg) payload. Ministry of Defence reportedly awarded a \$18 million contract in 2016 to procure parts for up to 17 Tigershark II UAVs.

R V Connex RTAF U-1: The RTAF has

fielded the indigenously developed U-1 tactical UAV 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.

Under Development/Consideration/Trials

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.

VIETNAM

Vietnam is pursuing self-sufficiency in UAV development and production by leveraging on its considerable indigenous aerospace and communications R&D capabilities provided by the state-owned Vietnam Aerospace Association (VASA) and telecommunications company Viettel Group.

Fielded Capabilities

Aeronautics Group Orbiter: Vietnam reportedly acquired two Israeli-made Orbiter 2 and Orbiter 3 mini-UAVs between 2014 and 2015 to boost the situational awareness and targeting abilities of its artillery and coastal-

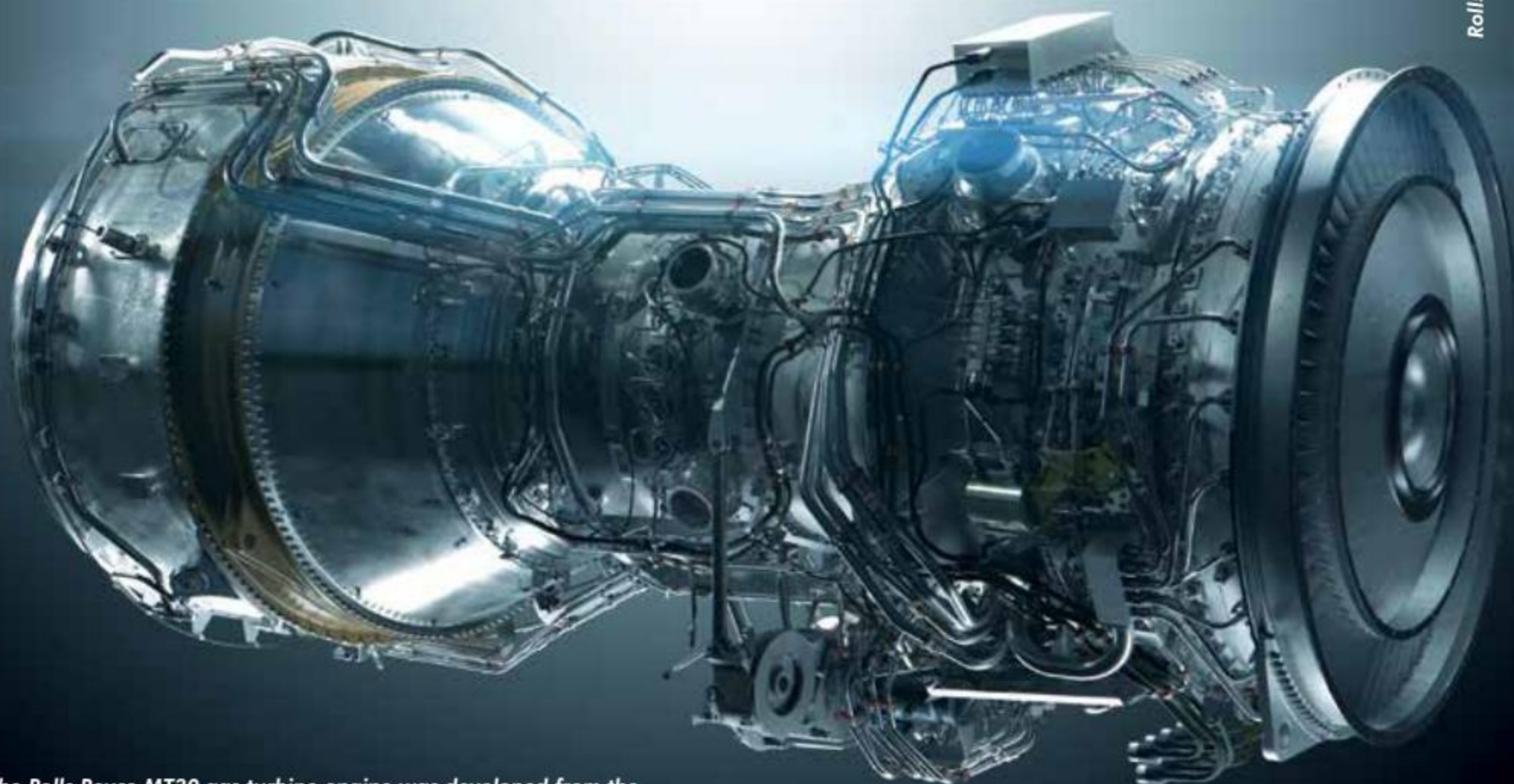
defence missile units.

Viettel Group Patrol VT: Viettel unveiled its 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 (31 miles) and carries an optical infrared camera that provides real-time transmission of high-definition imagery. It is now in service with the Vietnamese armed forces.

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 72ft (22m). Stated performance include a range of up to 4,000km (2,485 miles) and a 35 hour flight endurance. A prototype was reportedly completed by November 2015 with flight testing occurring during the second quarter of 2016.

Viettel Group armed reconnaissance UAV: A mock-up of a new MALE-class UAV featuring a twin-boom airframe design was unveiled during a display of Vietnamese military equipment at the end of September prior to the launch of the 11th Party Congress in late September 2020. A variety of weapons associated with the UAV was also showcased. [AMR](#)



The Rolls Royce MT30 gas turbine engine was developed from the Trent 800 aero engine. It is classed as a fourth generation GT that can produce 36MW of power going to 43MW.

MARINE ENGINE POWER - NOT JUST ABOUT KNOTS

Navies not only want more engine power, there are also coming under increasing pressure to become environmentally conscious.

by Tim Fish

The power and propulsion (P&P) systems for naval vessels have advanced considerably in recent decades. This feature aims to highlight the latest developments in the design and operation of the prime movers in those P&P systems. The prime movers are the gas turbines, diesel engine and steam turbines that convert the energy in fuel into mechanical energy that is used for propulsion or electrical systems.

For modern naval vessels the steam turbine has largely been replaced by arrangements of gas turbines (GTs)

and diesel engines. Depending on the operating profile of the warship it will need different types of prime movers to generate the necessary power and propulsion to perform its mission sets. Because these systems are so important to a ship's capability and are in essence its defining characteristic, designs of new ships have to consider the power and propulsion system first and foremost before anything else.

Diesel engines

Most naval vessels will use diesel engines to provide standard levels of

power for propulsion, sensors, weapons and the 'hotel load' to sustain the living conditions of the sailors such as heating/cooling, lighting, charging, cooking etc. Diesel engines can provide ships with speeds up to a maximum of about 28 knots although they are generally used to provide much lower patrolling or transit propulsion speeds.

But frontline warships, especially surface combatants like frigates and destroyers have a specific requirement for high-speed manoeuvres and this requires the ability for a sudden boost in power to achieve this. Adding GTs



Mitsui E&S Shipbuilding launching the Japan Maritime Self Defense Forces' first multi-mission frigate at its Tamano Works yard on 19 November 2020.

into a ship's power and propulsion arrangement offers a capability to provide a surge in power to attain top speeds from 28kts to in excess of 40kts. Typically marine GTs would provide propulsion power from 18-30kts in most frigates and destroyers with less than 18kts powered by direct-drive diesels or diesel gensets via electric motors.

Marine GTs have developed considerably over the past 20 years and have become an extremely specialised niche industrial capability. Today the two main providers of GTs for navies are Rolls-Royce and General Electric, which produce the most modern high-powered GTs, the MT30 and LM2500 respectively. Ukraine's Zorya-Mashproekt also builds marine GTs and since it stopped delivering its products to Russia following the Crimean invasion, Moscow has been developing a new marine GT capability at its aero-GT company NPO Saturn.

Marine GTs have been developed from aircraft gas turbines and the MT30 is one of the most modern on the market. Derived from the Trent 800 aero engine,

with 80 percent commonality between them, the MT30 is classed as a fourth generation GT that can produce 36MW of power going to 43MW if required.

The reason the MT30 is able to provide such large quantities of power is because the roots of its development lay in the 1980s aviation GT contract arrangement and 1990s computer power. During this period, Rolls-Royce entered into more leasing arrangements for its GT engines with commercial airlines whereby the company retained ownership of the engines while the airlines were charged for the power usage by the hour. This is one of the reasons why GT providers have been so hard hit by the COVID-19 crisis, because their engines are not being used.

As this type of contractual arrangement became more common, it meant that the risk of engine reliability was transferred to the owner giving them a huge incentive to conduct analysis of health and usage monitoring of the engine's components and improve performance through a total care package. At the same time, by the early

to mid-1990s engines were becoming more powerful as aerospace technology advanced through improvements in computer processing and the use of computational fluid dynamics and finite element analysis. The Trent 800 followed from this. Being a large diameter GT engine with a larger air mass flow it was far more powerful with enhancements to the compressor, combustion systems and the turbines, as well as giving higher margins on temperature. The result was that from this period onwards the Boeing 777 aircraft was able to operate with just two engines instead of the conventional four.

According to Richard Partridge, chief of Naval Systems at Rolls-Royce, the MT30 was developed because of the power requirements in the naval market for a much more power dense 36MW GT with higher levels of reliability. The Trent 800 was therefore selected for marine conversion rather than the Trent 700 or 500 because it was able to offer better outcomes.

"For the Japan Maritime Self Defense Force's new Mogami-class (FFM) frigate



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that gives the GT the ability to function within high temperature margins is the cooling system.

"The High Pressure Turbine, which is immediately downstream of the combustor, has a very intricate series of cooling passageways inside each of the rotating blades. It needs those to remove heat from the metal and allow the blades to actually survive in those conditions and to rotate at a very high rpm," Partridge said.

The level of design detail and the technologies required to build a properly functioning, reliable and efficient gas turbine are considerable. The level of knowledge in GT manufacturing companies has been built up over 70 years making it a high barrier for the entry of new companies into this market.

Because of the costs of design and development, it is not often that new GTs can be produced for the naval market unless there is significant demand and a gap or weakness in existing offerings. It is possible to create an even more powerful GT but this would require an increase in complexity and cost. Therefore the products have to match the market requirements whilst remaining competitive.

Meanwhile, although diesel engines are not able to match the power density offered by the GT, there have been improvements that can give warships more power and propulsion capability to sustain higher speeds and larger electrical loads as well as meet tougher environmental regulations. It means that diesel engines are becoming more attractive as an option if a navy is questioning the value of buying GTs.

The attractiveness of diesel engines has been helped by the move towards electric power and propulsion over the past two decades that started in the UK in the 1990s. With the inclusion of an electric motor, the diesel engines can be removed from the shaft line allowing more flexibility to meet some mission requirements.

Simon Riddle, general manager, Naval & Research Vessels at Wärtsilä Marine Solutions explains that another benefit is redundancy: "You can have maybe four gensets, and still operate the ship on three, but you'd still be able to maintain the fourth engine in reserve. It also means that you can improve the engine loading when the power demand from the vessel is lower, because you can shuffle the load around from one genset



The Wärtsilä 31 diesel marine engine was launched in 2018 with a focus on fuel efficiency.

programme we have actually been able to offer 43MW of power," Partridge said. The fact that it is so power dense means that ships can move to a one-GT power and propulsion arrangement alongside the diesel engines instead of two GTs allowing more space and flexibility in design. This was also evident in Korea where the MT30 was adapted to provide power to smaller ships and was selected for the new Republic of Korea Navy Daegu-class (FFX-II) guided missile frigates.

Furthermore, the reliability of the MT30 gives it an additional advantage in maintenance as it will never need to be taken out of the ship for overhaul offering lower cost of ownership. "The overhaul life is so long, based on typical naval utilisations of 300-600 hours per engine per year. It is literally a sort of fit and forget boost capability and that's fantastic for the operator in terms of reliability but also through-life costs," Partridge explained. Predictions are that the MT30 will have to undertake

in excess of 25,000 hours of operations before needing a full overhaul and the lead engine produced has not yet reached that level of use.

The MT30's large diameter core increases the air mass flow, which is then compressed creating a high temperature before fuel is injected and ignited in the combustor at the right air-gas ratio to produce the right amount of high-pressure exhaust gas that will turn the turbines.

"You can imagine just the centrifugal force trying to pull the engine rotatives apart exacerbated by the heat, but that allows much more efficiency from the turbine than hitherto available," Partridge said.

But it is not just the metrology (the measurements and calibration) that are a factor, there are additional niche technologies implemented to help the system withstand these pressures. While the turbine blades have a thermal barrier coating in order to withstand the heat generated, one of the big differences



The Wärtsilä 8V31 diesel generator will power the Royal Netherlands Navy's new combat support ship (CSS), *Den Helder*.

to another," he explained, "And you have a power management system that makes the loading on the engine more controlled than having a diesel engine running into a conventional gearbox."

Although naval forces do not prioritise fuel efficiency as much as the commercial market, this is still an important attribute in diesel engine performance. Riddle said that it has been the "biggest driver" behind the development of the new Wärtsilä 31 marine engine that was launched in 2018, which achieved a reduction in through-life costs.

The Wärtsilä 8V31 diesel generator has been selected to be fitted to the Royal Netherlands Navy's new combat support ship (CSS), *Den Helder*, which will be delivered in 2024.

"The first thing that we do with all engines is ask how can we design them with a reduced number of components. Reduced numbers of components means fewer actual chances of failures. Then we design it to mitigate a lot of service operations on the engine," Riddle explained.

The modular construction of the Wärtsilä 31 significantly reduces maintenance downtime and the need

for spare parts. Damen Schelde Naval Shipbuilding (DSNS), builder of the *Den Helder* has stated that the Netherlands Defence Materiel Organisation (DMO) requested that Wärtsilä equip the engines with extra combustion sensors so additional data can be collected to facilitate smart maintenance.

Securing the *Den Helder* CSS contract was a coup Wärtsilä, as the RNLN's previous supplier for its earlier Joint Support Ship HNLMS *Karel Doorman* was Rolls-Royce Bergen with its four V12A diesel generators.

Riddle said that for the CSS the DMO wanted a 'green footprint' which gave the Wärtsilä 8V31 an advantage as it is expected to achieve a six percent reduction in fuel consumption compared to similar engines.

Ultimately engines become greener by becoming more efficient and using less fuel. Much depends on the speed of the engine - the stroke - but the fuel injection system and turbo-charging methods are also important factors.

"When looking at efficiency we are trying to reduce the losses," Riddle said. "The things we looked at on the Wärtsilä 31 are: combustion shaping, combustion with injection and the use

of high maximum cylinder pressure - so we are constantly looking at improving fuel injection technology."

Wärtsilä is also supplying the CSS with a selective catalytic reduction (SCR) unit, that will reduce the NO_x [nitric oxide] emissions of the ship to adhere to International Maritime Organisation (IMO) Tier III regulations. The company provides its own SCR units without using a third-party provider which reduces the need to complete onboard certification whilst the ship is in construction.

Marine engine development is a specialist capability and with few providers of both gas turbines and diesel engines competition is tough. Driven by improvements in the commercial sector companies are able to offer more efficient and capable prime movers to their naval customers and give warships the right power and propulsion outfit to suit the mission profile.

The Rolls-Royce MT30 has been challenging the GE LM2500 over the past decade in the GT market with its power density and competitive through life maintenance cost reductions. Improved maintenance is also a key driver for Wärtsilä as it improves efficiency with its latest 31 engine offerings. [AMR](#)



During their deployment to Afghanistan in 2010, Australian Army soldiers leave Patrol Base Atiq for a night patrol. Preparations for the night patrol included weapon zeroing and adjustments to night fighting equipment such as machine gun sights and night vision goggles.

NEXT GEN NVGS - A CLEAR IMPROVEMENT

Fused and enhanced night-vision technology will make the difference to soldiers fighting at night.

by Mike Rajkumar

Night-vision technology is rapidly advancing with step changes in performance, user experience and comfort. These advances are a result of technology for Night-Vision Devices (NVD) transitioning from being hardware heavy and dependent on legacy processing platforms to software driven hardware. This has allowed NVD providers to harness the ever growing processing power of commercial computing platforms. Electro-Optic

(EO) devices today make use of edge video processing, have real time auto target recognition capabilities and utilise deep learning models to deliver night-vision capabilities far in excess of what was available only five years ago. Development of these advanced NVDs for mounted and dismounted soldiers however, is the realm of only a few companies worldwide, who are able to deliver on the highly challenging and competing demands of size, weight and power consumption and manufacture

these systems in volume. Militaries however, have been quick to take note of the advanced capabilities now available on NVDs and are planning accordingly.

Capability Overmatch

The Australian Defence Force's (ADF) continue to invest in state-of-the-art night-fighting capability and are on schedule to receive more than 5,500 cutting-edge helmet-mounted Fused Night Vision Systems (FNVS) from L3Harris. Deliveries are expected to begin next



A member of the New Hampshire Army National Guard, shows the wearable positions of the Enhanced Night Vision Goggle-Binocular (ENVG-B) during a Soldier Touchpoint event in 2019. The ENVG-B's capability of assuming various positions is one of the many features of the system decided by soldier feedback.

year with Final Operational Capability (FOC) slated for September 2023. "The new fused night vision systems will provide greater survivability to our ADF personnel through increased situational awareness and the ability to detect movement at greater distances," said Defence Minister Linda Reynolds. "The fused night vision system will also allow Augmented Reality (AR) enhancements, including location and navigation data in the Heads-Up Display (HUD)." Along with its investments in NVDs, the ADF is also working on a new integrated digital soldier combat helmet system for which New South Wales company Spearpoint Solutions was awarded \$2.7 million in February.

Missions Systems Australia, a subsidiary of L3Harris, received the night-vision systems contract worth \$173 million in December 2020, which included full in-country support and

repair. L3Harris announced in January that it would provide the advanced NVGs to the ADF under a \$118 million contract. L3Harris' FNVS fuses image intensification technology with thermal imagery to deliver enhanced situational awareness, targeting and identification capability to soldiers in all battlefield conditions and light levels. The FNVS can also deliver vital battlefield information directly to the soldier's eye when it is combined with the L3Harris battery pack

The ADF's night-vision procurements fall under its LAND 53 Phase 1BR project which sought to replace its helmet-mounted night-vision equipment and laser-aiming devices which attach to specified ADF weapons for dismounted combatants, including regular infantry, Special Forces (SF) and selected elements of the Navy and Air Force. Tranche 1 of LAND 53 Phase 1BR was

aimed at meeting requirements for new generation NVDs featuring the latest technology with improved ergonomic performance and reduced weight. The new devices would replace existing night-fighting products to enhance the ADF's dismounted night-fighting capabilities.

The first Tranche 1 contract was inked with L-3 Communications Oceania in September 2016. The five year \$208 million contract for night-vision imaging systems included binocular night vision goggles with white phosphor image intensification features, compact laser with integrated white light functions, miniature laser rangefinders and other detection and targeting tools to ADF. Amongst the systems supplied by L3Harris include: Binocular Night Vision Devices (BNVD) - L3Harris AN/PVS31A; Laser Aiming and Illumination Devices (LAID) - L3Harris AN/PEQ-16B LED / MIPIM; Laser Aiming, Illumination and Ranging Devices (LAIRD) - L3Harris SRF. L3Harris directly provides support for its night-vision systems to first and second line ADF brigades and end users from its Brisbane support and sustainment facility. Tranche 1 deliveries began in May 2017 and were completed in 2020.

Cutting-Edge NVG

The US Army is now fielding the most sophisticated military Night Vision Goggles (NVG) currently in operational service with initial deployment of the new Enhanced Night Vision Goggle - Binocular (ENVG-B) now underway. The US Army selected L3Harris in October 2020 to deliver the ENVG-B as its next generation night vision system to enhance situational awareness and increase soldier mobility. The advanced NVGs have already made an appearance in the region, when a US Army armoured brigade combat team equipped with ENVG-B's made a trial deployment in South Korea in 2019.

"The ENVG-B is the most advanced night vision goggle ever developed for and fielded by the US Army, enabling a soldier to see and manoeuvre in zero and low-light situations," said Lynn Bollengier, president, Integrated Vision Solutions, L3Harris. The ENVG-B features see through map overlays and a compass in addition to AR capabilities and a HUD that integrates wirelessly with weapon optics. Low Rate Production is now underway and approximately 5,000

ENVG-Bs have been fielded thus far with the 82nd Airborne Division already having received 1,500 units by March. The development of the advanced new NVG's is aimed at regaining American superiority in night-vision technology which had steadily eroded in recent years.

The ENVG-B binocular system provides greater depth perception than a traditional monocular sight. Its dual-tube design and improved Image Intensification (I2) resolution provide outstanding vision in low-light or no-light environments. The use of white phosphorous tubes means the soldiers will not have to see through a green tint as on current NVGs which make use of green phosphorous tubes.

In Reliability Growth Tests (RGT) held in June 2020, participants found the ENVG-Bs completely outperformed the PVS-14 Night Vision Monocular, which is the current standard military issue NVG for US troops. The PVS-14 is also in widespread use with many NATO countries and other U.S. allies. Troops wearing ENVG-Bs could engage targets out to 300 metres and even beyond, whereas troops equipped with standard issue PVS-14s had difficulty even seeing beyond 150 meters. Over the course of the RGT, troops reported a 'night and day' difference in terms of target detection and clarity between ENVG-B and PVS-14.

Crucially, ENVG-B will be integrated with Nett Warrior and Family of Weapon Sights - Individual (FWS-I) which are part of the US Army efforts to deliver capability to its warfighters far beyond what is the standard in today's battlespace. The ENVG-Bs will feature a wireless connection with FWS-I and be able to present a fused thermal image to the soldier. FWS-I provides enhanced target recognition and passive engagement capabilities, even behind cover and concealment and soldiers will be able to utilise the combined technology to detect targets through smoke and spot enemies even while obscured from view. The ENVG-B's can also be connected wirelessly to Nett Warrior, which provides access to blue force tracking, improved communication and mission planning tools.

India Needs NVG Upgrades

India's ongoing border confrontation with China has brought to light a shortage of modern night fighting



Indian company Tonbo Imaging's Spartan is a next-generation tactical thermal sight powered by Qualcomm Snapdragon chipset which gives high GPU processing power. The company claims that it is the world's lightest AI-powered scope, weighing only 300 grams. It was introduced in 2019 and also works as a monocular helmet-mounted sight.

equipment for large sections of the Army. The size of Indian requirements can be estimated from a 2019 Request for Information (RFI) for night sights for 56,000 7.62X51mm assault rifles spread across 40,000 Image Intensifier and 16,000 Thermal Imaging (TI) based sights. "Some of our recent programmes include TI sights for assault rifles and we are working on the Request for Proposal (RFP) for the procurement of more than 22,000 TI sights for SIG 716 assault rifles being imported," Ankit Kumar, CTO and co-founder of Tonbo Imaging an Indian firm specialising in night vision technology tells AMR. The military is also procuring 800 TI night sights for infantry units equipped with AGS-30 30-mm automatic grenade launchers as they currently lack TI sights for night operations with access only to a PAG-17 day sight.

In September 2020, the Army issued an Expression of Interest (EoI) for upgrade of 811 BMP-II and BMP-I/K Infantry Combat Vehicles with a 3rd Generation Thermal Imager based Gunner Sight, 3rd Generation Thermal Imager based Commander Sight (Panoramic), Modernised Fire Control System and Automatic Target Tracker. Tonbo Imaging displayed its proposed solution to upgrade the night fighting capabilities of Indian BMP IIs at Aero India 2021 in February and Army trials are slated to start soon for this project. "We are working through the IDEX programme to upgrade the BMP II with

See Through Armour (STA) Capability and enhance the situational awareness of the driver, commander and gunner sitting inside a closed hatch vehicle. We have successfully demonstrated a fully military qualified product integrated with the BMP and are looking forward to the pilot production order by IDEX under the \$136 million (1000cr) budget allocated by the defense minister for such successful projects by start-ups in IDEX," Kumar tells AMR. While the contract for night-vision upgrade of 811 BMP-II and BMP-I/K has been allocated to the Ordnance Factory Board and Bharat Electronics Limited, another 800 ICV's are planned to be upgraded.

The BMP-II was fitted with Tonbo Imaging's Wolfpack multi-aperture, multi-spectral see-through armour system. The Wolfpack system features a holographic Helmet Mounted Display (HMD), Inertial Measurement Unit (IMU) for navigation, AI enabled target recognition, video stabilisation, sensor fusion and threat analysis. The TI on the system delivers a 50hz frame rate with 4x digital zoom, while the Day Imager features a low lux CMOS with 720p HD resolution, 46-degree X 34 degree field of view and 10x optical zoom. The Wolfpack system enhances situational awareness via a network of an array of multi-spectral cameras constantly looking out to different directions around the vehicle generating seamlessly fused 360-degree panoramic images covering the surroundings of the entire vehicle.



In February 2020 Thales and MKU announced the co-development of the ELFIE Night Vision Device (NVD) for the armed forces in India and for export.

The solution proposed by Tonbo Imaging uses nine cameras that are integrated with the helmet display and the firm's STA technology gives the commander, driver and gunman a 360-degree view around their tank while sitting inside, even at night. This technology also caters to the drop in visibility due to smoke, dust and fog.

Tonbo is also awaiting a production order for supply of EO sights for a .50 cal Remote Controlled Weapon Station (RCWS) to be fitted on the Arjun Mark 1A Main Battle Tank (MBT). The EO sensors provided for the RCWS has completed successful user trials and once a production order for the Arjun MBT is in place, the company will gear up for production of the EO sights. Apart from supplying products to the US and Peruvian Army, Tonbo is gaining success with Indian armed and paramilitary forces as also SF units.

Kanpur-based defence manufacturer MKU is working together with French defence firm Thales to develop the ELFIE night vision devices for the Indian armed forces. As per the schedule, integration of the first pre-series of devices at MKU's facility in Kanpur was to have been completed in the first trimester of 2020 with a true model of a made in India, ELFIE night vision device to have been available in the first trimester of 2021. The lightweight monocular offers a wide field of view and is suitable for left or right eye use, providing stereoscopic vision in binocular configuration. It can be used in hands-free mode on a face mask/helmet mount or weapon-mounted. ELFIE is touted as being an ideal solution for vehicular use and for paratroopers and Special Forces (SF) operators.

Another important aspect when it comes to NVDs, especially for operators in the region is their support and maintenance. Typically for NVD's the Mean Time Between Failure (MTBF) varies from 1,500hrs to 10,000hrs depending upon the number of components inside a system or the complexity of the system. EO systems are also export controlled and it is not easy to send them across borders for repairs making investments into maintenance of such equipment of vital importance considering they will remain in service for more than a decade.

It is important for users to buy and maintain the manufacturer recommended list of spares and also special tools and equipment to repair the system as and when required as any cutting of corners here, leads to an adverse impact on the operational availability of NVDs. AMR



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The advanced bases established by amphibious forces will be used to maintain a line from Japan to the Philippines utilising land-based long-range missiles, unmanned systems, aircraft and ships to conduct both offensive and defensive operations

AMPHIBIOUS FORCES

New amphibious concepts are re-shaping marine forces to break the A2AD defensive line.

by **Tim Fish**

Amphibious warfare has existed as a pillar of western military strategy since World War II, particularly after the experience of the U.S. Marine Corps (USMC) in the island hopping campaigns in the Pacific. New concepts that have emerged and are currently under development will put amphibious forces at the centre of how the Western powers will meet emerging security threats not just in the grey zone under the threshold of war but in high-intensity conflict as well.

Commentators have long predicted the demise of amphibious warfare with

the advent of new technologies and weapons that can threaten and neutralise landing operations in the littoral, but amphibious forces have always been adaptable and remain relevant.

The recent adoption of Anti-Access Area Denial (A2AD) tactics and weapons by Russia and China are attempting to neutralise the threat an amphibious force presents. The introduction of long-range anti-ship missiles and sensors, unmanned systems, hypersonic missiles to add to existing air, land, surface and underwater defences makes a large-scale amphibious landing against a well defended coastline an extremely difficult

proposition.

To this extent the commentators were right, but a large-scale beach assault such as the invasion of Normandy (Operation Overlord) in France on 6 June 1944 are what many observers still associate with an amphibious attack. However, today's amphibious forces are extremely flexible and can be utilised for a variety of missions including different kinds of assault (Falkland Islands in 1982), raids, withdrawals, demonstrations and actions to support to other operations. Variations of these kinds of operations have been present throughout history.



The traditional view of amphibious landings seen here on the beaches at Normandy during World War Two. Future amphibious operations during conflict are likely to be radically different, especially in the Pacific

EABO

Mature military forces are changing their priorities to meet the developing geo-strategic environment by preparing for a near-peer high intensity conflict, with amphibious forces having a specific role to play in countering the A2AD threat.

In June 2018 the USMC embarked on a new amphibious warfare concept

called Expeditionary Advanced Base Operations (EABO). The EABO Handbook released by the Marine Corps Warfighting Lab, Concepts & Plans Division states that: "EABO creates a more resilient forward force posture that circumvents the efforts and obviates the investments of aspiring peer competitors employing long-range precision fires directed at dislodging

U.S. forces dependent upon legacy bases, fixed infrastructure, and large targetable platforms. By enabling persistent presence and a more resilient force posture, EABO offers the opportunity to conduct expeditionary operations to defeat an adversary's strategy without the requirement to destroy all of his forces."

To engage China this requires the USMC to occupy undefended islands and atolls in the Pacific and install land-based long-range sensors and weapons that can attack enemy surface and air targets. The range of these weapons will create a bubble around that island stretching hundreds of miles that would be risky for an opponent to enter.

By setting up numerous bases like these in the Western Pacific, the USMC can establish its own A2AD sphere and effectively blockade China. Not only will Chinese military forces be prevented from breaking out into the wider Pacific, its commercial operations and trade will be cut-off. Using these islands will make a significant contribution to the US Navy's (USN's) efforts to establish sea control in the approaches to the Western Pacific and with this secured more significant regular forces can be brought to bear. Without these forward bases and EABO, breaking the China's A2AD barrier from the sea alone will be either impossible or extremely costly. By making amphibious forces a key facilitator towards establishing sea control and blockading



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The Theodore Roosevelt Carrier Strike Group transits in formation with the Makin Island Amphibious Ready Group in the South China Sea on 9 April, 2021. Large deployments such as this would not be possible so close to China as the vessels would be vulnerable to strikes from long-range A2AD weapons

the enemy, amphibious warfare has therefore become central to US military strategy.

Although the ideas behind EABO are not new and similar operations were considered by the UK Royal Navy as far back as the 1920s it is a significant departure from the existing USMC concept of operations and the way the service is setup to operate. Since WW2 the central doctrine of the USMC has been manoeuvre warfare, sea-basing and the use of large amphibious ships that (once sea control is established by the USN) can concentrate at a specific point offshore and conduct a landing, either opposed or unopposed, putting troops and equipment ashore at a rapid pace. This is to establish and protect a beach head that can then be used as a transit station for bringing a larger force onto enemy territory for further inland operations.

Instead, in the build up to a crisis, amphibious forces are expected to move rapidly to occupy undefended islands and establish bases close to enemy positions for sea control operations. Large amphibious platforms and aircraft carriers are deemed vulnerable for forward deployment within the range of enemy A2AD weapons.

It means an extensive overhaul of tactics, training and procedures, the procurement of new platforms and equipment, the re-rolling of existing air, surface and undersea vessels and most importantly much better cooperation and integration with the USN, US Army and USAF. The USMC's Marine air-ground task forces (MAGTFs), from which the service forms its Amphibious Ready

Groups ARGs/Marine Expeditionary Units (MEUs) are optimised for power projection onto land – not sea control.

The most recent US Navy Shipbuilding Plan released in December 2020 has made a start towards putting the USN and USMC on the path towards developing its forces to confront the A2AD barrier. The USN inventory is expected to grow from 305 ships in FY2022 to 405 by 2051. The size of the amphibious fleet of warships is expected to grow from 31 to 62 and a combat logistics force of 31 ships to 69 in the same timeframe. The introduction of a large number of unmanned surface vessels will make up a significant proportion of the expanded fleet inventory.

The reason for a larger number of smaller ships is that the USN needs to become more distributed and has spread out over wider areas. In this way the USN can avoid presenting opposing Chinese A2AD forces with a concentration of ships that would be the perfect target for long-range strike weapons. All these platforms would be linked by a resilient multi-domain C4ISR architecture. The USN must develop its Distributed Maritime Operations (DMO) and Distributed Lethality (DL) concepts to disperse the fleet whilst retaining offensive power through the deployment of smaller 'hunter-killer' surface action groups (SAGs). This is complementary to the USMC's EABO concept as the land-based and sea-based assets can work together and has been developed as part of the concept of Littoral Operations in a Contested Environment (LOCE) that aims to fully integrate USN and USMC capabilities to overcome threats in the littoral areas.

The highlights of the Naval Shipbuilding Plan 2020 include the procurement of a new Light Amphibious Warfare (LAW) ship that is designed to rapidly transport new Marine Littoral Regiments (MLR) to the selected EABO islands; light aircraft carriers (CVL) to provide additional air support; Next Generation Logistics Ships (NGLS) to provide more distributed logistics support to forward deployed units; and unmanned vessels (extra-large, large and medium) to act as forward sensors, decoys and even potentially as weapons platforms.

However, the LAW has already attracted criticism in the media as initial concepts from the USN have been deemed insufficient for the role that the

ships are expected to undertake – mainly that they are too small, not capable enough with too short a lifespan making them too costly. Up to 35-40 could be acquired and a formal Request for Proposal is expected shortly. Meanwhile options for the CVL include converting the USN's America-class Landing Helicopter Assault (LHA) ships or developing new designs to succeed the Ford-class carriers.

In terms of other weapons, the USMC needs to get new long-range missiles and launcher platforms into the future Marine Corp structure as organic to its expeditionary units. It needs to become more integrated with the US Army to implement a land-based missile strategy for sea denial.

The outcome of a conflict in the Western Pacific could hinge on which side is able to take and secure islands in the area and best utilise them as part of their defensive and offensive strategy. Whilst China's amphibious forces are largely focussed on the ability to invade Taiwan the People's Liberation Army Navy (PLAN) has been developing longer range amphibious capabilities with its new Type 071 LPDs and Type 075 amphibious assault ships that can reach distant islands in the so-called First Island Chain and beyond. It could be a case of who gets there first.

As a result, more capable amphibious forces are also being developed by US allies in North East Asia: Japan, South Korea and Taiwan to support an island-grabbing strategy and prevent China from moving past the first island chain. Japan's most recent annual defence white paper, published in July 2020, states: "China has relentlessly continued unilateral attempts to change the status quo by coercion in the sea area around the Senkaku Islands, leading to a grave matter of concern. The Chinese navy and air force have in recent years expanded and intensified their activities in the surrounding sea areas and airspace of Japan, and there are cases involving the one-sided escalation of activities."

Japan's response has been the modification of the JMSDF's two Izumo-class (22DDH) helicopter carriers – classed as destroyers locally – to be able to launch and recover the F-35B. This will be useful in forward deploying aircraft to the farthest islands to provide air defence. Meanwhile in March 2018 the Japan Ground Self-Defense Force (JGSDF) established a new Amphibious



Republic of Korea Marine Corps assault amphibious vehicles advance past a smoke screen as their crews execute an amphibious landing at Doksuk-ri Beach in the Republic of Korea during Exercise Ssang Yong 2013, an annual bilateral training exercise in the ROK designed to strengthen combat readiness and interoperability of U.S. and ROK forces. (USMC)

Rapid Deployment Brigade in March 2018 designed to capture islands in the event of war.

It has 3,000 personnel across three amphibious regiments, combat landing battalions, artillery, reconnaissance, engineers, communications and logistics units. These are to be equipped with AAV7 amphibious assault vehicles, MV-22B Osprey tiltrotor aircraft, 120mm mortars and boats. One major issue is transportation as the existing three Oosumi-class transport ships are unable to lift the entire brigade, additional commercial high-speed ferries are being rented to fill the gap. Replacement ships have not been included in the most recent Japanese defence programme but this may change if the security situation

worsens.

In what looks like a deployment similar to what an EABO might be like, the JMSDF has already increased its forces stationed on Miyakojima Island part of the Ryukyu archipelago that is part of the First Island Chain and close to Taiwan and south of the disputed Senkaku Islands. The force includes mobile anti-ship missiles, surface-to-air missiles and armoured vehicles. The Izumo-class and the amphibious brigade would be tasked with reinforcing these islands if hostilities break out.

In South Korea the latest Mid-Term Defence Plan (MTDP) released in 2020 signified the intention to procure a light carrier, in a programme known as LPX-II. The new ship design will

be based on the existing two Republic of Korea Navy (RoKN) Dokdo-class (LPX-I) amphibious platform docks (LPDs). With a displacement of up to 40,000t LPX-II will have space for F-35B aircraft and helicopters it could inform the development of USN's planned new CVL. The Dokdo and Marado LPDs each have the capacity for 720 marines and approximately 200 vehicles or Korean Amphibious Assault Vehicles (KAAVs) with two Landing Craft Air Cushion (LCAC) hovercraft to transport them ashore at speed approaching 40kt. There are spots for five helicopters on deck with space for 10 helicopters in total. Also announced in the MTDP is an expansion of the ROK Marine Corps that will receive additional transport helicopters and a new programme for attack helicopters will be initiated. Other items for acquisition include new fast landing ships and the KAAV-II amphibious assault vehicle.

In April Taiwan launched its own domestically built LPD called Yu Shan at the CSBC Corporation shipyard. The vessel is due to enter service with the Republic of China Navy (ROCN) in early 2022. Importantly it includes the capability to launch anti-ship missiles and surface-to-air missiles – a trend that is expected to increase in future amphibious ships to enable improved protection and offensive capabilities. The ship is designed to protect and re-supply Taiwan's islands in the South China Sea and start to replace the ROCN's three existing second-hand amphibious ships. Taipei has a requirement for four such LPDs and as they can host Taiwan marines, AAVs, a Chinook helicopter, medium helicopters and landing craft it represents a considerable uplift in capability and a shift away from a strictly main island defensive posture.

The shift towards making amphibious warfare a priority indicates where the decisive actions are expected to be taken in the Indo-Pacific region. The occupation of islands across the Western Pacific and South East Asia and establishment of EABO by the US and its allies will be essential to success if an initial containment strategy and blockade of China is to be effectively achieved. This not only requires the development of the right amphibious force mix and operational doctrine but the ability to network those units and ensure integration with other services. [AMR](#)



The Japanese Amphibious Rapid Deployment Brigade see here deploying from an AAV7 during its activation ceremony at Camp Ainoura in Japan on 7 April 2018. Most recently the ARDB trained alongside the US III Marine Expeditionary Force's 3D Marine Expeditionary Brigade (MEB) in Yama Sakura 79 – a command and control exercise encompasses large distances using the sea to manoeuvre while establishing expeditionary advance bases in order to occupy key terrain.



SOC PAC KEEN TO SHARE JOINT DOCTRINE AND TRAINING

The return of Great Power competition means that US SOCPAC is more than ever seeking joint training opportunities with regional special forces.

by Andrew White

Special Operations Forces (SOF) offer the US Department of Defense (DoD) a force-multiplying and flexible solution as it pivots towards countering aggression below the threshold of full conflict from the likes of the People's Republic of China (PRC) and the Russian Federation.

As a unifying special operations command in the Indo-Pacific, the US Special Operations Command Pacific (SOCPAC) has become a critical tool for the US DoD and its Indo-Pacific Command (INDOPACOM) as it seeks to sustain relationships with dozens of SOF entities throughout the region, and

counter PRC and Russian Federation activities.

Addressing the AFCEA TechNet Indo-Pacific Conference in Honolulu, Hawaii on 1 March, the US INDOPACOM commander, Admiral Phil Davidson described how SOF comprised an important element of the Joint Force as it seeks to shape the region.

Describing ongoing efforts to overcome shortfalls in the face of this "Great Power Competition", Davidson explained how China remains "emboldened to take action to supplant the established rules-based international order".

The pivot towards operations

associated with the Great Power Competition was first officially discussed by SOCPAC and its regional partners at the Transregional Resistance Working Group (TRWG) in Monterey, California in February 2020.

The event, entitled The Role of SOF and Great Power Competition – Comparative Dialogue of Russia and China, featured the participation of SOF representatives from across the region, including Canada, Estonia, France, Georgia, Japan, Mongolia, New Zealand, South Korea, Sweden, Taiwan, Ukraine, the United Kingdom and the US.

SOCPAC, which is based out of Camp Smith on the Hawaiian island of



Soldiers from 1 Special Forces Group and Thai Special Operations Forces conduct a night mission during the annual Exercise Cobra Gold in February, 2020, in Thailand.

O'ahu, is ideally suited to supporting the INDOPACOM's main effort which is to "provide combat credible deterrence to protect free and open access to trade routes through the air, sea, land, space, and cyberspace".

"To effectively deter, we need to arm the Joint Force with the proper capabilities, capacities, authorities, and indeed the doctrine to support rapid force employment, accurate offensive power, and effective defences," Davidson explained at the AFCEA event.

Supported by SOF elements from the Army's 1st Special Forces Group, based at Torii Garrison; the US Air Force's (USAF's) 353rd Special Operations Group, based at Yokota Air Base; and the US Navy's Special Warfare Unit One, based in Guam; SOCPAC is tasked with strengthening ties with allies and partners throughout the region.

"Our constellation of allies and partners is the backbone of the free and open international order, providing a powerful force to counter malign activity and aggression. We are seeking every

opportunity to increase the frequency and intensity of our combined operations, exercises, and training with our allies and partners," Davidson explained.

"Even in the face of the COVID pandemic, we are increasing our interoperability and compatibility across the region to enhance our capabilities and improve our coordination for competition. This manifests itself in information sharing agreements, foreign military sales, expanded military cooperation, and international security dialogues – such as TechNet – designed to address our mutual security concerns alongside our closest allies and partners."

COVID disrupts training

SOCAP is also able to support INDOPACOM's final focus area which comprises "exercises, experimentation, and innovation" according to Davidson.

"The most effective way to combat the security challenges and demonstrate our resolve in today's dynamic operating environment is through a continuous campaign of joint experimentation and

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Multi-national Special Operations Forces (SOF) participate in a submarine insertion exercise with the fast-attack submarine USS Hawaii (SSN 776) and combat rubber raiding craft off the coast of Oahu, Hawaii during Rim of the Pacific (RIMPAC) exercise, July 2018.

high-fidelity, multi-domain training," he explained.

The ongoing COVID-19 pandemic, however, has restricted efforts in terms of multi-lateral training opportunities in the Indo-Pacific. In May 2020 the Republic of Korea and SOCPAC gave consideration to cancelling all multi-lateral training events over the course of the year - annual events which are conducted both in the Republic of Korea as well as the continental US. The decision was confirmed in August 2020 and followed the cancellation of the *Rim of the Pacific* (RIMPAC) exercise in June/July 2020.

The biennial exercise was once again expected to include a SOF-specific training programme, organised by SOCPAC and led by the Okinawa-based 1st Special Forces Group of the US Army.

Force elements expected to participate include maritime SOF entities from Brazil, Chile, India, Japan, Philippines, Peru and South Korea, with training sites including Joint Base Pearl Harbor Hickam, Marine Corps Base Kaneohe Bay, and Bellows Air Force Base.

The exercise aimed to focus on the "command and control of SOF forces within RIMPAC; multinational interoperability training; direct action raids; and maritime/dive operations", SOCPAC explained to *Asian Military Review*.

Training serials were scheduled to feature Helicopter Assault Force operations; Fast Rope Insertion Extraction from rotary wing platforms; maritime Close Quarter Combat; submarine operations; small boat operations; military freefall, and combat diving.

Example of some recent multi-lateral exercises which have taken place across the Indo-Pacific since the start of the pandemic include a joint training package organised by SOCPAC and featuring Japanese SOF.

Conducted in November 2020 across the Kanto Plain, Japan, the exercise featured the USAF's 353rd Special Operations Group and Japan's Special Operations Group (SOG) who trained in special operations mission planning; parachute insertion of personnel and cargo.

Exercise Keen Sword also provided the opportunity for the SOG to work with the USAF's 320th Special Tactics Squadron, conducting a series of joint Combat Search and Rescue (CSAR) training serials at the Combined Arms Training Centre Camp Fuji.

SOG operators were also able to practise fast rope insertion and hoist training from USAF Bell Boeing CV-22 Osprey tilt-rotors - a capability which has just entered service with the Japanese Self Defence Force (JSDF) and one which provides the SOG and the navy's Special Boarding Unit (SBU) with a crucial tactical insertion/extraction and resupply capability.

Just a month earlier, Japan's SOG also participated in a joint training package aimed at practising an airborne assault on Ryukyu Island.

As SOCPAC exercise officials described to *Asian Military Review*, the exercise was designed to "develop and refine" tactics, techniques and procedures in addition to increasing tactical planning, coordination and interoperability.

SOF operators from the US and Japan inserted onto the island by high altitude low opening parachutes in addition to UH-60L Black Hawk helicopters.

"The ongoing tension around North Korea's nuclear program has added an additional layer of importance to the annual exercise," sources added.

Another nation state currently under threat in the age of GPC is the Republic of China or Taiwan which continues to face invasion by the People's Republic of China (ROC).

Illustrating the threat, the PRC's People's Liberation Army conducted a mock invasion of an island, widely accepted by the world's intelligence community to represent the ROC.

The joint assault, which was conducted at night, feature special operations forces, paratroopers and unmanned aerial vehicles during a 'three dimensional' operation, according to Chinese media sources.

In June 2020, the US Army's 1st SFG published a video on its official Facebook site which featured joint training serials with the ROC's Aviation and Special Forces Command (ASFC).

The serial illustrated US and ROC SOF operators executing a ground assault exercise serial at an undisclosed location. Following the assault, SOF operators were airlifted by Black Hawk helicopters.

SOCPAC is also understood to be advising the AFSC in regards to the foundation of a Joint Special Operations Command which would be capable of bringing together SOF components from the army, navy and air force in order to more successfully execute joint, multi-domain special operations.

Sources described to AMR how such a move would improve the command and control of ROC SOF, particularly in terms of optimism operational effectiveness in asymmetric warfare.

First suggested in the third quarter of 2020, the possibility of a JSOC continues to be considered by the National Security Council with the support of the armed forces. No official indication has been in regards to when the JSOC might be established and when it might achieve an initial operating capability.

Elsewhere, SOCPAC continues to monitor the ongoing security situation along the PRC's border with India.

On 16 June 2020, there was a fatal 'skirmish' between the Indian Army and People's Liberation Army (PLA) in Ladakh on the Line of Actual Control (LOAC).



In October 2019, Teledyne Brown Engineering (TBE) was awarded a contract from the Naval Sea Systems Command (NAVSEA) for the follow-on production of MK11 Shallow Water Combat Submersible (SWCS) Systems. The SWCS System is a manned combat submersible vehicle specifically designed to insert and extract Special Operations Forces (SOF) in high threat areas.

In June 2020 PLA SOF supported a joint training programme with the Tibet Military Command following a fatal skirmish between Chinese and Indian personnel along the border on 16 June 2020 in Ladakh.

Elsewhere, SOCPAC is building up relationships with Nepal which shares a land border with the PRC. Between September and October 2020, SOF operators from the army's 1st SFG trained at the High Altitude and Mountain Warfare School (HAMWS) which belongs to the Nepali Army.

Also featuring SOF representation from Pakistan and Bangladesh, training focused on the execution of offensive operations in high altitude areas and mountainous terrain.

"Recent border skirmishes between India and China demonstrate the strategic importance of these areas. As Great Power competitors test historical borders, the ability to incur costs on forces encroaching through high altitude and mountainous regions remains a principal capability in the defence of sovereignty," revealed a SOCOM source.

Personnel conducted a six-week programme which including "ascending and descending techniques, survival and rescue techniques, use of special equipment and tactics concerning cliff assault in both rock and alpine areas". The exercise culminated in the ascent of the 20,020ft Thorang Peak mountain.

Meanwhile, SOCPAC continues to build up relations with The Maldives

following an exchange with the Maldives National Defense Force (MNDF) in January 2021.

Focused on communications and combat medicine, the exercise involved operators from the 1st SFG and the MNDF's Special Forces although all participating personnel were forced to quarantine ahead of the programme. Tactical communications focused on the extension of line of sight networks through relays; while medical training focused on tactical combat casualty care and evacuation.

SOCPAC's training with the MNDF falls in line with the Framework for U.S. Department of Defense-Maldives Ministry of Defense and Security Relationship which was signed in September 2020. The agreement outlines future "engagement and cooperation in support of maintaining peace and security in the Indian Ocean".

Other regular joint training exercises organised across the Indo-Pacific by SOCPAC include *Cobra Gold* and *Balakatan*.

Cobra Gold is conducted with the Royal Thai Armed Forces every year with a focus on special operations in addition to conventional force operations. The exercise, which is conducted in Thailand, features army, navy and air force teams with a focus on counter-insurgency and counter-terrorism mission sets.

Exercise *Balakatan* last took place between 12-23 April 2021 in the Philippines and again featuring a heavy

emphasis on special operations. SOCPAC components conduct direct action, special reconnaissance and humanitarian aid/disaster relief training serials.

The exercise also demonstrates "cooperation and interoperability between the Philippines and the US, consistent with the Mutual Defense Treaty and Visiting Forces Agreement. This event highlights the two militaries continued commitment to train and share information to improve their ability to coordinate a multilateral response to crisis," SOCPAC officials shared.

Conclusion

Finally, SOCPAC is well positioned to support innovation injections across the Indo-Pacific, particularly in terms of sub-surface capabilities. Examples include USSOCOM's Shallow Water Combat Submersible (SWCS) platform, also referred to as the Mk11 Swimmer Delivery Vehicle, designed for the clandestine insertion of combat divers to avoid detection by enemy forces.

SOCPAC and Naval Special Warfare continue to test initial deliveries of the Teledyne Brown Engineering SWCS out of Joint Base Pearl Harbor Hickam on the island of Oahu. However, due to ITAR restrictions, partner forces across the wider Indo-Pacific (with the exception of five eyes partners including Australia and New Zealand) are unlikely to benefit from any foreign military sale of the technology. **AMR**

TIME TO RESET TRILATERAL RELATIONS

By **Andy Wong**



United States President Joe Biden has made it a top priority of his Administration to repair and re-energise global alliances during its first year in power. This is a necessary strategic and political calculus made in light of growing global security, public health, and environmental challenges that will require cooperation and multilateral contributions. President Trump's 'America first' policy did much to undermine confidence in such relationships over his time in office.

Given that a key challenge is the continuing escalation of geopolitical tensions with China in the Indo-Pacific theatre, U.S. foreign policy is turning towards repairing and strengthening bilateral alliance ties between the U.S. and two of its most important North Asian allies: Japan and South Korea. This effort is not just consigned however, to bilateral U.S. - Japan/South Korean relations, but also in trying to broker renewed political and military cooperation and understanding between these two Asian powers within a trilateral framework with the U.S. as bonding agent.

The new U.S. Secretary of State, Anthony Blinken has picked up from his role as deputy Secretary of State days in 2015 under the Obama Administration by holding regular meetings with top diplomats from Japan and South Korea, alongside U.S. Secretary of Defence Lloyd Austin. Their first trip together to Tokyo and Seoul were calculated to be overt public reaffirmations of trilateral cooperation between the three powers.

Challenges remain however, to make this ambition less than smooth. Historical antipathy and legacies of wartime grievances from WWII still weigh strongly on Japan-South Korea

ties, and there is little current incentive for both powers to seek rapprochement with each other. This is despite North Asia continuing to face increasing levels of naval buildups, and specifically North Korea's renewed missile testing and live-firing in regional waters. During the previous four years under the Trump Administration, the trilateral alliance network had been allowed to fray during the 'American First' foreign policy that prized bilateral direct dealings over multilateral cooperation. These bilateral dealings were often couched in heavily mercenary manners, with the US being singularly focused on both Asian allies paying their fair dues for U.S. military deployments in their countries.

The return to traditional diplomatic and geopolitical motivations for U.S. re-engagement in the Indo-Pacific and with its Asian allies is welcome for reasons of stability and continuity with traditional U.S. foreign policy approaches. Still, South Korea and Japan have to now weigh the possibilities of such a return to form for their trilateral alliance with the US being something that will outlast different US presidential administrations, as well as their renewed security and political calculations as the frontline allies of the US amidst deepening US-China geopolitical and military competition.

Future military developments with Japan also threaten to complicate the U.S. - Japan-South Korea trilateral alliance further, in a political atmosphere that already has precious little room for nuance-understanding, information sharing, and reassurances. Japan and South Korea already have existing information and intelligence sharing initiatives, such as a 2014 trilateral Information Sharing Agreement with the U.S. to monitor North Korean nuclear

and ballistic missiles development, and a bilateral General Security of Military Information Agreement (GSOMIA) which allowed for Japan and South Korea to directly share classified military intelligence with each other. However, as recently as 2019 such intelligence-sharing between the two Asian powers has come close to being permanently undone, when South Korea came within hours of allowing the GSOMIA to expire without renewal after general bilateral ties froze over historical and trade grievances.

The upgrading of the Japanese Maritime Self-Defence Force (JMSDF)'s Izumo-class helicopter-destroyers to become de-facto light STOVL aircraft carriers has also caused disquiet in Seoul. Given historical memories of Japanese military aggression during WWII, the regained capability for what is seen as an offensive striking power in the Izumos being able to deploy F-35Bs is seen by South Korea as more latently worrying for its own security interests than a welcome boost to the combined strategic striking power of both countries. Japanese military observers have long argued that Japan needed to more clearly explain its military acquisitions and upgrades to South Korea, so as to reassure them about such improved capabilities not being an offensive threat aimed at South Korea, however unlikely.

These issues highlight the critical need for the U.S. to get the trilateral alliance back on track not just as a collective whole, but also brokering a renewal of trust and cooperation directly between its allies. Without Japan and South Korea being willing to work hand in glove on common defence, security and geopolitical issues such as North Korea and China, the U.S. will find itself significantly weakened in its goals of containing Chinese influence and power in the region. [AMR](#)

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+66 (0) 2036 0500 ext 212

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