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The Indian Air Force has steadily upgraded its fleet of Su-30 MKI fighters with new engines, a new radar, electronic warfare suite and beyond visual range missiles. (Photo: *Katsu Tokunaga*)

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Editorial

US DECLASSIFIED STRATEGY ALIGNS ALLIES TO KEEP CHINA IN CHECK

How will the change of President in the White House affect existing United States policies and actions in the Indo-Pacific region? It will be interesting to see if recently inaugurated President Biden changes direction away from that laid down by the *US Strategic Framework for the Indo-Pacific* 2018, a document which was surprisingly declassified and made public on 12 January, with few redactions. Traditionally it would not have been due for public release until 2043.

In the document, China is outlined very clearly as the main threat to peace, stability and the continuation of US prosperity. One standout aspect of the document is the emphasis on supporting its regional allies and partners to ensure "a shared vision for a 'free and open Indo-Pacific.'"

"Strengthening the capabilities and will of Japan, the Republic of Korea and Australia" were seen as keystones to "puncturing the narrative that Chinese regional domination is inevitable." Rather than simply lead, the strategic policy saw an alignment with those of heavyweights across the region - Australia, Japan and India - to create a "quadrilateral security framework."

There is commitment to maintaining the "rules based order" and to publicly "show the strings attached to China's 'Belt and Road' Initiative (BRI)." China began its BRI in 2013 as an international development strategy that encouraged and financially rewarded countries for participating. However, it has been accused of leading countries into a 'debt-trap' when loans to Chinese banks cannot be paid back, ensuring China can strong-arm them into assisting its strategic interests.

Taiwan also figured in the document. Assistance would be given to the country (which is claimed by China to be part of its nation like Hong Kong) so that it could "develop an effective asymmetric defense strategy and capabilities that will help ensure its security, freedom from coercion, resilience and ability to engage China on its own terms." Existing alliances with other regional nations including Thailand and the Philippines were also to be strengthened.

The public policy towards North Korea was focused on getting leader Kim Jong-un to cease in his development of nuclear weapons by economic isolation and constraint. One offshoot of this was to try and bring South Korea and Japan closer together, as international relations between the two nations has not been good for some time. However, there has been little progress here that has been publicly announced.

An underlying theme was also to prevent the spread of terrorism by engaging some of the Southeast Asian nations into the anti-Isis (Daesh) coalition.

Ex-President Donald Trump's personal success in the region was limited. His grandstanding with Kim Jong-un appears to have got the US no further forward than when he came to office, apart from giving the North Korean leader the opportunity to be seen as an equal to the US President. Trump's 'America first' policy alienated many of the region's nations who suddenly were not sure of America's loyalty, particularly economically. However, the strategy document seems to have lacked impetus over the last few years. The Biden Administration would be wise to re-evaluate what has been done recently, and which parts need to be urgently reestablished.

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MORE BANG FOR YOUR BUCK

Most Asian nations that operate fleets of legacy fighter aircraft continue to procure upgrade packages to increase capability and the extend service life of their jets. Around the Indo-Pacific, numerous upgrade programmes for American, European and Russian types are underway.

by **Mark Ayton**

One of the biggest fleets of fighter aircraft currently operated by an Asian nation resides in India. Fielding a fleet of 260 Su-30MKI multi-role jets (the last of 272 produced by Hindustan Aeronautics was completed in April 2020, with 12 lost to attrition), the Indian Air Force (IAF) is a major operator of Pavel Sukhoi's best-seller. It is the mainstay of the IAF strike-fighter fleet and will remain so for decades to come. Given its age, the type first entered service in 2002, and the recent cross-border tussles with the People's Republic of China and Pakistan, the IAF needs to maintain the jets in a configuration that provides a combat advantage over Pakistan Air Force (PAF) Lockheed Martin F-16s and JF-17s, and People's Liberation Army Air Force (PLAAF) J-16s, J-20s and Su-35s. Also, the Air Force desperately needs to improve the Su-30MKI's mission availability rates.

Such a need can only be satisfied by a fleet-wide upgrade programme. The IAF has kept the Su-30MKI upgrade programme on its shopping list for several years.

Unofficially known as the Super 30, by the summer of 2019 HAL chairman Shri Madhavan confirmed an engine upgrade, a new radar, electronic warfare suite and beyond visual range missiles are

Katsu Tokunaga

The Indian Air Force has an upgrade programme for the Su-30MKI fleet in its wish list.

included. Some speculate the new engine model is likely to be the Russian NPO Saturn AL-41FS rated at 32,000lb thrust with afterburner, and new radar to be the Tikhomirov NIIP Irbis-E hybrid passive electronically scanned array based on the N011M Bars system.

According to an official HAL presentation, some of the indigenous systems included in the Super 30 upgrade are: upgraded EO/IR targeting system; advanced weapon control system; enhanced electronic warfare suite; digital radar warning receiver; two 230x305mm high-resolution LCDs with a multifunction control panel; AESA radar with LRDE Active Array Antenna Unit (AAAU); new laser-designator pod; new mission computer; new helmet-mounted display system (HMDS); and HAL digital head-up display with 20x30 degree wide field of view

Away from the Super 30 upgrade, the IAF has undertaken successful integration of the 5,500lb (2500kg) air-launched Brahmos/DRDO/NPO Brahmos-A conventionally armed standoff missile, giving the Su-30MKI a lethal maritime strike capability, with an estimated 215nm (400km) range and Mach 3 cruise speed. Integration efforts on the Su-30MKI were completed in December 2019. Release to service was due in late 2020. Two squadrons are expected to be assigned a fleet of 40 Su-30MKIs configured to carry the Brahmos-A missile. Based at Air Force Station Thanjavur in southeast India, 222 Squadron was the first to stand-up in January 2020.

India's Defence Research and Development Organisation (DRDO) has designed the Bharat/DRDO Astra beyond visual range air-to-air missile with all-weather day and night capability. Billed as India's first indigenously-developed beyond visual range air-to-air missile, the Astra was first fired from a Su-30MKI in March 2016, entered production the following year and should be fielded with IAF Su-30MKI squadrons.

Indonesia

Indonesia's Tentara Nasional Indonesia-Angkatan Udara (TNI-AU) operates a mixed fleet of F-16 Fighting Falcons comprising ten Block 15 OCUs acquired in 1989, and 24 Block 25s upgraded to Block 52ID standard. Delivered between 2014 and 2017, all 24 aircraft were upgraded by the US Air Force's (USAF) Ogden Air Logistics Center at Hill Air Force Base, Utah. Each aircraft received a new set of

Republic of Korea Air Force

The US State Department approved a foreign military sale to the Republic of Korea involving the upgrade of 134 KF-16s to an advanced configuration as part of the Republic of Korea Air Force's F-16 Peace Bridge Upgrade programme.

wings, horizontal stabilisers, landing gear, and structural enhancements. Systems installed included a new modular mission computer, Link 16 data link, Raytheon ALR-69 radar warning receiver, Terma ALQ-213 electronic warfare management system, BAE Systems ALE-47 countermeasures dispenser system, and enhancements to the original APG-68 radar.

In February 2020, the first upgraded Block 15 jet made its first flight. Each of the ten remaining Block 15 aircraft are undergoing Lockheed-Martin's Falcon Star mid-life update to bring their service lives up to 8,000 hours including installation of avionics and radar upgrades. Upgrade work is being undertaken by PT Dirgantara Indonesia (PTDI) in partnership with Lockheed Martin and TNI-AU personnel.

The TNI-AU's Skadron Udara 16 (Air Squadron) at Pekan Baru Air Base in Indonesia's eastern island of Sumatra operate the Block 15 OCU aircraft, while Skadron Udara 3 at Iswahyudi Air Base operates the Block 52ID jets.

Japan

Japan's Air Self-Defense Force (JASDF) continues to build-up its Lockheed Martin F-35A Lightning II force at Misawa Air Base, and its Ministry of Defence has overseen a partnership between Lockheed Martin and Mitsubishi Heavy Industries to develop is F-X fighter; the planned replacement for the F-2 fighter in the 2030s timeframe. All Phantom F-4EJs were retired in December 2020 leaving the Mitsubishi Heavy Industries F-15J Eagle as the nation's primary interceptor. Assigned to seven frontline squadrons, another for training and a dedicated aggressor unit, JASDF Eagles are getting old; the first aircraft entered service in 1981, the last aircraft built was delivered in 1999. If the Japanese government decides to continue operating its F-15 fleet, which is especially important given the increasing number of incursions into its air defence identification zone (ADIZ) by Chinese and Russian aircraft, the aircraft will need to be upgraded. In fact, 98 F-15Js were earmarked for upgrade to F-15JSI (Japan Super Interceptor) standard during this decade, but the plan is in doubt because of cost.

According to an 29 October, 2019 release by the US Defense Security Cooperation Agency (DSCO), the upgrade programme includes the APG-82(V)1 active electronically scanned array radar, the Advanced Display Core Processor II (ADCP II) mission system computer, the ALQ-239 Digital Electronic Warfare System; all three systems are standard fits on the USAF F-15EX. Boeing claims the APG-82 radar's antenna is the largest array face currently available on a fighter in the world.

All of the avionic systems on the aircraft, and all data migrating around the aircraft are run by Boeing's ADCP II mission system computer. According to Boeing the ADCP II has gargantuan processing power with the ability to operate at 87 billion instructions per second and enables the full exploitation of the APG-82 radar's ability to track a large number of targets, operating mode simultaneity, and provide increased track data.

Other systems include an ARC-210 digital radio, a selective availability anti-spoofing module for the aircraft's GPS receiver, and a joint mission planning system. Aircraft and munition integration and test support is also provided to include integration of the Lockheed-Martin AGM-158 Joint Air-to-Surface Standoff Missile. That's a big deal. Integration of the AGM-158 on the F-15JSI would make the Eagle Japan's first combat aircraft equipped with an air-to-surface strike capability.

Buried within a media release about a Direct Commercial Sale agreement between Boeing and Mitsubishi Heavy Industries to support Japan's F-15JSI programme, Boeing listed an all-new advanced cockpit system as part of the upgrade. Boeing has developed this advanced cockpit system to ease the

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A rendering of an upgraded Japan Air Self-Defense Force F-15JSI loaded with air-to-air missiles and a single air-to-surface glide weapon on the centreline weapon pylon.

workload in managing the amount of sensor and data fusion provided to the pilot. Assuming the F-15JSI's advanced cockpit is Boeing's Advanced Crew Station (ACS), as fitted in the F-15EX, it will feature a 19x11-inch high-definition display designed and produced by Israeli company Elbit Systems. According to Boeing: "The display integrates tactical data, mission planning and flight information into a complete situational picture, and responds to specific mission phases and pilot controls. Boeing's primary objectives for designing the ACS were to improve the pilot's interaction with the aircraft and operate in synch with the head-up display. These aspects improve the pilot's situational awareness and increase mission effectiveness."

Malaysia

In 1993, the Malaysian government procured eight F/A-18D Hornets. Today the aircraft are assigned to the Royal Malaysian Air Force's (RMAF) 18 Skuadron 'Lipan' based at Butterworth. The squadron is tasked with the all-weather strike role.

In 2017, the Hornets entered a phased upgrade programme that included integration of colour moving map displays and an enhanced IFF transponder. But the larger component of the upgrade involved integration of new weapons and targeting systems. More specifically, Boeing's Joint Helmet-Mounted Cueing System and the ASQ-228 Advanced Targeting Forward-Looking Infrared pod. Weapons integrated were Raytheon AIM-120 AMRAAM and AIM-9X-2 Block II Sidewinder air-to-air missiles, and GBU-31, GBU-32, GBU-38 and GBU-54 Joint Direct Attack Munitions.

Republic of Singapore

Seven years ago, the US State Department approved a foreign military sale (FMS) to Singapore for an upgrade package to provide a fleet-wide upgrade of the Republic of Singapore Air Force's (RSAF) 60 Block 52 and Advanced Block 52 F-16s. Valued at $2.43 billion, the programme includes integration of the Northrop Grumman APG-83 Scalable Agile Beam Radar, an active electronically scanned array type, a new mission computer, and the Joint Helmet Mounted-Cueing System. Weapons being integrated are the AIM-9X Sidewinder air-to-air missile, CBU-105 sensor-fused weapon, GBU-38 Joint Direct Attack Munition and the GBU-49/GBU-50 Enhanced Paveway II dual-mode precision-guided bombs. Integration of an advanced datalink and the GBU-39/B Small Diameter Bomb were added to the programme in a $130 million follow-on request. Two RSAF F-16s are currently conducting a flight test programme with Lockheed Martin from its Fort Worth facility.

Singapore's ST Engineering Aerospace is performing the upgrade work from its Peya Lebar base in Singapore, and expects the first upgraded F-16 aircraft to be rolled out in 2021. This upgrade programme will maintain the F-16-fleet's capability to counter emerging threats into the 2030s when the type is expected to be replaced by the F-35 Lightning II.

Singapore is one of three Asian nations currently undertaking or preparing to upgrade their respective F-16 fleets. Both the Republic of Korea and the Republic of China also have active upgrade programmes.

Republic of Korea

The Republic of Korea Air Force (RoKAF) operates one of the largest F-16 fleets in the world comprising 40 Block 32 F-16C/Ds and 140 Block 52 KF-16C/Ds. Those designated KF-16s were built in country by Samsung and Korea Aerospace Industries (KAI).

On 18 November, 2016 the US State Department approved a foreign military sale to the South Korea involving the upgrade of 134 KF-16s to an advanced configuration similar to Lockheed Martin's F-16V model, one of the most advanced configuration. The sale valued at $1.2 billion is part of the RoKAF's F-16 Peace Bridge Upgrade (PBU) programme originally launched in November 2009 and designed to ensure interoperability with US assets.

The PBU includes an active electronically scanned array radar, a new avionics subsystem, a large-format, high-resolution centre pedestal display, a high-volume, high-speed data bus, the Joint Helmet Mounted Cueing System II, the AIM-120 AMRAAM air-to-air missile and the GBU-31 Joint Direct Attack Munition.

Lockheed Martin expects to complete upgrade of the last of 134 aircraft by November 2025.

In March 2020, the US State Department approved another foreign military sale to the Republic of Korea involving an upgrade package for its fleet of Block 32 F-16s, with an estimated price tag of $194 million.

Systems listed in the notification include the Link 16 datalink, the APX-126 combined interrogator transponder (a Mode 4 and Mode 5 capable system which allows US and allied aircraft to

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Royal Thai Air Force JAS 39 Gripens are set to receive Saab's Material System 20 package according to the service's 2020 White Paper.

conduct combined air operations via Mode 5), an ARC-238 software-defined radio comprising two transceivers, one installed in the avionic bay, remotely controlled, and one installed in the cockpit controllable by the pilot, and frequency hopping algorithms to protect voice and data communications against eavesdropping.

Republic of China

The Republic of China's (Taiwan) remaining fleet of 141 F-16A and F-16B Fighting Falcons is currently part way through the $5.3 billion Phoenix Rising upgrade programme. It was approved by the US State Department back in 2011. As with the Singaporean and Korean programmes, Phoenix Rising includes the Northrop Grumman APG-83 active electronically scanned array Scalable Agile Beam Radar, a new mission computer, updates to the electronic warfare suite and avionics. The integration of the AIM-9X Sidewinder air-to-air missiles and precision-guided Joint Direct Attack Munitions.

The programme experience delays in its initial development stage due the discovery of airframe corrosion and various technical issues. Taiwanese defence company, the Aerospace Industrial Development Corporation handed over the first upgraded Republic of China Air Force (ROCAF) F-16V in October 2018 at its Taichung facility. A further 36 aircraft were due to have been handed over to the ROCAF by December 2020, with the last aircraft due to be completed by 2023.

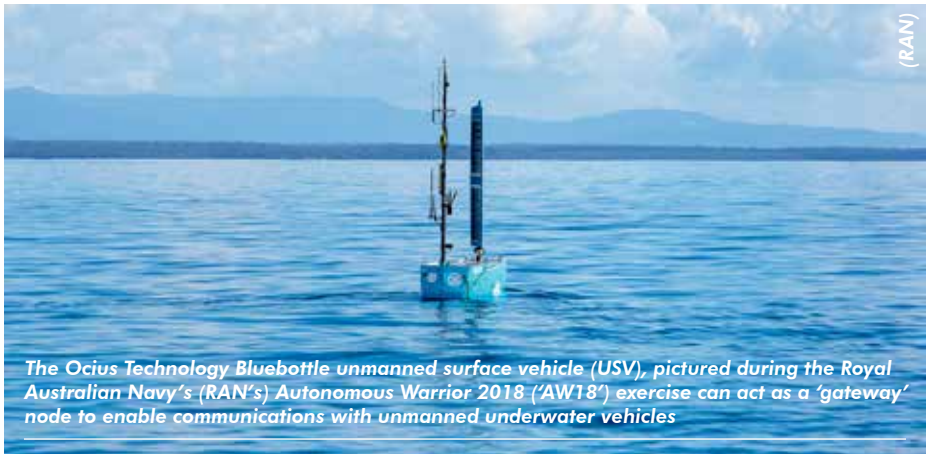
For years, the United States refused to sell to Taiwan new, advanced model F-16s. That all changed in August 2019 when President Trump's administration approved the sale of 66 Block 70 F-16s under the foreign military sale programme named Phoenix Soaring. The programme is valued at $8.1 billion.

More types of weapon are planned for integration on ROCAF F-16 in the medium term. Following US State Department approval in 2017 and October 2020, the ROCAF is due to receive three types of air-to-surface missiles; the Raytheon AGM-154C Joint Stand-off Weapon, the AGM-88 High-Speed Anti-Radiation Missile dubbed HARM, and the AGM-84H Standoff Land Attack Missile Expanded Response missile. The ROCAF requested these weapons as a means to counter People's Liberation Army aircraft ships transiting the Straits of Taiwan.

Thailand

Operating an 11-aircraft fleet, Royal Thai Air Force (RTAF) JAS 39 Gripens are configured with Saab's Material System 19 (MS19). This enabled integration of the Link 16 NATO-standard data link, an ARC-164 Have Quick II secure radio, and night-vision goggles. Additionally, the MBDA Meteor and Diehl BGT Defence IRIS-T air-to-air missiles, and the GBU-49 laser-guided and Enhanced Paveway II GPS-guided bombs were included.

The RTAF 2020 White Paper contained details of the service's aspiration for upgrading the jets to Material System 20 standard. That supports a number of new capabilities including the Mark 4 version of the PS-05/A radar, which Saab claims will double the air-to-air and air-to-ground detection ranges, improve the aircraft's ability to detect targets with a very low-radar cross-section, and facilitates the first operational capability of the MBDA Meteor missile. AMR


(RAN)

The Ocius Technology Bluebottle unmanned surface vehicle (USV), pictured during the Royal Australian Navy's (RAN's) Autonomous Warrior 2018 ('AW18') exercise can act as a 'gateway' node to enable communications with unmanned underwater vehicles

RAN MELDS UNMANNED SYSTEMS INTO NEW MODEL NAVY

The Royal Australian Navy's new strategy for developing unmanned surface and sub-surface systems delivers both capability and capacity to support the navy's new fleet.

by **Dr Lee Willett**

Navies around the world are investing in unmanned systems, to provide short-term fixes for operations today and to grow longer-term capability and capacity to enable a more sustained operational contribution from such systems in the future.

The challenges of operating unmanned systems out of sight – for example, unmanned surface vehicles (USVs) beyond the horizon or unmanned underwater vehicles (UUVs) below the surface – has perhaps contributed to some navies' reticence in fully embracing what unmanned systems can bring. Such reticence can also be explained by some navies having to find a financial and operational balance between investing in unmanned systems or in new manned platforms.

The Royal Australian Navy (RAN), however, is one navy actively introducing unmanned systems for current and future operations, and to augment the output of its people onboard its range of new platforms. The RAN certainly intends to combine its manned navy with new unmanned kit.

Australia's new navy is manifested in different platform types. At the centre of this new force structure are several already-operational platforms: two Canberra-class landing helicopter dock (LHD) amphibious assault ships; and three Hobart-class air-warfare focused guided-missile destroyers (DDGs). These ships will be joined in the medium to longer term by: nine Hunter-class guided-missile frigates, 12 Attack-class diesel-electric submarines, and 12 Arafura-class offshore patrol vessels (OPVs).

The RAN's approach to employing unmanned systems is that it will use such capabilities to integrate and enhance – not replace – the outputs of crewed platforms. This approach was set out in the navy's new unmanned systems strategy, titled RAS-AI Strategy 2040: Warfare Innovation Navy, published in October 2020.

Fighting and thinking

RAN Chief of Navy Vice Admiral Michael Noonan sees his service as a 'fighting' and a 'thinking' force. In this context, the Chief noted (in his Foreword to the strategy) that, "As a fighting and thinking navy, we must leverage these advances [provided by unmanned systems] to … transform, and improve, our ability to fight and win at sea." Such advances must be leveraged, he continued, to support delivery of the five 'Navy Outcomes' (also known as 4PC): force protection; force projection; partnership to improve joint force integration; maximising force potential; and control (namely, sovereign capability).

The RAS-AI Strategy 2040 defines the challenges and opportunities presented by unmanned systems, and sets out how the RAN aims to develop lines of effort to realise their benefits, especially in enhancing warfighting output and the role of people therein. "In embracing technology, we must remember that warfare is, and will remain, a fundamentally human activity. Our people will be at the core of our technological advances, and we must design systems with them at the centre," Vice Adm Noonan wrote. "RAS-AI [Robotics, Autonomous Systems, and Artificial Intelligence] will make our people better warfighters, and will enable us to achieve expanded reach across the region."

In the strategy, the RAN presented its technology context, vision, and design principles for developing its RAS-AI approach and capability. The navy noted that military-off-the-shelf (MOTS) technologies developed by other Australian services or international partners do not necessarily provide the right capability or capacity to meet the limitations, constraints, and opportunities inherent in Australia's unique geostrategic maritime environment. To meet such bespoke needs, the document, while not singling out specific technologies, defined the drivers, trends, and challenges that RAS-AI create for maritime forces, seeking in particular "common enablers that will be required to make the navy 'RAS-AI ready'". Looking out to the 2040 timeframe, the strategy will be supported by a campaign plan consisting of milestones, key performance indicators, lines of effort metrics, and a strategy review (timetabled for 2024).

According to the RAN, the regional geography it operates in is defined by distance and challenging environmental conditions. Across and through this geography, forces (including unmanned


(RAN)

Members of Australian Mine Warfare Team 16, MCDGRP and DSTG conducted initial training on the Bluefin 9 autonomous underwater vehicle (AUV) from a mine countermeasures support boat during Project Sea 1778 development work at Pittwater, New South Wales in early 2020.

systems) must: build common operating pictures; maintain long-range communications; collect, process, and disseminate information in a timely manner; and generate massed effects in multiple locations. Here, the navy noted the role of unmanned systems in operating independently but also in complementing manned platform operations.

In addition, the strategy observed that rapid regional military technological modernisation is reducing strategic warning time. Consequently, unmanned systems need to provide (in operational terms) forward-deployed, wide area, persistent presence, and (in capability terms) a 'toolbox' of agile, flexible systems. Highlighting unmanned systems' role in enhancing crewed platform operations, the RAN assesses that "[the navy] is growing its surface fleet through programmes such as the Hunter-class frigate and the Arafura-class OPV. These systems, however, will require supplementation by RAS-AI to increase presence across Australia's maritime interests."

Across the RAN's vast and complex operating environment, the strategy highlighted the security threat to Australian interests generated by the pace of technology modernisation. Here, the RAN saw a need to "pursue disruptive RAS-AI technologies that have the potential to be 'game changing'". In this context, although the RAN is procuring a range of manned platforms, for unmanned platforms it will "require a system-of-systems acquisition methodology that is not platform centric", underlining the role of unmanned systems as enablers and integrators for crewed platforms.

Mission potential

Set against this context, the RAN sees the mission potential of USVs and UUVs as evolving, from today's operations (using existing technology adapted for naval operations), across likely near-term opportunities (drawing on projects currently in planning), and towards long-term development (subject to technology improvements) out to the 2040 timeframe.

For USVs, the strategy listed current mission profiles as including: intelligence, surveillance, and reconnaissance (ISR) tasks in permissive environments; mine-sweeping; and search and rescue. Likely near-term tasks could include: mine countermeasures (MCM) operations; armed escort; anti-submarine warfare (ASW); air and missile defence sensing; electronic warfare; and remote-controlled


(RAN)

HMAS Sydney (foreground), the RAN's third Hobart-class guided-missile destroyer (DDG), is pictured passing the landing helicopter dock (LHD) amphibious assault ship HMAS Adelaide at the RAN's Fleet Base East, Sydney in 2018.

countering of fast-attack craft (FAC). By 2040, tasks potentially could include: ISR in hostile environments; mine laying; kinetic air- and missile-defence operations; autonomous countering of FAC; and ground attack.

For UUVs, current tasks listed include: MCM; countering deployed sensors; monitoring sub-surface infrastructure and coastal areas; communications relay; decoy tasks; inspection of infrastructure and ship hulls; and oceanographic activities. Near-term tasks could include: long-endurance ISR; tracking submarines to support ASW; countering surface vessels; operating as a communications node to connect other assets; and navigation survey tasks. The RAN sees the long-term potential of UUVs as offering simple but significant impact – providing rapid response, time-critical (and covert) land attack capability.

Thus, the RAN envisions unmanned systems as potentially offering a broad range of significant operational impacts, enhanced when integrated with the platforms in the navy's new force structure. Such vision is also not theoretical. On operations, the RAN, its sister services, and other Australian security agencies are already sharing unmanned systems to provide co-operative capability. The benefits of such technologies are also being tested in extensive experimentation. "To fulfil our potential, we need to engage in constant experimentation, and encourage collaboration and innovation at all levels," Vice Adm Noonan wrote.

Exercising lessons

One of the most significant recent developments for the RAN was Autonomous Warrior 2018 (AW18), which took place in November 2018 off the coast of New South Wales. The culmination of five years work, including the RAN's Hell Bay trials series and Wizard of Aus exercise as well as international activities like the UK's 2016 Unmanned Warrior exercise, AW18 was designed to demonstrate the potential of unmanned systems to transform defence capability and capacity.

As set out in the strategy, and underlining the importance of regular and rigorous testing in developing unmanned systems concepts and capabilities, from 2021 Autonomous Warrior will transition from being a biennial exercise series to a schedule of four annual events. In 2020, the RAN conducted a national Autonomous Warrior exercise to inform development of the four-event series for 2021 (known as AW21). According to the strategy, this evolved schedule for Autonomous Warrior will help the RAN "demonstrate, evaluate, and trial emerging RAS-AI capabilities at a variety of TRL [technology readiness levels]": it will also increase defence and industry collaboration, and RAN familiarity with RAS capability. Such co-operation, the strategy revealed, "will underpin a programme of learning by doing, continuous improvement, and development", and will enable rapid capability introduction.

Shortly after the RAN hosted AW18, Australia's first major RAS programme – MCM capability development, under Project SEA 1905 – was announced. MCM activities are an initial focus for many navies in developing and operating unmanned systems, given particular desire to keep personnel out of harm's way. However, the RAN sees the operational impact of unmanned systems as very wide ranging.

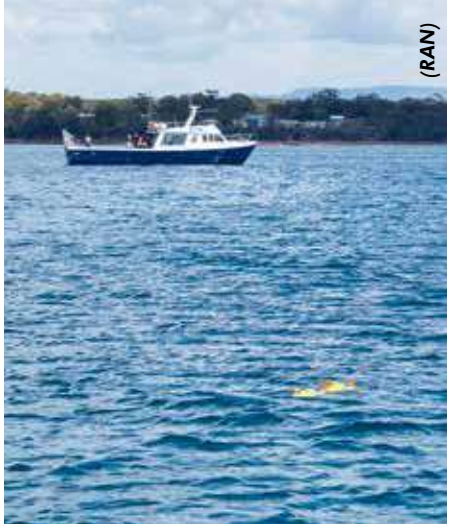
In capability terms, "We envisage there are very few operational tasks that cannot be enhanced by RAS and AI," Commander Paul Hornsby, the RAN's lead for autonomous warfare systems, told AMR. In operational terms, the complexity of the RAN's challenge is emphasised by the fact that it faces security challenges ranging from low- to high-end risks in waters ranging from shallow, archipelagic littorals to deep blue ocean. "While littoral operations are the priority, there are no operational applications that we are not exploring [for] the use of these technologies," Cdr Hornsby added.

Combining the capability and operational requirements, Cdr Hornsby pointed to five primary reasons why RAS-AI technologies are important to Australia. First, Australia has large territories and interests, ashore and at sea, to protect with a relatively smaller population. Second, the need to 'be there' across such territories and interests thus requires a balance between human and autonomous presence. Third, there remains the need to reduce risk to personnel. Fourth, unmanned technologies can enhance platform and people outputs. Fifth, there is technology innovation and sovereign capability value in building systems bespoke for the unique challenges of the RAN's operating environment.

AW18 demonstrated to the RAN not only the 'art of the possible' with unmanned systems, but also the importance of trials. "Perhaps the most important lesson of AW18 was just how important it is to conduct operational experimentation," said Cdr Hornsby. "RAS and AI technology is developing so fast and with such a rapid capability life-cycle that, to stay ahead, we must 'snapshot' emerging technologies alongside leading industry products and operational fleet capabilities."

Reflecting the effectiveness of combining national and multinational activities in the build-up to AW18, Cdr Hornsby said that the rolling 'Autonomous Warrior' programme from 2021 will provide focused domain activities every quarter, with the RAN also continuing to learn from allies and their programmes. For the RAN's own programmes, he explained, "'Unmanned Warrior' was about the acceptance of RAS and AI technologies; AW18 was about the application of these technologies. Subsequent programmes are not just about integration and interoperability but, in the near future, interchangeability."

AW18 and steps forward from it also reflect elements of the RAN's '4PC' Navy Outcomes construct, for example in terms of partnering with other stakeholders and how this is already delivering technology and capability to support operational use of USVs and UUVs. "Since AW18, the RAN and Australia's Defence Department have established three particular means to leverage industry and academic innovation," said Cdr Hornsby. "These are: the Defence Innovation Hub [DIH], which largely deals with smaller turnkey proposals;


(RAN)

A REMUS 100 AUV is pictured conducting sonar and oceanographic survey work during 'AW18'. Australia's Deployable Geo-Spatial Survey Teams (DGST) operates vehicles including the REMUS 100 to support its work.

the Defence Co-operative Research Centre [CRC] for Trusted Autonomous Systems, which deals with larger and more complex partnerships in addition to legal and ethical considerations; and, specific to the RAN, our East and West Coast Centres For Innovation (CFIs), which encourage grass-root proposals from the 'waterfront'." The RAN's two main fleet bases are located on the country's East and West Coasts: Fleet Base East, at HMAS Kuttabul, Sydney, New South Wales; and Fleet Base West, at HMAS Stirling, near Perth, Western Australia.

As regards the impact of the new partnering constructs, "We are getting a lot of winners, and a lot of lessons, from these three entities," said Cdr Hornsby. There are several examples. These include, via the DIH, the RAN and Ocius Technology delivering the Bluebottle USV: the wind-, wave-, and solar-powered vehicle, currently being tested off Darwin on Australia's North Coast, can act as a 'gateway' surface platform to enable communications with UUVs and can also be used for surveillance tasks across the spectrum of operations. Similarly, Defence CRC has enabled the establishment of the 'Autonomous MCM In-A-Day' project, while the two CFIs have also delivered applications for printing unmanned aerial vehicle (UAV) parts.

Programmes and technologies

As the RAN begins to move towards the 2040 timeframe and its vision of what unmanned capabilities could achieve, for the period up to 2030 several key programmes are already underway. Alongside SEA 1905, these are: SEA 1770, seeking to develop capability for rapid environmental assessment; SEA 1778, looking to develop a deployable MCM capability; and SEA 129, developing maritime unmanned tactical aerial systems.

The RAN also is keeping a close eye on emerging technologies that will be central to these programmes. "I would envisage Common Control Systems (CCS) and nanotechnology being fundamental to leveraging unmanned systems, and quantum processing being fundamental to leveraging AI," said Cdr Hornsby. CCS concepts involve the development of a common system for delivering co-ordinated command and control of various different unmanned platforms. Cdr Hornsby also highlighted other technologies that may better enable and integrate the use of USVs and UUVs: "The key ones are underwater communications and combat AI; [these] by requirement need to be as limited as possible. After all, water is never going to be an efficient medium in which to transmit data, by sound or light."

Australia's unmanned capabilities are being driven forward by bottom-up and top-down approaches. In the bottom-up context, such is the progress the RAN has made in developing unmanned capabilities that operational squadrons dedicated to their development and operational use have been stood up. These include 822X Squadron (responsible for UAV capabilities) and Australian Mine Warfare Team 16 (USV and UUV capabilities). These squadrons are now well established, said Cdr Hornsby, although he noted that the navy's Deployable Geo-Spatial Survey Teams (DGST) are perhaps further ahead in applying unmanned capabilities for operations.

In the top-down context, senior officers across the RAN are underlining how unmanned systems have evolved from being 'add-ons' to manned RAN capabilities, to being integral to naval activities. Such a combined bottom-up/top-down approach is enabling the RAN to meet another of its 4PC outcomes: maintaining sovereign control in developing unmanned system capabilities. Overall, taking sovereign steps forward in developing unmanned capability is central to the RAN's strategy. In closing his Foreword, Vice Adm Noonan said "The race in autonomous warfare has already begun. Doing nothing, or waiting for allies to solve our requirements, in not an option." AMR


USAF

An F-35A Lightning II pilot assigned to the 4th Expeditionary Fighter Squadron prepares for a combat sortie in the US Air Force's Central Command area of responsibility 26 April 2019, Al Dhafra Air Base, United Arab Emirates.

NEW DIMENSION TO GULF DEFENCE MARKET

The normalisation of relationships with Israel through the Abraham Accords will potentially stimulate the growth of the defence industry, not least among the signatories.

by **Gordon Feller and Andrew Drwiega**

Leaders in Washington DC have concluded that President Biden will probably not seek to change "the Abraham Accords". Those are the US-brokered agreements of 2020 which normalised Israeli diplomatic relations with the UAE on 13 August, 2020 and Bahrain on 15 September 2020. Sudan normalised relations with Israel on 23 September and a formal letter confirmed Morocco's 'new era of relations' with Israel on 22 December 2020. It was the first breakthrough in the normalisation of relations between Israel and Arab countries since Jordan in 1994. While defence and hi-tech trade did exist 'out of sight' before these Accords and agreements, these public statements will formalise such business into the future.

At the time of their signing, the broad consensus was that these Accords would alter the arms trade dynamic in the region. What might be the expected in the short to medium term is the expansion of not only international defence industries looking to grow their footprints, and their profits, in the Gulf, but also a maturing of the Gulf's own fledgling national defence industries.

Saudi Prince Alwaleed bin Talal once admitted that arms sales in the Middle East and the Gulf are ordinarily "highly secretive and subject to no ministry of finance oversight or controls." Gulf monarchies (plus the governments of the Arab world, Iran, and some developing states) are governed in ways such that that are not subject to the same arms trade rules of the kind prevailing inside NATO members or allies.

Gulf monarchies operate under none of the arms restrictions which most democracies have in place, nor is there any national institution which regulates

The General Atomics Predator XP is an updated version of the Predator RPA. It has been licensed by the US Government for sale to a broader customer base, including Middle Eastern, North African, and South American regions.

arms acquisition standards. In essence, the Gulf's governments have created decision-making processes which are intentionally meant to be opaque. This may continue to cause difficulties for defence manufacturers located in highly regulated countries.

According to a tracker developed by one US-based non-profit, Forum on the Arms Trade, more than $42 billion has been specified in mandatory Foreign Military Sales notifications since 30 March, 2020.

To better understand the impact of the Accords we asked notable experts to provide their views about the interplay between the Gulf's monarchies, the US government, and those defence firms which are looking to sell arms to the Gulf monarchies. These discussions were conducted before the 20 January inauguration of President Biden. Here's what we learned:

Raffaella A. Del Sarto, associate professor of Middle East Studies at The Johns Hopkins University School of Advanced International Studies. Ms Sarto thinks that "it is very unlikely that the Accords will bring any degree of greater transparency to the region. The accords with Israel have further boosted the international reputation of these countries and their image as 'moderate' regimes, especially in the US. They are likely to be seen as real partners in a turbulent region, and the sale of advanced weapons to these countries is likely to increase. In addition, the Accords promise to boost business deals on advanced technology with Israel even further (which were conducted secretively before).

The weapons industry provides huge profits and employment, which is even more relevant in times of economic crises, most recently experienced globally as a result of the COVID pandemic. The Gulf states are key clients as the Middle East is currently one of the most militarised regions in the world.

Dr. Osamah Khalil, associate professor of History at Syracuse University in New York believes that "the Abraham Accords will facilitate greater arms sales to the Persian Gulf region. Even before the agreement, the United Arab Emirates (UAE) sought a greater role in US military planning and operations, and purchased large quantities of US weapons." It also was a consumer of Israeli surveillance technologies.

Bahrain is home to the US Naval Forces Central Command and the US Fifth Fleet, and is responsible for US naval activities in the Persian Gulf, Red Sea, Arabian Sea, and parts of the Indian Ocean. Both the UAE and Bahrain have sought expanded ties with Washington to contain Iran's influence in the region. As demonstrated by the sale of up to 50 Lockheed Martin F-35 fighters, 18 armed General Atomics MQ-9 Predator XP unmanned aerial systems and other defence equipment to the UAE worth around $23 billion, there will be an even greater demand for US and Israeli weapons and technology.

Dr. Eckart Woertz, director of the German-based GIGA Institute for Middle East Studies sees an additional benefit, in that "one aspect of the arms trade in the Gulf is to cultivate foreign alliances, not necessarily to increase military effectiveness."

Dr. William D. Hartung, director of the Arms and Security Program at the Washington, DC-based Center for International Policy does not expect the Abraham Accords to lead to more transparent arms procurement: "They are the result of a pragmatic decision by the governments of the UAE and Israel to publicly align in service of their de facto alliance against Iran; curry favour with the (then) Trump administration; and open up potentially beneficial economic and security ties. For its part,

PRESIDENT BIDEN PAUSES DEFENCE SALES TO SAUDI ARABIA AND UAE

As *Armada International* was going to press news was breaking that newly inaugurated President Biden was pausing arms sales to the United Arab Emirates and Saudi Arabia. These sales and others, such as arms sales to Taiwan, were cleared by ex-President Trump as he neared the end of his tenure as President. As noted elsewhere in this article, this directly impacts high value arms sales including Lockheed Martin F-35As, General Atomics Predator XPs and munitions among many others. Although not specifically mentioned in the announcement, there has been growing concern regarding how the war in Yemen has been fought, particularly with weapons and munitions from arms manufacturers in the West.

With the IDEX and NAVEX 2021 defence exhibitions already reconfirmed to take place at the Abu Dhabi National Exhibition Centre (ADNEC), Abu Dhabi, UAE, from 21 - 25 February 2021, this breaking development is likely to cause considerable confusion for those major defence compa-nies attending.

US Navy

The Ticonderoga-class guided-missile cruiser USS Leyte Gulf transits the Persian Gulf after a port visit. The vessel was on a routine deployment to the US 5th Fleet area of responsibility.

the Israeli government has discussed a countervailing $8 billion arms package from the US, one that would include additional F-35s beyond those it already possesses, along with attack helicopters and other offensive weaponry.

Taufiq Rahim, senior fellow in New America Foundation's International Security programme stated that "the normalisation of relations between the UAE and Israel take a relationship previously in the shadows into the public view, which will inevitably lead to greater attention, security, and ultimately heightened transparency."

Rahim was asked about the possible implications of the Abraham Accords – especially for those who are seeking to encourage more transparency in arms procurement. He thinks that "there will be opportunities for media and academic institutions to openly engage in further exploration of the relationship between the defence sectors …and given the open media in Israel, this will be a natural result."

Dr. Seema Gahlaut, director, Strategic Trade Management Initiative & Senior Fellow, Trade, Technology and Security Program at The Henry L. Stimson Center; a noted expert on munitions export controls and sanctions, was asked about the most likely categories of arms that the US might sell (via the FMS process) or allow its companies to sell via direct commercial sales (DCS) and 600 Series programs (through the Commerce Control List)) to Bahrain. "In 2018, Bahrain's arms imports were reported to be $65 million. These figures do not include military equipment such as small arms and light weapons, trucks, small artillery, ammunition, support equipment, technology transfers, and other services. Some of these excluded categories have been part of what US allies (such as the UK) have been selling to Bahrain for over a decade." Dr Gahlaut says these categories are "now part of the 600 Series in the Commerce Control List, where the traditional emphases has been on promoting US sales, with much lower level of due diligence than the State/DDTC-managed, ITAR-controlled, arms sales."

Dr. Gahlaut concludes that, "on the issue of diversion, Bahrain's own regulatory structures provide some protection: arms, ammunition, explosives and military weapons cannot be imported/exported into/from Bahrain without a No Objection Certificate from the Ministry of the Interior."

While the defence industries of the signatories are all likely to benefit directly from the brokered Accords, international defence manufacturers and suppliers will also find an expanded market which is likely to be less restricted than before. AMR

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DESIGNED FOR SPEED AND OFFSHORE SECURITY

Coastal and fast patrol craft are being increasingly used to protect coastlines and offshore economic assets. Armada talked to Israeli Shipyards' Oded Brier about recent and future developments.

by **Andrew Drwiega**

Israel Shipyards (ISL) has a built a reputation for designing and manufacturing fast attack craft and offshore patrol vessels. At the end of 2019 it was engaged by Israel's Ministry of Defence to design a new advanced combat vessel, the Reshef-class based on the S-72 design, to replace its existing SA'AR 4.5 fast attack missile corvettes. However, in November its flexibility was also proved when the Israel MOD and the Israeli Navy requested ISL to supply of a floating dock and maintenance for 10 years.

Initially established as part of the Israeli Government's defence base, it was privatised in 1995 and is now managed by ex-naval officers. It has been in business by the side of Haifa Bay since 1959, celebrating its 60th Anniversary in 2019. It is on a 330,000 square metres site by the coastline and within the site has up to 45,000 square metres of internal space. Infrastructure includes long deep water docks and a floating dock for repair and maintenance.

The first vessels that it built were SAAR 4 fast attack craft for the Israeli Navy in 1960. The modern day equivalent is the Shaldag fast patrol craft which is capable of speeds up to 50 knots, and offshore patrol vessels (OPVs) that can travel at 24kts. These OPVs can be specified to lengths of 45m, 58m or 62m.

In July 2020 the shipyard announced a contract to supply an West African country with two OPV 45s complete with ongoing support, training and a maintenance programme as part


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Israeli Shipyards

Fast patrol craft such as the Shaldag have been one focus for ISL since its founding in 1959.

of its Logistic Support (ILS) services. The vessels will feature day/night observation systems and a stabilised weapon systems.

Israel Shipyards vice president marketing, Mr. Oded Breier, talked to Armada International about how his organisation was addressing the current and future needs of the Israeli Navy and positioning itself for other international naval customers.

Armada International: How has the product portfolio of ISL changed from five years ago?

Oded Breier: Naturally, developing a new vessel is a long process that involves extensive resources and effort. Nevertheless, over the last five years, ISL was able to develop and lunch two new vessels. The SA'AR S-72 which is a medium-size corvette, that can also serve as an OPV, depends on the required weapons configurations. The SA'AR S-72 was chosen during 2020 by the Israeli Navy and Israeli Ministry of Defense to be the basis from which to develop the Israeli Navy's future platform (Reshef-class) to replace the successful SA'AR 4.5. The SA'AR S 72 will be exceptionally low cost to maintain as a result of its hybrid propulsion system and economic design.

The second vessel that was launched is the OPV-45 which is, like all of our products, based on a combat-proven design and being supervised by the International Association of Classification Societies (AICS). The OPV-45 is a modular and versatile vessel that can conduct a wide range of missions starting from naval operations and homeland security missions, to civilian hydrographic survey, anti-pollution missions, and more. The OPV-45 will be

able to carry up to two 20 feet containers which could be fitted with various configurations, from mission-ready weapons and search and rescue (SAR) equipment to humanitarian support/ disaster relief supplies.

These two vessels expanded the range of solutions ISL provides to it's customers by offering a range from interceptors and fast patrol craft up to larger corvettes and OPV sized vessels.

AI: What are currently building?
OB: As mentioned, the OPV45 was just recently launched and already we have started constructing two vessels for a customer in West Africa. The vessel is built to a unique production method that better enables the vessel to be able to share future transfer of technology (ToT) if required. It also allows ISL to build some compartments and sections outside of our facility to significantly shorten the construction time in special cases. We have had extensive discussions with various customers across the world regarding the OPV45 underlining its cost-effective operation and mission adaptability.

AI: What investments has IS made in specialist machinery so that a new component design can be manufactured?
OB: Although the following year was unorthodox in every single way, ISL managed the situation internally and even made some investments during the year. We are renewing all of our heavy machinery in accordance with the highest standards found in the naval shipbuilding industry in all disciplines, both in terms of software and hard ware.

AI: What does ISL produce that is/or can be unmanned?
OB: Unmanned technology is steadily evolving in the naval and maritime domain and is currently more focused on anti submarine warfare (ASW) and mines counter-measure (MCM) missions, and less on core naval operations. Adding this to the fact that ISL's vessels are relatively large platforms, starting from 25m length overall (LOA) and up to 72m. These vessels are not engineered by design to be unmanned. However, being part of Israel's defense community, we constantly monitor recent developments in the unmanning possibilities and capabilities that will help in the future create operational and mission-ready unmanned vessels.

AI: Where do you see new international business today and into the future? I am think of the international customer tour that you have just completed?
OB: In the foreseeable future, ISL will expand its reach in the strategic markets, which are Africa, Latin, and Central America as well as the Asia Pacific with numerous projects already signed and many more on the line. Additionally ISL will expand collaboration with the supplementary defense industry to maximise the value given in each solution and project. In terms of new markets, the Indian market, as well as the European markets are currently being evaluated. AMR

(French Navy)

The French Navy frigate Courbet, part of the European-led Maritime Awareness mission in the Strait Of Hormuz (EMASOH) escorts a tanker to ensure freedom of navigation in the Persian Gulf and the Strait of Hormuz.

GCC NAVIES BUILD FOR PERSISTENT PATROLS IN HOME WATERS

While international navies provide larger warships to patrol the waters of the Gulf, GCC nations are building their strength to sustain a constant presence.

by **Dr Lee Willett,**

The Gulf region remains a global security hotspot, and its waters are a melting pot of different security challenges. Moreover, the region's security context is in some senses unique: whereas, in other global regions, low- and high-end risks can to a degree be compartmentalised, the restricted geophysical and constricted geostrategic nature of the Gulf's maritime layout means that low-end and high-end maritime challenges to good order at sea are intertwined, creating a highly volatile area of hybrid, 'grey zone' risks.

Lower-end, maritime security-based threats in the region include counter-narcotics and other smuggling across the Northern Arabian Sea as well as other maritime terrorism risks to commercial ships transiting the Straits of Hormuz. At the opposite end of the risk spectrum, the Gulf region reflects the global trend of a return to state-based naval competition: Iran continues to improve its naval potential across the board, while also developing joint capability that poses an anti-access/area denial risk to the Straits of Hormuz; Western navies – notably, the United States Navy (USN), the Royal Navy (RN), and the French Navy (FN) – continue to build permanent high-end naval presence in the region, both at

(Abu Dhabi Ship Building)

UAE Navy's Abu Dhabi-clas Baynunah-class Corvette has multi-mission capabilities including coastal patrol and surveillance, mine detection and avoidance, helicopter operations, and anti-air / anti-surface capabilities.

sea and ashore, to support national and multinational security interests.

GREY ZONE THREAT

In between these two ends of the spectrum, hybrid, 'grey zone' risks are playing out actively at sea across the region. In one of the most prominent recent episodes, in mid-2019 several commercial ships were attacked with explosive devices while at anchor and underway, and others were boarded at sea or were seized with the crew held. These incidents prompted substantial international response, for example with two multinational naval task forces established to increase maritime surveillance and security capacity in the region: the nine-country International Maritime Security Construct (IMSC) – for which Coalition Task Force (CTF) Sentinel is the operational component; and the European-led European Maritime Awareness in the Straits of Hormuz (EMASoH) task force.

These two new task forces sit alongside the maritime security presence already provided by the USN-led, Bahrain-based Combined Maritime Forces (CMF) partnership. With 33 international partners contributing, CMF generates three separate Combined Task Forces (CTFs): the counterterrorism-focused CTF-150; the counter-piracy-focused CTF-151; and the maritime- and wider theatre security-focused CTF-152.

The strategic ethos of many regional and extra-regional navies operating in and around the Gulf region is to provide presence to support both national and multinational maritime security interests. This is reflected very much, too, in the perspective of another key group of navies operating in the region – the indigenous forces of the Gulf Co-operation Council (GCC) navies.

GULF NAVAL STRENGTH

The six GCC members – Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE) – all have naval forces that contribute actively to national and multinational operations in the region.

In the multinational context, for example, five GCC members – Bahrain, Kuwait, Qatar, Saudi Arabia, and the UAE – are also CMF members. Bahrain, Kuwait, Saudi Arabia, and the UAE have all commanded different CTFs at different times. The Saudi Arabian navy and border guard are currently commanding CTF-150 and -152, respectively; the Pakistan Navy is commanding CTF-151.

Across the Gulf region, while the USN, RN, FN, and other Western navies bring the higher-end capability, the GCC navies bring a collection of key maritime security capabilities. Moreover, they have the locality and capacity to bring persistent presence.

The Saudi Arabian navy operates modern frigates, and it (along with the UAE) also has mine warfare and maritime patrol aircraft capability. However, where the GCC navies collectively add prominent capability to


(Abu Dhabi Ship Builders)

Inside one of the construction facilities at Abu Dhabi Shipyards.

the regional maritime security mix is in patrol forces – namely, corvettes, patrol vessels, fast attack craft (FACs), and interceptors. All six bring patrol force in some form. While these forces are a mix of old and new capabilities, some of the new platforms are notable – for example, the Royal Navy of Oman's Khareef-class corvettes and Al-Ofouq-class patrol vessels, and the UAE Navy's Abu Dhabi-class corvette and Baynunah-class FACs. Also of note from a maritime security context, all six GCC member states have a coastguard or maritime police force. This underlines the lower-end capacity GCC naval forces bring in providing maritime security presence across the region. One capability highlight here is the UAE coastguard receiving two new Arialah-class offshore patrol vessels.

When combined with their local presence, the ability of the collective GCC navies to generate patrol force and coastguard capacity at sea adds significantly to the region's maritime security balance.

The CTF Sentinel/IMSC maritime security construct provides a good example of where and how regional navies bring significant security impact. From amongst the six GCC navies, three – Bahrain, Saudi Arabia, and the UAE – are IMSC members. CTF Sentinel's concept of operations is that 'Sentinel' duties – requiring more capable platforms (like destroyers and frigates) to be present in more risky regions (like around the Straits of Hormuz) – are performed by larger navies like the RN and the Royal Australian Navy; 'Sentry' duties – requiring, in principle, patrol forces focused on a wider range of regions to bring surveillance and reassurance presence – are performed largely by the regional navies.

Despite this clear division of labour in a construct like CTF Sentinel, providing more consistent presence more widely across the region will require the GCC navies, individually and collectively, to maintain and augment key capabilities. Such capabilities might include improved sensors and communications – allowing these navies to more ably enhance and share collective understanding of the recognised maritime and common operating pictures. Such enhanced, shared collective understanding of the regional maritime picture is essential to understanding the 'grey zone' risk in particular, and boosting the effectiveness of the presence required to address it. AMR


(US Navy)

The patrol coastal ship USS Tempest (PC 2) transits the Strait of Hormuz acting as an escort on 2 December 2020.

A NEW EQUIPAGE OF THE NIGHT HUNTER

The Mi-28N has been nicknamed the Night Hunter by the Russian troops thanks to its ability to perform combat missions at any time in simple and adverse weather conditions. The same nickname has been inherited by its export version – Mi-28NE.

The Mi-28NE is designed for fire support of the forward land troops and when deployed as a part of anti-mechanized defence, for destruction of armored vehicles, striking low flying and low-speed air targets, carrying air reconnaissance as well as providing target designation to combat helicopters and fixed-wing aircraft. The Night Hunter is heavily armored and features high combat survivability.

The Mi-28NE with dual control system being operated both by the Russian Army and internationally possesses all the functions of the attack helicopter and yet significantly simplifies the training process for military pilots who need flying practice with Night Hunters. Besides in combat operations in case of emergency the aircraft control can be taken by the second crew member.

The Night Hunter has already happened to take part in full-scale combat operations. Apart from destruction of armored vehicles and militants' manpower the Mi-28NE provided fire support in combat operations in urban terrain and traced insurgents' group and individual vehicles.

The experience of military conflicts of the recent years has proved that attack helicopters are deployed in close contact with the enemy.

Anti-terrorist operations have vividly demonstrated that the armed forces of many countries are in burning need for such helicopters, featuring high maneuverability, lethal power and being up-to-date and highly-effective.

The extensive application of the helicopter in local conflicts made it possible for the customers to develop new requirements for the Night Hunter.

The most valuable advantages of the Mi-28NE include not only all-weather and round-the-clock combat application capability but also fire power.

A subsequent upgrade of the helicopter manufactured by Rostvertol PJSC (the leading company of the Russian Helicopters) is primarily focused on the extension of the armament variety. The upgraded Ataka anti-tank guided missiles with laser guidance system and Khrizantema missiles with a dual-control system featuring both radio and laser-beam channels have been incorporated. Deployment of the missiles have enabled the increase of target destruction range up to 10 km. Besides the upgraded helicopter can be equipped with air bombs, which has effectively been proven in local conflicts of the last decade.

The upgraded Mi-28 is outfitted with MR blades of a new design enhancing its performance in high-mountainous and hot-climate areas and expanding helicopter capabilities in terms of performing aerobatics. The stabilizer of the enlarged surface area has made it possible to improve the helicopter controllability. The aircraft is also equipped with more powerful engines and a new Russian-made auxiliary power plant.

Being in step with the times the aircraft has a UAV-link capability.

Today Mi-28NE is becoming more and more widespread. The main customers of the Mi-28NE are foreign MODs. The Russian-made helicopters are traditionally in demand in Asian-Pacific region, Latin America, Middle East, Africa, Asian-Pacific region and CIS countries.

The helicopter operators who have got these modern combat machines believe that this has led to a quantum leap in the development of the national army aviation.

AST

The ARROW-12 RWS was developed by AST of Singapore. It can accommodate 7.62mm, 12,7mm or 14.5mm machineguns in ground vehicle or naval applications. Various optic suites can be provided suitable for day and night engagement.

REMOTE FIREPOWER

Taking a crewman away from a gun allows greater flexibility in the choice of weapon and where it is located.

by **Stephen W. Miller**

The introduction of unmanned or remote weapon stations (RWS) has altered the design parameters available to combat platform designers. Eliminating the human crewmen from the weapon station opens a range of options in configuring the platform to enhance its capabilities and performance. Although the RWS is more generally applied to combat vehicles, its unique attributes are equally relevant to naval craft and even fixed ground sites.

The RWS is built around a weapon, its ammunition storage and feeding, and optics for acquiring and engaging targets. All are integrated into a structure that can be mounted with minimal intrusion onto a platform. Controlling the station and its functions are done remotely. Advances in electro-optics, digital controls and networks, and high definition displays as well as the introduction of stabilisation are resulting in performance of essential tactical tasks equivalent to a manned turret. The RWS is increasingly becoming a preferred solution for light and medium armament. Ground and naval forces in the Asia-Pacific have joined this move with several defence companies in the region taking leading roles in offering unmanned stations.

RWS advantages

A primary benefit of the RWS is the increased flexibility that can be provided in armament. In a combat vehicle, the operator can be positioned

inside protected by its armour while the roof mounting frees interior space. Eliminating the 'crew basket' of a manned station allows a vehicle to carry more infantry or equipment. For a naval vessel the weapon can be placed for optimum coverage without exposing an operator to weather and other adverse conditions. In addition, an unmanned station can, with its lower weight, allow a larger calibre weapon to be employed while staying within the capacity of the platform. Adopting an unmanned, remote weapon can enhance the combat capability and expand mission possibilities of the host platform. The largely bolt-on configuration of the RWS allows it to be relatively easily installed, increasing combat effectiveness with minimal impact on the base design.

The adaptability of the RWS has been further demonstrated with the added integration of guided anti-armour missiles, such as the Raytheon/Lockheed Martin FGM-148 Javelin. Improved optronics, the availability of high-resolution cameras and the introduction of networking that integrates all on-board sensors are addressing one of the past shortcomings of remote and unmanned stations – their ability to maintain adequate situational awareness. New surveillance and target acquisition packages, such as panoramic sights and full perimeter cameras, have come far in compensating for the reduced heads-out observation possible in a manned turret.

On land or sea

The RWS is increasingly common on combat vehicles and naval craft. Often the configurations are quite similar with those for use on the small craft and patrol boats being 'marinised' to resist salt, spray and submerging in rough water. The weapons fit to the RWS range from medium 7.62mm machine guns, to .50 calibre (12.7mm) heavy machine guns, automatic grenade launchers, and 30mm auto-cannon such as the M230 Chain Gun. With a stabilised mount, the operator in a secure position and ability to incorporate both aiming aids and ballistic correction, can provide more accurate and effective fire whatever the platform conditions or movement.

Singapore's ST Engineering has been a leader in RWS technology for some time. Its Adder family offers stations accepting weapons from 7.62 to 30mm. The Adder Micro RWS specifically addresses the need for a station that can be fitted to smaller platforms with lower payloads. An ST spokesperson stated that the "Micro weighs less than 50kg and can be equipped with a servo-driven twin weapon cradle that can accommodate a variety of small arms. Not only can it traverse a full 360 degrees in the azimuth but elevates at angles of -20 to +60 degrees permitting it to engage targets both close-in and at heights above as in cities and mountains." The Adder Micro has been successfully demonstrated on the Milrem unmanned ground vehicle (UGV) in challenging field environments.

Another mid-calibre RWS is the ARROW-12 from Asia Security

ST Engineering

ST Engineering's ADDER is actually a family of RWS ranging from a lightweight single 7.62 machine gun mounting through dual. 50 MG/40mm AGL weapon configurations suitable for installation on wheeled or tracked vehicles.

Australia's EOS Defence has positioned itself as a leader in remote weapon's technology recently being awarded a contract by the Australian MOD to supply its RS200 7.62mm machine gun RWS to equip the Hawkei and Bushmaster vehicle fleet.

Technology (AST), a Singaporean private enterprise. First shown at the Homeland Security Expo Vietnam 2019, ARROW 12 provides both fully automatic and remote manual modes. With the integration of day and night cameras, laser rangefinder as well as ballistic computer, it offers high stabilisation performance and hit accuracy even in adverse environmental and combat situations. Designed in compliance with military standards MIL-STD-810, it is suited for both land and marine applications.

Malaysia, through the local firm DRB-Hicom Defence Technologies (DefTech), manufactures its AV8 wheeled combat vehicle through a collaboration with Turkey's FNSS. One of the AV8 infantry carrier variants mounts a 12.7mm RWS. In 2016, a local Malaysia firm DETRAC, part of the Destini Group, was also reported to be in the final stages of developing such a RWS capable of mounting either the 12.7 or a 40mm AGL which has been displayed.

Singapore's Next Generation Fighting Vehicle – the Hunter – utilises an entirely unmanned weapon turret. The crew are positioned in the vehicle hull and use a suite of networked panoramic, perimeter, and sighting cameras for surveillance and target acquisition and engagement.

Republic of Korea's Hanwha Defense has its own line of RWS. An electric drive RWS fitted with the .50 K6 machine gun and 40mm K4 AGL with elevation from -20 to 60 degrees was developed for the Korean Marines' AAV7A1 amphibious assault vehicle. Being stabilised in two axis with roll compensation with a day camera, thermal night camera, integrated laser rangefinder and automatic target tracker it was specifically optimised to deliver suppressive fire during a beach assault.

Hanwha's own RWS designs have primarily focused on mounting options for the K6 and K4 heavy machine guns and AGLs alone or in combination with advanced optronics for combat vehicle and naval craft. It is noteworthy that Hanwha's Redback candidate for the Australian Force 400 Infantry Combat Vehicle will have an integrated RWS built by Australia's EOS Defence Systems. In addition, the Republic of Korea Army has announced an upgrade to its K1A2 main battle tanks including installation of a turret roof RWS. Hanwha Defense Systems is also currently working with AVP Engineering in Malaysia to develop the Tigon 6x6 armoured combat vehicle. Three types of remote-controlled/ unmanned weapon station possibilities are offered including a 12.7mm machine gun, a 30 mm automatic gun or a 90mm gun. Tigon configurations were displayed at DSA 2018 in Kuala Lumpur.

The Philippine Navy (PN), the Department of Science and Technology's Metals Industry Research and Development Centre, and the Mechatronics and Robotics Society of the Philippines have been collaborating on the the development of an RWS. This project 'Building a Universal Mount for Heavy-Barrel Automated Weapon Integration' (BUHAWI) is part of the broader Self-Reliance Defense Posture Programme (SRDP) intended to enhance domestic defence participation. A prototype mounting the M2 .50 machine gun was demonstrated in January 2020. It is intended for use on warships and patrol vessels.

The Philippine Army has also adopted the RWS. Since 2018 it issued contracts to Israel's Elbit Systems for upgrades to its M113A1 armoured personnel carriers. One involved installing Elbit's Dragon 12.7mm RWS plus its Combat

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NG Battlefield Management System (BMS) while a second mounted a UT-25 unmanned station carrying a 25mm Bushmaster gun onto the vehicles.

Australia's Electro Optic Systems (EOS) has emerged as one of the more innovative RWS developers in the Asian-Pacific region. Its offering ranges from the R400S-Mk2 with a 30mm ATK M230 cannon and the Rada Radar aCHR compact all-threat air surveillance radar system intended for the counter-UAS role to its lightweight R200 7.62mm machine gun system. The latter is being delivered to the Australian Army for its Hawkei and Bushmaster vehicles. More recently EOS debuted its R800, the next generation RWS. An EOS spokesperson explained that "R800 integrates advanced surveillance capabilities including battlefield sector scanning with up to 200 programmable target references allowing rapid engagement of targets directly from surveillance mode. First-round hit probability assured by a ballistic solution that considers weapons, ammunition, range, atmospherics, vehicle attitude and target motion." In addition, EOS is teamed exclusively with Hanwha Defence Australia offering its T2000 turret for Hanwha "Redback" IFV.

The People's Republic of China's NORINCO Naval RWS line is offered for patrol boat applications providing a fully stabilised all-electric powered platform with -5 to +60 degree elevation in a 260kg package. It is suited for fitting machine guns from 7.62 to 14.5mm or automatic grenade launchers. The company is also offering its UW4A RWS armed with a 30mm dual-feed cannon and a 7.62mm co-axial machine gun, although it appears to be primarily for export. It carries 120 ready rounds of 30mm ammunition and 200 rounds of 7.62mm. As common with many RWS of similar design once the ready-use rounds have been expended the crew must expose themselves to reload. It's sighting package includes a day sight, a colour CCD camera, an uncooled thermal imager, and a laser rangefinder which is often included with larger calibre weapons.

Unmanned Weapon Stations

The Unmanned Weapon Station (UWS) differs from the RWS primarily in its configuration. Whereas the RWS is often mounted on a pedestal or cradle, the UWS may replicate a traditional turret layout. In it, however, the crew is positioned separately with only the gun, optics, and ammunition in the turret. All controls are remote. The approach is favoured for heavier, higher performance guns such as the Northrop-Orbital ATK Mk44/XM813 30mm, Oerlikon 35mm, and Bofors 40mm auto-cannon. The approach allows for a large calibre gun that can be fitted to lighter vehicles using the existing chassis.

One of the first introductions of the UWS to a major combat vehicle was in the Singapore Armed Forces Hunter Next Generation Fighting Vehicle (NGFV). The Mk44 30mm armed system places the commander, gunner and driver side-by-side in the chassis. They rely on an array of networked multi-spectrum panoramic, perimeter, and gun mantle cameras to provide situational awareness, surveillance and targeting. The Army selected a customised Raphael Samson Mk II station which is integrated by ST Engineering. Hunter is expected to enter service in 2021.

RWS Sentries

The RWS has found a new application performing the role of a sentry post in perimeter or border security. One of the leading providers of systems for this role is the Republic of Korea's DoDAAM. Its Super aEgis II, introduced in 2010, is typically installed on a tower overlooking the area to be covered. According to CEO, Myung Kwang Chang, it is currently used on the Korean DMZ and in the Middle East, including United Arab Emirates air bases, the Royal Palace in Abu Dhabi, in Qatar and to protect power plants, pipelines and military airbases around the world. The weapon mount itself uses a .50 heavy machine gun with day and thermal cameras. Its principal difference is that the system is provided with image processing intended to detect, acquire, track, identify, and engage any intrusion into its area of coverage. Although in current applications firing is initiated by a human; DoDAAM engineers suggest that the system can act entirely autonomously. As Chang points out: "Our weapons don't sleep, like humans must. They can see in the dark, like humans can't." It could be viewed as the ideal sentry.

The Future

The performance of RWS and UWS, facilitated by advances in associated enabling technologies, are approaching that of the traditional manned station. In cases of naval RWS, although they more costly, an accurate engagement at maximum ranges appears better than with a manned gun. On a combat vehicle they open new armament options and expanded capabilities. Further improvements in situational awareness will only make these capabilities more appealing in the future. AMR

The Philippine Army upgrade of its M113 APC fleet by Elbit Defence includes both .50 and 25mm RWS. The relative straight forward modification illustrates one of the advantages provided by the RWS design.

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The Indian Air Force order for 83 Tejas Mk-1A Light Combat Aircraft (LCA) provided a much-needed boost for local defence industry.

LOOKING INWARD

India's Government is trying to meld its *Atamnirbhar Bharat* Initiative towards its military aviation ambitions.

by **Mike Rajkumar**

India's ongoing border face-off with China along the Sino-Indian border, near the disputed Pangong Lake in Ladakh and the Tibet Autonomous Region, has triggered the Indian Government into a troop build-up to strengthen defences on its Himalayan borders.

The urgent requirement to modernise India's armed forces has been impacted by the slowdown in its economy due to the ongoing COVID-19 pandemic. This has forced the military to prioritise weapons acquisitions. The Government led by Prime Minister Narendra Modi is promoting a policy which provides an impetus to indigenous defence production under its 'Atamnirbhar Bharat' (Self Reliant India) drive to reduce the import of costly defence equipment from abroad.

Reducing imports

The Government has been strongly promoting its Atamnirbhar Bharat initiative and in August, the Ministry of Defence (MoD) released a list of 108 systems and subsystems identified for design and development by Indian industry. The import of these systems would be banned completely by 2021. In December, the Defence Acquisition Council (DAC) led by Defence Minister Rajnath Singh accorded its Acceptance of Necessity (AoN) for procurement of six Airborne Early Warning & Control (AEW&C) Mk-II aircraft under the 'Buy (Indian-IDDM)' category of the new Defence Acquisition Procedure 2020.

While there is no official confirmation yet, it is expected that the earlier Airborne Warning and Control System (AWACS) India programme for which the Airbus A330 had been selected will make way for the AEW&C Mk-II project. The Indian Air Force (IAF) operates three Beriev A-50I Phalcon AWACS and two Defence Research & Development Agency (DRDO) developed AEW&C platforms called 'Netra' based on Embraer EMB-145 aircraft. The Indian AEW&C Mk-II programme however, calls for pre-owned Airbus A-319/321 aircraft from state owned carrier Air India to be used as the platform. The IAF received its second Netra AEW&C aircraft in September 2019 and is slated to add a third, completing the programme. Additional A-50I orders have been in the news for many years, but the contract for two new aircraft to join three of the type already in service, has not fructified.

A major beneficiary of the Atamnirbhar Bharat initiative is state-

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ВОЕННО-ПРОМЫШЛЕННАЯ КОМПАНИЯ
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One of two DRDO developed 'Netra' AEW&Cs operational with the IAF. Indian efforts to develop a homegrown AEW&C/AWACS platform have been hampered by funding constraints and delayed decision making

owned airframer Hindustan Aeronautics Limited (HAL). While much of HAL's history has seen manufacture Russian and British military platforms under license, today it has a credible rotary wing design, development and manufacturing capability and has ironed out production related issues for the Tejas Light Combat Aircraft (LCA), with larger orders expected soon. To overcome the performance limitations of the Tejas Mk-1, the Aeronautical Development Agency (ADA) and HAL have offered the substantially improved Tejas Mk-1A which will feature an Israeli Elta Active Electronically Scanned Array (AESA) radar, new Air-to-Air Missiles (AAM) in MBDA's ASRAAM and the indigenously designed and developed Astra, Self-Protection Jammer (SPJ) along with other improvements. "The contract for the production of 83 Tejas Mk-1A is in final stages and is likely to be signed shortly. HAL has proactively gone ahead with the task of design and development of Mk-1A specific systems like AESA Radar, EW suite etc. The details of prototype roll-out and first flight would be shared after the contract is signed and the relevant steps are worked out," HAL chairman R Madhavan told Asian Military Review..

Tejas is now operational in its Mk-I Initial Operational Clearance (IOC) and Final Operational Clearance (FOC) variants with two IAF squadrons, entering operational service with No. 45 Squadron 'Flying Daggers' in July 2016 and No. 18 Squadron 'Flying Bullets' in May 2020. All 16 aircraft in IOC configuration have been delivered by HAL, which has also started delivery of the FOC standard aircraft. These feature improved weapons capability, an enhanced fight envelope with improved low speed handling and inflight refuelling capability. Production of Tejas twin-seat trainers is also underway, with 16 aircraft having been delivered to the IAF in IOC configuration. Delivery of FOC aircraft is now underway.

An indigenously developed Basic Trainer Aircraft (BTA), HAL's Hindustan Turbo Trainer 40 (HTT-40), is expected to complete developmental trials in 2021. The DAC has already approved the procurement of 106 aircraft and the new type will join the existing fleet of 75 Swiss Pilatus PC-7 MKII BTAs. HAL is geared-up to commence the delivery of aircraft within two years from the placement of the order and plans to attain a peak production rate of 20 aircraft per annum. While initial aircraft production as well as further developmental activities will be carried out at Bengaluru, the bulk production will be done from HAL's Nashik Plant in Maharashtra. Current plans call for major structural components to be outsourced to Indian private sector companies in order to ramp up production capacity. An armed light attack variant of the trainer is also planned for development.

Growing Indigenous Capability

HAL has successfully developed a range of helicopters with five variants of the five tonne Dhruv utility helicopter, followed by the 5.8 tonne Light Combat Helicopter (LCH) and three tonne Light Utility Helicopter (LUH). The airframer has also commenced work on a future replacement for IAF Mi-171V medium lift helicopters under the Indian Multi-Role Helicopter (IMRH) programme which will be in the 8-10 tonne class. An IMRH developmental timeline of eight years at a cost of $1.3 billion (Rs 100 billion) has been indicated by HAL. Design and development of the LCH is now deemed as largely complete and HAL has commenced manufacture for a Limited Series Production (LSP) of the helicopters split between the army and IAF. "We expect to complete deliveries of the LCH in a shorter span of time and it would probably take us a maximum of two years to deliver all LSP LCHs once we receive the contract,"

(IAF)

Air Chief Marshal RKS Bhadauria flew a sortie on the under-development HTT-40 trainer aircraft in Bengaluru on 14 November 2019

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HAL's Light Combat Helicopter (LCH) is the first attack helicopter to land at Indian forward bases on the Siachen Glacier, located at heights in excess of 15,400ft (4,700m) above sea level.

said S Anbuvelan, chief executive officer, Helicopter Complex, HAL. A minimum order for an additional 145 LCH is further expected.

All of HAL's indigenous rotorcraft are powered by Safran Helicopter Engines powerplants. Dhruv Mk-I, Mk-II and its civilian variants are powered by TM333 engines supplied directly by the French engine maker, while the Dhruv Mk-III, MK-IV variants and the Light Combat Helicopter are powered by Shakti (Ardiden 1H1) engines, which are produced in India by HAL. The Ardiden 1U engine which is a variant of Shakti, modified for single engine operation, powers the LUH. "For many years now, we have been producing Shakti (Ardiden 1H1) engine kits to be transformed into Shakti engines by HAL. From 2018, till now we have almost completed the production of the order that came in 2017 for 184 kits, which are is dedicated to the order for 73 Dhruv helicopters from the Indian armed forces," said Benoit Gadefait, vice president Medium Helicopters at Safran Helicopter Engines.

At present, HAL is completing contracts with the Indian Army, Indian Navy and Indian Coast Guard (ICG). The Army has 40 Dhruv helicopters on order, split across 22 MkIII utility variants and 18 MkIV 'Rudra' armed helicopters. The Navy and ICG each have 16 Dhruv MkIII utility helicopters configured for maritime and coastal surveillance missions respectively. HAL inked a contract with the ICG in March 2017 for 16 Dhruv MkIII helicopters. All 16 ALH Mk-III helicopters are planned for delivery by September 2021 and deliveries of the first two helicopters is slated for January. HAL has completed modifications related to upgrading these helicopters with state-of-the-art maritime sensors and

systems and an integrated architecture display system (IADS), surveillance radar, electro optic infra-red (EO-IR) systems, automatic identification system (AIS), 12.7mm cabin mounted gun, high intensity search light (HISL) and so on. The ICG will use the new helicopters to undertake operations ranging from shore and ship borne operations for maritime surveillance, search & rescue (SAR), medical evacuation (MEDEVAC) and casualty evacuation (CASEVAC), logistics support and pollution response sorties.

Coast Guard Awaits

The ICG continues to progress its case for the purchase of 14 twin engine heavy helicopters (TEHH). A Request for Proposal (RfP) was issued to four global vendors in June 2020 and Acceptance of Necessity (AoN) for the purchase was obtained in January 2020. It is understood that the ICG hopes to conclude a formal contract by March 2022, ending a procurement process that began more than a decade ago. Deliveries are slated to take place between 2025-26. Adding to its fleet of soon to be inducted Dhruv MkIII helicopters, the ICG's choice of TEHH will undertake maritime surveillance, SAR, medical evacuation and pollution response missions up to 200 nautical miles (nm) from the Indian coastline.

The ICG is also upgrading its fleet of Dornier Do-228 Maritime Patrol Aircraft (MPA). As per a contract inked in February 2020 with HAL which produces the type under license in India, 17 Do-228s will be receive a mid-life upgrade at HAL's Transport Aircraft Division (TAD) in Kanpur. The first aircraft will enter the upgrade in September 2021 and is due to completed by July 2022. The upgrade of all 17 Do-228s is planned for completion by December 2025. HAL will also upgrade the Do-228s with 20 new systems and sensors including a glass cockpit, new mission management system, pollution surveillance aystem (PSS), 12.7mm gun, and five blade propellers.

Modernising Airfield Infrastructure

The modernisation of Indian military airfields under the Modernisation of Airfield Infrastructure

(MAFI) programme has made significant progress. Phase-I of the airfield modernisation programme, which involved 30 IAF airfields was contracted to Tata Power SED in March

2011 under a $166 million (Rs12.2 billion) contract, which was completed in December 2019. Air Force Station Bhisiana (Bhatinda) an airfield in the Western sector, was selected as the pilot project for the MAFI programme and commissioned in March 2014. Phase-I of the MAFI project also included installation of one Doppler VHF Omni-Directional Radio Range (DVOR)/ Distance Measuring Equipment (DME) at Kochi Naval Base.

Phase-II of the MAFI programme will encompass 37 airfields (24 IAF, nine Navy, and four others) with upgraded navigational aids and infrastructure to enable operations even in adverse weather and poor visibility conditions. The MAFI Phase-II contract valued at $140 million (Rs10.19 billion) was awarded in May 2020 to Tata Power SED, which will manage the turnkey project, including installation and commissioning Cat-II Instrument Landing Systems (ILS), Cat-II Airfield Lighting System (AFLS), DME (High and Low Power), DVOR, Tactical Air Navigation (TACAN) etc, along with integration and calibration of the equipment with Automated Air Traffic Management (ATM) at Air Traffic Control (ATC). The Surveillance Radar Elements (SRE), Precision Approach Radars (PAR), UHF Ground-to-Air Radio sets and Commutated Automatic Direction Finder (CADF) systems are being provided by the IAF.

Procurement Push

The DAC recently accorded its AoN for procurement of new weapons such as the Astra Beyond Visual Air-to-Air Missile (BVRAAM) missile, Smart Anti-Field Weapon (SAAW), Long Rang Land Attack Cruise Missile (LR-LACM), etc. The Astra BVRAAM can be fired from Indian SU-30 MKI, Tejas, MiG-29 and MiG-29 K aircraft. Design and development of the new Indian BVRAAM was undertaken by the Defence Research & Development Laboratory (DRDL) Hyderabad, which comes under the Defence Research & Development Organisation (DRDO) and the manufacturing agency is Bharat Dynamics Limited (BDL), Hyderabad. User trials with the IAF have been completed for the missile, which has a claimed range in excess of 100 km and features midcourse guidance and RF seeker based terminal guidance. The IAF is also upgrading its legacy Pechora Surface-to-Air Missile (SAM) systems, which were acquired around 1987 vintage. Pechora missile system firing units are being digitized as part of a contract inked in September 2020. Further looking to bolster indigenous sourcing of defence equipment, the IAF has awarded Indian industry with orders for prototype design & development of chaff and flares, infra-red search and track (IRST) for its Su-30 MKIs, foldable fiberglass mats for runway repair, 125kg aerial bombs and fuzes. A Technology Development Fund (TDF) managed by DRDO has also been setup by the government. There are presently 18 projects underway and contracts have been awarded to Indian vendors for design and development of Su-30 MKI video processing/switching board and Mirage 2000 engine burner rings.

Despite sustained efforts to increase its defence manufacturing base, India has the dubious distinction of being one of the largest importers of defence equipment in the world. Long delays in finalisation of defence deals, often due to political considerations have also meant that Indian industry rarely has access to state-of-the-art technologies and is yet to achieve the economies of scale needed to reduce the cost of procurement vis-à-vis imported equipment. Much of the equipment often touted as indigenously developed by India's public and private sector companies often features very high levels of import content. It will be a challenging task for the mandarins in the higher echelons of Indian defence planning to balance the conflicting needs of budget pressures, looming obsolescence, and recapitalising large defence fleets with the rapid technology leapfrogs taking place in defence technology today and attendant investments to keep the Indian defence industry relevant for the modern battlefield. AMR

On completion of license production of 222 SU-30 MKIs, HAL will transition to manufacturing Tejas LCAs at its Nashik production facility.

The H-6K variant of China's main strategic bomber.

CHINESE AIR FORCE SPREADS NEW WINGS

China's military aviation industry has evolved from reverse engineering to indigenous design and development.

by **JR Ng**

Chinese airpower took centre stage in the Asia Pacific in the latter part of 2020, as the People's Liberation Army Air Force (PLAAF) repeatedly entered the Republic of China's (ROC, commonly Taiwan's) air defence identification zone (ADIZ). This clearly amounted to a show of force intended to erode not just Taiwanese resolve in resisting Beijing but also the smaller and less well-resourced Republic of China Air Force's (RoCAF's) ability to generate airpower.

The PLAAF show of force reached its peak on 18 September midway through a three-day official visit by US Under Secretary of State for Economic Growth, Energy, and the Environment, Keith Krach. As many as 18 aircraft – including Xian H-6 strategic bombers, single-engine Chengdu J-10 and twin-engine Shenyang J-11 and J-16 multirole combat aircraft – split into five groups which then carried out sorties to the northwest of Taiwan and in the southwest portion of the ADIZ, with some crossing over the median line in the Taiwan Strait.

The next day, another 19 PLAAF aircraft – comprising bombers, combat and patrol aircraft – flew six sorties to an area off Taiwan's northwest and the southwest section of its ADIZ, with several aircraft again flying over the median line.

According to the Federation of American Scientists (FAS), China has perpetrated more than 4,400 intrusions into the ADIZs of Japan, South Korea, and Taiwan since 2013, with Chinese military aircraft often flying routes that consecutively transgress the ADIZs of those countries and pressure their respective air forces.

The PLAAF's aggressive moder-

The Chengdu J-10C features an active electronically scanned array (AESA) radar.

nisation since the 1990s, initially fuelled by Russian combat aircraft and weapon imports but now underpinned by new and increasingly capable indigenous systems, have significantly shifted the aerial balance of power in East Asia and places it in a favourable position to challenge Japanese, South Korean, Taiwanese, and even US regional airpower.

Air superiority

State-owned Chinese military aerospace companies have made some remarkable advancements over the past 20 years, moving up the value-chain from adapting or reverse engineering Soviet and Russian aircraft technology to developing indigenous platforms.

China's military aerospace ambition can be seen in a growing number of local designs, starting from the single-engine Aviation Industry Corporation of China (AVIC) J-10 'Menglong' (Vigorous Dragon) multirole combat aircraft which was developed during the 1980s by the Chengdu Aircraft Corporation (CAC) and entered PLAAF service in 2003. The initial model, the J-10A, was superseded by the improved J-10B with a redesigned airframe and more powerful Russian-made Salyut AL-31FN Series 3 engine which in 2013 provided 134.4kN of thrust.

In terms of radar and avionics, the J-10B has also benefited from a passive electronically scanned array (PESA) version of the original mechanically scanned KLJ-3 radar developed by the Nanjing Research Institute of Electronics Technology (NRIET), an electro-optical targeting suite comprising an infrared search and track (IRST) and laser rangefinder, as well as a rear-aspect missile approach warning system (MAWS).

The latest variant of the J-10 is the J-10C, which made its maiden flight in December 2013 and entered service in April 2018. The J-10C features a new active electronically scanned array (AESA) radar of unknown designation, improved avionics including a new datalink for the PL-15 beyond visual range anti-air missile (BVRAAM).

Ultimately, more than 600 J-10s are expected to enter service with the PLAAF to eventually replace the ageing CAC J-7 fighter-bombers, which entered service in the late 1960s and early 1970s.

CAC has also developed the twin-engine J-20 Weilong (Mighty Dragon), a single-seat multirole fighter with low-observability features such as twin, outward-canted, serrated edge landing gear doors, equipped with a chin-mounted electro-optical targeting system (EOTS) that appears to be comparable to the one found on the Lockheed Martin F-35 Joint Strike Fighter.

Low-rate initial production (LRIP) aircraft are believed to have been fitted

The CAC J-20 is a single-seat multi-role fighter with low-observability features.

with the domestic WS-10B engine, although conflicting reports have also suggested that these LRIP aircraft feature a heavily modified version of the Russian 99M2 (AL-31FM2). However, it is known that serial production J-20s will eventually be equipped with the domestic WS-15 engine that is believed to offer thrust-vector control (TVC) and super-cruise performance. However, such a high-performance domestic powerplant has yet to emerge despite years of investment and development.

Other in-service PLAAF twin-engine combat aircraft include the AVIC Shenyang Aircraft Corporation (SAC) J-11B air superiority fighter, which is essentially derived from reverse-engineered technology from imported and locally assembled Russian Sukhoi Su-27 airframes. Initial deliveries of the type commenced in the late 1990s, followed by a tandem-seat version, the J-11BS, around 2010.

The latest J-11B variant, which reportedly entered serial production in late 2020, features substantial improvements including a strengthened airframe with reduced radar cross-section (RCS), an improved AESA fire-control radar, as well as modernised avionics and the domestically produced Liming WS-10B engine.

SAC has also developed a long-range strike variant of the J-11BS, the J-16, featuring locally developed avionics and weapons as opposed to the mainly Russian-supplied equipment used in the earlier model. The J-16 further improves on the J-11 with an increased stores carrying capacity using 12 hardpoints as opposed to the 10 available to the latter, as well as a wider range of precision guided munitions. With the fielding of the stealthy J-20 for air superiority missions, the type is now considered by many to be an ideal standoff engagement platform comparable to the F-22/F-35 and F-15 mix being explored by the US Air Force (USAF).

A new electronic warfare (EW) variant of J-16, known as the J-16D, was first sighted in December 2015. This model features a shorter nose cone believed to house an AESA radar and large wingtip pods with vertical antennas, as well as the removal of the IRST and cannon for additional EW mission equipment and ventral antennas.

A flurry of upgrades for the type was revealed by Chinese state broadcaster CCTV on several occasions. In March 2019 it reported that a low-observable coating – addressing both the visual and electromagnetic spectrum – has been developed for the J-16 to increase its combat effectiveness and survivability. Footage released in November 2020 highlighted a new helmet featuring a helmet-mounted display system (HMDS) for improved situational awareness. With these, the J-16 is expected to serve as the PLAAF's primary strike platform for the foreseeable future.

Strategic aircraft

The PLAAF's primary long-range bomber is the twin-engine H-6 manufactured by Xian Aircraft Industrial Corporation, which is essentially a modernised variant of the Russian Tu-16 bomber aircraft. Production of the localised H-6A commenced in the late-1960s following several years of assembling and licence-producing Tu-16 airframes, and multiple variants have been introduced since.

These include the H-6H, which entered service in the late 1990s and armed with two optically guided YJ-63/KD-63 land-attack cruise missiles (LACMs), as well as the H-6M, which entered service in 2007 and is equipped with four wing pylons plus new EW and MAWS capabilities. In contrast, the more recent models such as the H-6K uses a glass cockpit with at least five multifunction displays (MFDs) and is the first H-6 to use ejection seats for its four-person crew. Revealed as a prototype in 2007, the H-6K is the most radically modified variant, replacing the traditional glass nose housing the navigator's station with a solid nosecone protecting a large radar – presumably a PESA or even AESA type – and new EOTS. Its Russian-supplied D-30-KP2 turbofans and lighter-weight composites have reportedly extended its range by 30 percent over earlier models with a combat radius of 3,500km.

The latest variant, the H-6N, made its first public appearance in a fly-past for China's National Day Parade on 1 October 2019 armed with two KD-20 and two KD-63 LACMs. This model can be easily distinguished from earlier H-6 variants with its inflight refuelling (IFR) probe above the nose radome, although its key feature is a special concavity in place of the bomb bay doors, enabling it to carry a large external weapon or unmanned aerial vehicle (UAV). The PLA Navy Air Force (PLANAF) also operates this variant, designated the H-6J, with EW pods along with long-range missiles.

The KJ-2000 Y-8 'Moth' Balance Beam (foreground) and KJ-2000 (Mainring) airborne early warning and control (AEW&C) aircraft stand side by side.

"In October 2019, China signalled the return of the airborne leg of its nuclear triad after the PLAAF publicly revealed the H-6N as its first nuclear-capable air-to-air refuellable bomber," the US Department of Defense (DoD) noted in its annual report of the Chinese military.

The PLAAF is expected to field a fully indigenous stealth bomber presently known as the H-20. No official details of its design has been disclosed to date, but it is understood that it is under development by Xian and adopts a flying wing airframe comparable to the USAF's B-2 Spirit and future B-21 Raider strategic bombers.

Logistical and special mission aircraft

The PLAAF's current aerial refuelling aircraft fleet comprises the Xian HU-6 and Ilyushin Il-78M tanker-transporter, augmented by buddy refuelling pods carried by several of its tactical aircraft types. All these employ the probe-and-drogue technique for air-to-air refuelling (AAR) operations and provide the service with a relatively modest ability to sustain its tactical and strategic aircraft further afield.

While no new dedicated AAR platforms are known to be currently in development, a new air refuelling variant of the Xian Y-20 strategic airlifter will be fielded in the near future following indications by PLA officials in recent years.

The existence of a Y-20 based AAR capability was first revealed via commercial satellite imagery of Xian's main production facility at Xian-Yanliang airfield in late 2018, where a Y-20 in PLAAF markings was seen fitted with under-wing inflight refuelling pods. More similarly configured prototypes were seen in the same location throughout 2019, suggesting that flight testing was well under way.

It is believed that this platform will offer a fuel carrying capacity of approximately 90 tons, which will be comparable to the Il-78M and more than three times the HU-6's capacity.

In terms of airborne early warning and command (AEW&C) capabilities, the known types in PLAAF service include the Shaanxi Aircraft Industry Corporation's 'Kongjing' (KJ) aircraft featuring the KJ-200 (Y-8 airframe with a two-planar 'balance beam' AESA radar array), KJ-500 and KJ-2000 (Y-9 and Il-76 with AESA and phased array radar, respectively).

The KJ-500 is the PLAAF's latest AEW&C aircraft.

Meanwhile, CCTV footage in December 2019 revealed that Shaanxi has commenced serial production of Y-9 surveillance/special mission aircraft at a newly created and dedicated assembly line at its Hanzhong facility, with each airframe progressing through five assembly stations before the completed aircraft emerges from the plant. CCTV noted that this approach has enabled Shaanxi to achieve a 30 percent increase in throughput.

The Y-8's platform design is derived from the Antonov An-12 'Cub' and locally manufactured from the early 1970s following several examples bought from the Soviet Union. Production of the Y-9 – a modernised version of the Y-8 – commenced from 2010, with the aircraft entering PLAAF service from around 2012.

The Y-8/Y-9 airframe has also been used for the development of several variants of the 'Gao Xing' series of special mission aircraft, which includes variants specialising in anti-submarine warfare (ASW), maritime patrol, communications intelligence (COMINT), electronic intelligence (ELINT), electronic countermeasures (ECM), and psychological operations (PSYOPS). Externally, these aircraft can be easily distinguished by its physical features, comprising a satellite communications antenna fairing above its rear fuselage; six or more blade aerials above its wing centre section and forward fuselage; a ventral radome beneath its forward fuselage, and a prominent nose radome.

Conclusion

Looking to the future, China has at least two new fighter programmes under way that emphasise low-observability and super-cruise capabilities, active phased-array radar technology, and manned-unmanned teaming (MUM-T).

Already an experience operator of UAVs, the PLAAF appears to have shown interest in stealthy high-altitude long-endurance (HALE) air vehicles, with several major defence companies including AVIC, China Aerospace Science and Technology Corporation (CASC), and China Aerospace Science and Industry Corporation – vying for potential contracts with their own designs. Other novel designs, such as the supersonic 'Wuzhen-8' (WZ-8) reconnaissance UAV have also emerged in recent years.

Although PLAAF modernisation has certainly gained considerable momentum, much work remains to be done as the PLA attempts to boost co-operation between its three services and perform effective joint operations. For example, joint service training with other services – such as the PLANAF – is still in its infancy although this deficiency is gradually being addressed through a focused effort to develop the necessary operational expertise, equipment, and processes to mount attacks on major enemy surface combatants. AMR

SINGAPORE'S NEW AIR DEFENCE UMBRELLA

By Andy Wong

In 2018 the Republic of Singapore Air Force (RSAF) took initial delivery of its newest air defence system, the French MBDA Aster-30 SAMP/T medium-ranged surface-to-air missile system. Since August 2020 the RSAF has been conducting round-the-clock operational deployment of the Aster-30 SAMPT system, and has fully integrated it into the RSAF's Island Air Defence System (IADS).

The Aster-30 SAMP/T was originally procured by Singapore to replace its legacy American I-Hawk PIP III surface-to-air missile system, which has already seen service for three decades with the RSAF. There are several marked benefits that the Aster-30 SAMP/T brings to the table in replacing the I-Hawk PIP III. Firstly, the Aster-30 missile boasts a marked range increase over the I-Hawk PIP III's MIM-23B missile, with a maximum range of up to 120km in comparison with the MIM-23B's 40km. Secondly, the Aster-30 also has a much faster flight speed of up to Mach 4.5, allowing for much faster target interception and less time for enemy aircraft to deploy countermeasures and evade impact. Finally, the Aster-30 is vehicle-mounted atop an 8x8 heavy military transporter truck, with up to eight missiles in individual cells ready to fire at a moment's notice. When compared to the I-HAWK PIP III missile system that is vehicle-towed and with only three missiles at full load, the Aster-30 SAMP/T enjoys greater mobility, allowing for quick relocations to evade enemy artillery attacks and to counter new air threats on different operational fronts with minimum notice.

The Aster-30 SAMP/T system is an important piece of Singapore's latest IADS air defence network. Coupled with the shorter-ranged SPYDER system using Python and Derby missiles from Israel, the Aster-30 SAMP/T represents the outer range layer of Singapore's comprehensive layered ground-based air defence network. Its procurement and subsequent full deployment and integration into IADS gives Singapore one of the longest-ranged anti-air umbrellas in South East Asia, especially when compared to its immediate neighbours, Malaysia and Indonesia. Singapore's pairing of the Aster-30 SAMP/T system with its suite of advanced early warning sensors and radars under IADS, such as the Multi-Mission Radar (MMR) and System for Hybrid Interceptor Knowledge of Recognised Air (SHIKRA) radar, allows for the maximum capabilities of the Aster-30 missile to be utilised in detecting and countering medium and long-ranged aerial threats such as enemy aircraft, air munitions such as cruise missiles and unmanned aerial vehicles (UAVs).

IADS is of critical importance for Singapore's defence interests and combat operational strategy of preemptive defence. It allows for the freeing up of RSAF aircraft assets from conducting combat air patrols over local and battlefield airspace against intruders, and their better utilisation in conducting deep air strikes against enemy rearguard formations and command structures. Furthermore, having one of the longest-ranged "medium-range" air defence network with the Aster-30 SAMP/T system within IADS as a whole also allows for greater operational freedom for Singapore's ground army to operate in the field and prosecute much more aggressive and deep breakthroughs in its manoeuvre-centric warfare strategy. The presence of an effective long-range antiaircraft missile umbrella was key to the lightning success of the Egyptian Army against the Israeli Defence Force and Israeli Air Force during the early stages of the 1973 Yom Kippur War, which neutralised superior Israeli air power over the Suez Canal region deep into the Sinai peninsula and denied their effective usage against quick Egyptian armoured breakthroughs. This would also be the most likely warfare strategy for the Singapore Armed Forces in line with its preemptive defence doctrine.

Singapore's Aster-30 SAMP/T also allows for marked improvement in the RSAF's manning productivity in light of falling manpower numbers due to Singapore's low birth rate and ageing population. Aster-30 SAMP/T is highly automated, allowing for a crew count as low as six to operate the system effectively. It also shares commonality in missile components and can be deployed with the Republic of Singapore Navy (RSN)'s Aster-15 missiles aboard its Formidable-Class frigates, further streamlining Singapore's defence supply chain logistics. This allows for potential cross-utilisation of assets in Singapore's anti-air defence network, with a common medium-ranged SAM missile that can be used on both RSAF and RSN assets hooked up into the SAF's battlespace network. AMR

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