VOLUME 28/ISSUE 6

NOV/DEC/JAN 2020-2021
US$15

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NOV/DEC/JAN 2020-2021
VOLUME 28 / ISSUE 6

ASIAN MILITARY REVIEW

Australian Mine Warfare Team 16, recover a General Dynamics Bluefin 9 AUV from a Mine Countermeasure Support Boat (MCMSB) in January-February 2020. *(Australian Department of Defence).*

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Editorial

STRONGER TOGETHER

Reports of a new defence pact to be signed between the Australian and Japanese Governments by the end of the year is an important sign that nations which are increasingly concerned by China's economic and geographical expansionist ambitions (backed by a build up of military force) are seeking to strengthen alliances in Asia Pacific.

Australian Prime Minister Scott Morrison is expected to travel to Tokyo for a meeting with recently appointed Japanese Prime Minister Yoshihide Suga in the next few weeks "to sign a reciprocal access agreement that has been under negotiation for six years and would codify rules for hosting visiting troops to each other's country for training and operations," reported The Australian Financial Review on 10 November.

While Japan is still fundamentally dedicated to self-defence under Article 9 of the Japanese Constitution, previous Prime Minister Shinzo Abe sought to widen the terms of the armament of Japan's self-defence forces. This is a reaction to increasing Chinese pressure on the Japanese Senkaku Islands, that have been administered by Japan since 1895 (except in the post-World War II period). To the north, Japan is also in dispute over the Kuril Islands, which have been administered by Russia since 1945. Interestingly, in recent years China and Russia have also stepped up their joint exercises around the world.

Joseph Biden, the President-elect of the United States will be almost certain to support this move after he takes office in late January. As this column was being written, President Xi-Jinping of China was still to congratulate Biden on his victory, perhaps surprising after the volatility and unpredictability of the Trump administration. In direct contrast, President Morrison was quick to congratulate Biden on his victory, and extended an early invitation to the new President to visit Australia in 2021 to participate in the 70th anniversary of the ANZUS treaty signed with New Zealand on 1 September 1951.

The establishment of a US Marine Rotational Force based in Darwin, Australia, nine years ago was designed to allow the Marines to undertake regional training, particularly alongside the Australia Defence Forces. The ninth rotation of Marines to Darwin began in June and ended in October this year, notably including the deployment of US Air Force B1 and B2 bombers to participate in exercises. Although only a modest 1,100 personal participated, this could be quickly expanded in the future should the security situation in the region require it. In addition, the intention of the US Department of Defense to integrate the Marine Corps and the US Navy in terms of strategic capability though mutual support and networking is intended to create a US military capability that could be deployed throughout the Indo-Pacific to counter-Chinese forces, if required.

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Tel: 66 (0)-2204 2370, Fax: 66 (0)-2204 2390 -1

Audited Media Association Australia cab

Circulation Audit Board

Controlled circulation: 22,183 (average per issue)
for the period 1st January 2019 to 31st December 2019.
Subscription Information
ASIAN MILITARY REVIEW can be obtained
by subscription. Subscription rate for one year
(8 issues) is U.S.$ 100.00 Readers should
contact the following address:
Subscription Department,
Media Transasia Limited.
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FAST. FORWARD.

Anti-ship missile threats are a significant concern for Western navies. In the Asia-Pacific region, missile capabilities are being deployed to both deter and defend against such threats. Pictured is a Kongsberg Naval Strike Missile (NSM) being tested in an anti-ship role.

DEFEND AND DETER

The air defence threat-and-response equation exists increasingly in integrated layers. *AMR* looks at two examples of how Western navies use missiles to defend against and deter the integrated air threat.

by **Dr Lee Willett**

The expanding levels of naval missile capabilities deployed in the maritime operating environment are both cause and effect of the increasing levels of naval operational focus on such capabilities. Indeed, such developments sit at the centre of increasing naval operational activity levels that are the at-sea manifestation of the returning state-based rivalry in strategic theatres across the world.

The Asia-Pacific region was the first theatre to stage the return of state-based rivalry at sea. From around 2008, China pursued its ambition to build its regional presence at sea; various regional and extra-regional navies have since sought to respond. Today, different navies are operating national and multinational task groups across the region, as countries seek to develop presence and demonstrate power in areas of interest.

Task group operations are central to such developments, and in debates about defending such groups against missile attack. Western naval task groups, particularly those operating in the Asia-Pacific region, have for some time been focused on developing high-end surface-to-air (SAM) missile capabilities to deal with the perceived anti-ship ballistic missile (ASBM) threat. Increasingly in recent years, the broad anti-ship missile (ASM) threat is coming in the form of cruise missiles (ASCMs). Such missiles can be air-, ship-, or submarine-based. Western navies are focused on this threat, including the uncertainty over whether an incoming ASCM is conventional or nuclear. Adversaries' surface ships or submarines are a primary area of focus for Western navies who, in return, are developing their own ASCM capabilities, particularly to deter surface ship-based ASCM threats.

PLAN capabilities

The primary strategic concern for Western navies is the capability developments and operational activities of China's People's Liberation Army Navy (PLAN).

In May 2020, the PLAN's lead aircraft carrier *Liaoning* completed one of its latest deployments, operating in the South China Sea, but was also reported to have sailed close to Japanese and Taiwanese waters. According to reports in the Global Times, the carrier was accompanied by two pairs of escorts: two Type 052D Luyang III-class destroyers and two Type 054A Jiangkai II-class

frigates. Global Times also reported in May that *Liaoning's* sister carrier, *Shandong*, was conducting its first testing and training missions at sea.

China's escort ship fleet, along with its submarine flotilla, carries a range of different ASCM capabilities. These include the YJ-12, YJ-18, YJ-62, and YJ-83 missiles. These and other systems bring a mix of ranges and a mix of sub- or supersonic capabilities. China is also reported to be developing hypersonic ASCMs.

Western presence

Western navies also are routinely operating task groups in the Asia-Pacific theatre. Several groups came together at the US Navy (USN)-hosted *Rim of the Pacific 2020* (RIMPAC 2020) exercise, off Hawaii in August, for a scaled-back version of the annual event (due to COVID-19). Ten participating navies generated 22 surface ships and one submarine.

The Royal Australian Navy (RAN) sent four ships, in a maritime task group (MTG) based around HMAS *Hobart*, one of the RAN's three new guided-missile destroyers (DDGs) that bring specialist anti-air warfare capability within a wider, multi-mission role. Hobart was the first RAN DDG to deploy to RIMPAC and was joined by the ANZAC-class guided-missile frigates HMAS *Arunta* and *Stuart*. The three surface ships were supported by the tanker HMAS Sirius. According to an Australian Department of Defence (DoD) report on 27 August, the group was conducting a regional presence deployment through South-East Asia and the Pacific, including RIMPAC participation.

The RAN is developing different MTG constructs, based either around a Hobart-class DDG or one of its two Canberra-class amphibious assault ships. The RAN's emerging task group presence is one of the most prominent maritime capability developments in the region.

In parallel with this developing task group comes the need to defend them and other ships they operate with. Consequently, significant elements of the RAN's participation at RIMPAC focused on countering the different layers of missile threat, addressing both the threat from incoming missiles and the presence of hostile launch platforms with the RAN's own layers of responses.

In terms of dealing with incoming missiles, Hobart became the first RAN DDG to conduct a live firing at the exercise. According to the Australian DoD report, this involved the ship's Raytheon Standard Missile-2 (SM-2) capability. Arunta successfully fired its Raytheon Enhanced SeaSparrow Missile (ESSM) SAM system, its first ESSM exercise firing since completing the ANZAC Midlife Capability Assurance Programme upgrade: Arunta was the first ship to complete this programme (in mid-2019), and was the first post-upgrade ANZAC to participate in RIMPAC. In a DoD YouTube video, Arunta's commanding officer, Commander Troy Duggan, stated: "We defended the ship using ESSMs against high-speed, remote-controlled drones, demonstrating the lethality of the upgraded ANZAC-class frigate."

In terms of dealing with the platforms that deliver the missile threat, an Australian DoD spokesperson told *AMR* that *Stuart* successfully fired two Boeing Harpoon missiles and co-ordinated the missile firings of three other ships during the exercise's SINKEX serial. The RAN's ANZAC frigates carry the Harpoon Block II ASM.

The RAN's surface fleet is also embarking widely the new Sikorsky MH-60 Romeo Seahawk helicopter which operates from both the DDGs and the ANZACs. It contributes to RAN anti-ship capability with its Lockheed Martin Hellfire air-to-surface missile. At RIMPAC. RAN MH-60Rs conducted successful Hellfire missiles firings

Maintaining and enhancing operational capability and agility is key for navies like the RAN, given continual enhancements and evolutions in the threats they face. "Regional military modernisation, including a range of advanced technologies such as stealthy, long-range, high-speed weapons and advanced strike capabilities, have significant implications for maritime operations," said the spokesperson.

The Royal Australian Navy (RAN) guided-missile destroyer (DDG) HMAS Hobart (foreground) and ANZAC-class guided-missile frigate HMAS Stuart are pictured conducting exercises with US and Japanese naval forces in the Philippine Sea in July 2020, during an extended regional deployment by a RAN task group.

US Navy


Norwegian Armed Forces

NSM is pictured being fired from a surface ship. Deployed in a box launcher, NSM can be launched from both surface ships and trucks, and operates in both anti-ship and land-attack modes.

An effective air-defence capability is essential for surface combatants to protect deployed forces, contribute to the broader joint force integrated air and missile defence [IAMD] capability, [and support] force projection in an increasingly complex maritime environment.

While *Hobart* was busy enhancing its air-defence capabilities, the destroyer's two sister DDGs – HMA Ships Brisbane and Sydney – sailed together for trials, testing the RAN's fit of the USN's Co-operative Engagement Capability (CEC). All three DDGs are fitted with CEC: Australia is the first country outside of the United States to receive and successfully test its CEC capability.

In adding another component to Australia's ability to respond to air-defence and other threats, "CEC combines data from multiple sensors into a single, real-time, composite picture and provides a secure communications capability between Australian and US [CEC-]equipped ships and aircraft," the spokesperson said. "CEC enhances weapon capability by enabling a unit to detect and, if needed, engage a threat identified by another ship or aircraft. CEC and other real-time sensor fusion capabilities will form part of the Australian and allied Joint Integrated Fire Control Capability that will enable the fully networked joint force vision." Such joint and wider combined integration of sensors and shooters will be increasingly critical in Western naval efforts to deter and defend against the missile threat.

Aegis Combat System

For many Western navies, like the RAN and the USN, another central element of this integrated capability for countering the missile threat is the Aegis combat system. On 1 September, Australia announced planned upgrades for the Aegis components of the RAN's air-defence capability.

According to the RAN: "The Aegis combat system upgrade will align the Hobart-class destroyers and the [forthcoming] Hunter-class frigates with the USN Aegis Baseline 9 capability, providing access to the Aegis Common Source Library."

Hobart-class Aegis upgrade work is planned to commence in 2024, said the spokesperson: work will occur in Australia, with the government scheduled to consider location options in 2021.

A RAN statement reads: "The Aegis Common Source Library will enable rapid capability insertion activities to take place, through increased levels of system virtualisation and open architecture, in order to counter emerging threats." Such an evolution of the Aegis combat system means that adding new features to the common source library will be similar to adding 'apps' to a smartphone.

"Additional functionality introduced by Baseline 9 includes improved [IAMD] capability," the a RAN spokesperson. "As forecast in the government's Force Structure Plan 2020, the Aegis combat system upgrade will enable the Hobart


US Navy

The US Navy Independence-class Littoral Combat Ship (LCS) USS Gabrielle Giffords is pictured supporting the navy's Nimitz-class aircraft carrier USS Theodore Roosevelt during operations in the Pacific Ocean in September 2020. Ship-based missile capabilities are key to protecting task groups.


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The Royal Australian Navy guided-missile destroyer HMAS Hobart test fires a Standard Missile-2 (SM-2) during the US Navy-led 'RIMPAC' exercise in 2020. Air-defence capability is central for Western navies in offsetting the integrated air and missile defence threat.

class to employ current and future advanced maritime guided weapons, including extended range SAMs, subject to government consideration."

The Force Structure Plan 2020, published in June, said the Australian government would continue with investment to support "sustainment and upgrades to the three Hobart-class destroyers to maintain these as leading-edge air warfare platforms to protect deployed naval forces." The plan also noted Australian focus on developing a replacement for the DDGs in the longer term, following completion of build-work on the Hunter-class frigates, with the DDG replacement platforms designed "to sustain the navy's air warfare capability". According to the RAN, the Hunter-class frigates are due to begin entering service in the late 2020s; regional media reports suggest the last of the nine new frigates is scheduled for delivery in 2042.

Delivering deterrence

Air-defence capability provides what could be seen as the defensive deterrent element, denying an adversary successful missile strikes. The offensive deterrent element, designed to deny an adversary the ability to operate launch platforms, can be provided by other emerging systems.

Kongsberg's Naval Strike Missile (NSM) is being delivered to the USN for its Littoral Combat Ships (LCSs) through a Raytheon-Kongsberg strategic partnership.

Under a May 2018 contract, box-launched NSMs will equip the USN's two LCS variants, the Freedom and Independent classes. With a range greater than 100 nautical miles (nm), NSM will provide over-the-horizon reach to deliver precision anti-ship strikes, providing improved lethality for LCS but also bolstering both LCS and wider task group survivability both by deterring adversaries and being able to defend against them with stand-off precision strike capability.

Kongsberg's NSM/Joint Strike Missile (JSM) family may appear in the Asia-Pacific region in various forms. NSM is already operational there, with the Independence-class LCS USS *Gabrielle Giffords*, forward deployed at the time on a rotational deployment, becoming in September 2019 the first LCS to receive its full NSM fit.

The USN has also chosen NSM for its future frigates and amphibious shipping. Underlining the increasing levels of 'blue/green' integration at sea, the US Marine Corps (USMC) is also looking to invest in an NSM capability to provide a mobile, land-based system delivering both defensive and offensive support in expeditionary operations.

Another regional LCS platform taking NSM will be the Royal Malaysian Navy's (RMN's) six Maharaja Lela-class ships. These LCSs are based on French company Naval Group's Gowind 2500 design.

NSM's air-based counterpart JSM will also operate in theatre, having been selected for Japan's F-35 fighter aircraft. Hans Kongelf, Kongsberg's Defence and Aerospace Missile Division vice president for Marketing, told AMR that JSM had been specifically designed to be slim enough to fit the F-35's internal weapons bay.

Designing JSM as a slim weapon could, in the future, provide other capability options for Asia-Pacific navies. NSM is deployed in box launchers as a coastal defence system ashore or a surface ship-based anti-ship/land-attack system at sea. Norway and Germany have entered into a strategic partnership to develop naval and other capabilities: under this arrangement, NSM will be fitted to the German Navy's surface fleet; a version of NSM could also equip the new Type 212 Common Design submarine the two countries are building together.

As the weapon will need to be fired from the boat's 533mm standard-sized torpedo tubes, the JSM airframe would be used to provide a submarine-based NSM capability. The development of a submarine-launched NSM may be of interest to several Asia-Pacific navies operating established or emerging submarine forces.

What NSM brings is a rapid response, low-observable, sea-skimming, high-speed manoeuvring capability, able to use an infra-red seeker and autonomous target recognition to find, fix, and strike specific targets. Its land target set, said Kongelf, is air-defence sites including command-and-control nodes.

One of the major recent strategic developments in the Asia-Pacific theatre is China's development of an anti-access/area denial (A2/AD) strategy to restrict in particular the maritime movement of US and partner forces. Overlaid atop this strategy in any regional conflict will be levels of congestion, confusion, and complexity, likely including the denial of data and network access. Here, Kongelf pointed to NSM's ability to operate independently in a denied environment, using its self-contained guidance and target recognition capability. AMR

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PENETRATING MARITIME A2/AD

Increasing the range of air-to-surface missiles has become an important factor in penetrating A2/AD defences, particularly in the maritime environment.

by **Jon Lake**

In the early years of air power, aircraft had to overfly their targets in order to deliver a meaningful effect, thereby exposing themselves to anti-aircraft defences. Even strafing (striking a ground target with gun or cannon fire) usually required the attacking aircraft to fly within the envelope of defensive weapons and systems. More recently, unguided rockets allowed an attacking aircraft to stand off a little further, but with a loss of accuracy and precision such that Royal Air Force (RAF) pilots in the 1980s viewed the unguided rockets such as the Societe Nouvelle des Etablissements Edgar Brandt (SNEB) 2.7 inch (68mm) as an 'area' weapon and not as a precise direct fire weapon like a gun.

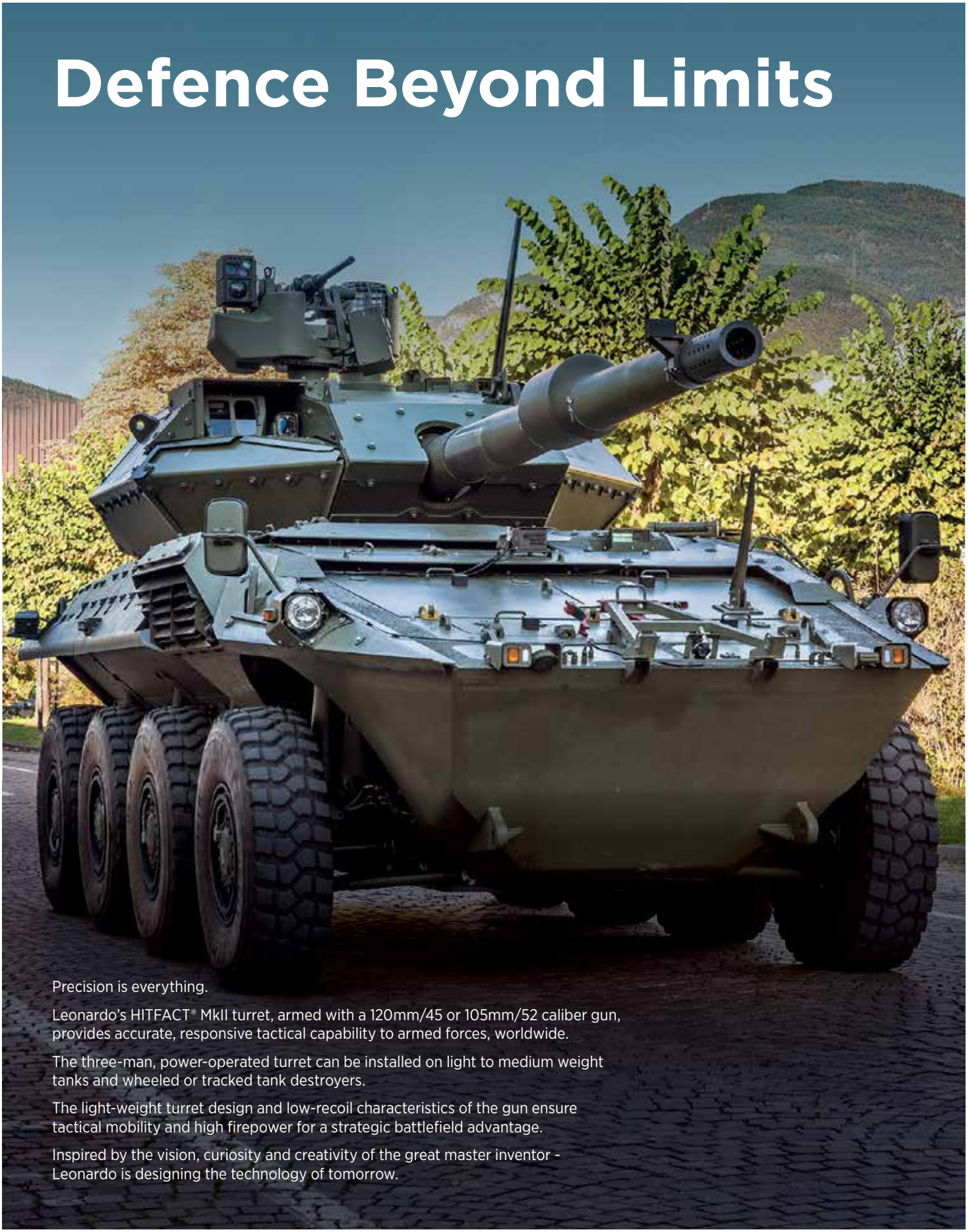
Guided missiles offer greater stand-off range and precision. But because missiles represent a difficult target, it is always preferable to engage the missile launch platform before it has reached its firing point. This has led to the development of longer-range defensive systems which have, in turn, required the production of longer-ranged, faster, lower-flying, and lower signature missiles.

The employment of long-range air launched missiles in much of the Indo-Pacific region is further complicated by China's growing anti-access/area denial (A2/AD) capabilities, which aim to push enemy missile launch platforms further out from Chinese targets, preventing them from operating close enough to China's coast to be able to pose a threat.

The anti-access element of China's A2/AD strategy uses attack aircraft, warships, and submarines, as well as precision-guided ballistic missiles and advanced land-attack cruise missiles to create a heavily contested air and surface environment over a very wide area.

Area denial (the denial of an enemy's freedom of action in areas under friendly control) relies on the use of defensive systems including anti-aircraft fire (AAA), surface-to-air missiles (SAMs),

Defence Beyond Limits



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fighter aircraft, and other air defence systems. In recent years anti-satellite weapons have been added to the mix, giving an ability to disrupt the satellite communications and GPS capabilities on which attacking aircraft, ships and other forces rely.

China's A2/AD bubble

China's occupation and militarisation of islands and reefs in the South China Sea – especially in the Spratly Islands (which China calls the Nansha islands) and the Paracel (Xisha) islands has extended China's A2/AD bubble so that it stretches beyond the so-called first island chain that stretches from the Kamchatka Peninsula to the Malay Peninsula, encompassing the Kuril Islands, Japanese Archipelago, Ryukyu Islands, Taiwan (Formosa), the northern Philippines, and Borneo, and which already includes most of the Yellow Sea, the South China Sea and the East China Sea.

By building advanced airbases that could accommodate tactical aircraft, bombers and missiles on Fiery Cross Reef, Subi Reef and Mischief Reef (all of which lie within the Philippines' 200 nautical mile Exclusive Economic Zone), China has effectively reneged on Xi Jinping's September 2015 assurance that it did not intend to pursue militarisation of the Spratly islands, and has affectively brought the second island chain within China's A2/AD bubble (including the Mariana Islands, with the United States territory of Guam).

A2/AD does not create an impenetrable zone, nor some kind of 'no go area', but it does turn what would have been a permissive operating environment into one that is contested. It does not necessarily prevent enemy forces from operating within a particular area of operations, but it does place them at risk if they do so, and it does severely constrain their freedom of movement and freedom of navigation when doing so. It places even greater emphasis on stand-off weaponry, because long range missiles minimises the launch platform's exposure to enemy defences.

Due to the Missile Technology Control Regime (MTCR) multilateral export control regulations, relatively few Asian air forces have a significant stand-off overland attack capability. Though MTCR was intended to limit the spread of of weapons of mass destruction (WMD), it does so by reducing the proliferation of missiles and missile technology, and specifically targets weapons capable of delivering payloads of 500-1,100lb (500kg) or more over ranges greater than 190 miles (300km).

Apart from China, Australia and South Korea are the main Asian operators of long-range air-to-surface missiles. The Australian government selected the Lockheed Martin AGM-158 Joint Air-to-Surface Standoff Missile (JASSM) in 2006 to equip the Royal Australian Air Force's F/A-18 Hornet fighters. The Hornets had to replace F-111s equipped with AGM-142 Popeye stand-off missiles. The JASSM has a range of 230 miles (370km) and was selected after a KEPD 350 offer was withdrawn by its makers, a joint venture between MBDA Deutschland

Air-to-surface and anti-ship missile inventories, Asia

Australia
c.300 x AGM-84 Harpoon anti-ship missiles
AGM-88 HARM anti-radiation missiles
50 AGM-154 JSOW stand-off glide bombs
260 AGM-158 JASSM stand-off air-to-surface missiles

China
CJ-10K cruise missile, CJ-20 and YJ-100 are related.
YJ-12 supersonic long-range anti-ship missiles
KD-20 (K/AKD20 or DF-10K) long range ALCMs
KD-63 (K/AKD63, or YJ-63) cruise missiles
YJ-83K (C-802) turbojet powered anti-ship missiles
KD-88 anti-ship missile
CM-400AKG supersonic stand-off missile
CH-AS-X-13 anti-ship ballistic missile

India
Kh-31/P anti-radiation missiles
Kh-35 anti-ship cruise missiles
AGM-84 Harpoon anti-ship missiles
BAE Sea Eagle anti-ship missiles
MBDA Scalp cruise missiles
30 Crystal Maze (Raptor) air-to-surface missiles
Brahmos supersonic cruise missiles

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500 BGM-71 TOW anti-tank guided missiles
192 AGM-114 Hellfire anti-tank guided missiles
214 AGM-154A-1/C JSOW stand-off glide bombs
44 AGM-84 Harpoon anti-ship missiles

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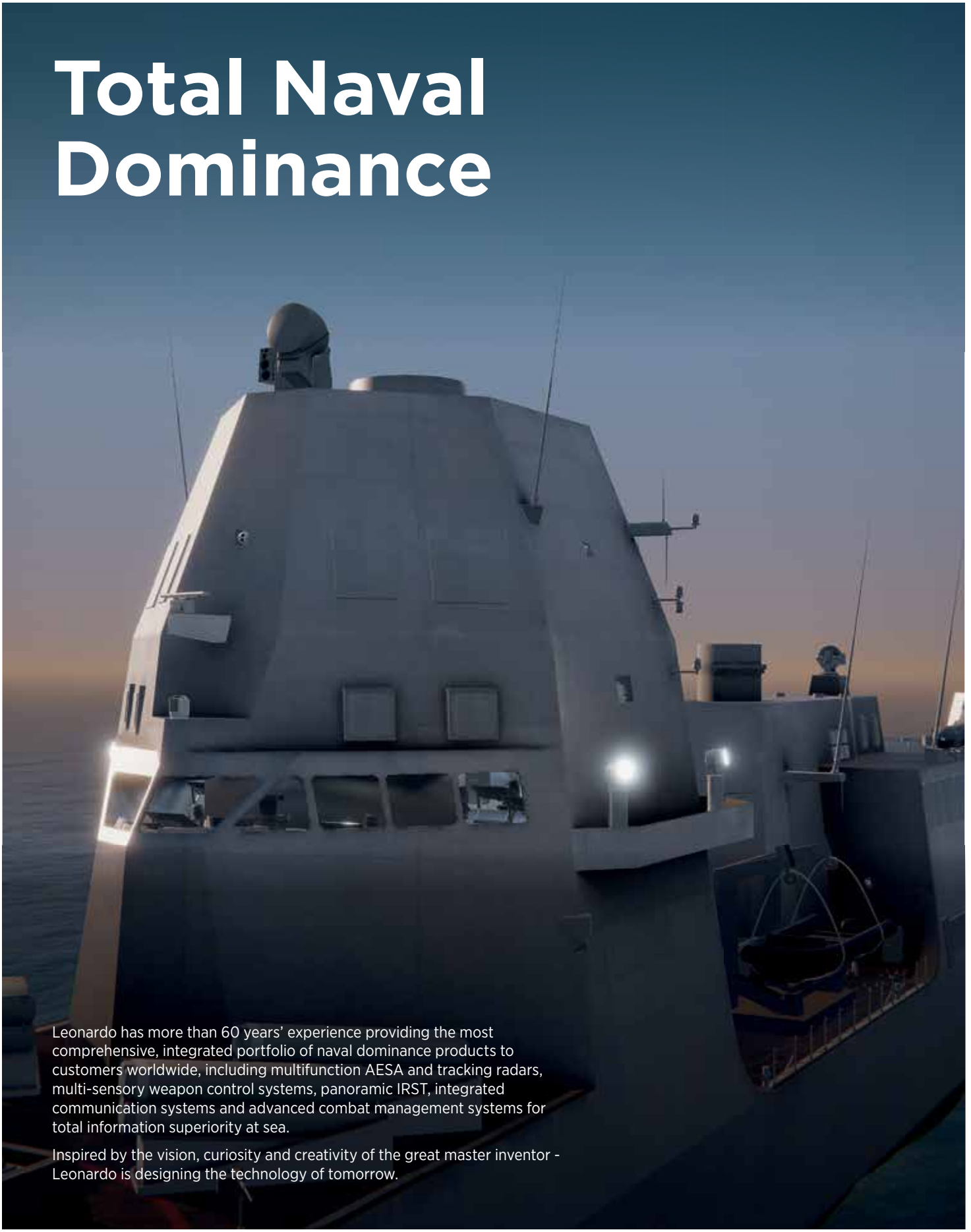

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An ATM-84J Harpoon is released by a RAAF P-8A Poseidon aircraft during RIMPAC 2018.

and Saab Dynamics.

In South Korea, by contrast, the KEPD-350 (which has a range in excess of 310 miles (500km) was chosen after the US refused to supply the JASSM to Seoul. The Republic of Korea Air Force (RoKAF) also operates the shorter-range 155nm (270 km) Boeing AGM-84K Stand-Off Land Attack Missile – Expanded Response (SLAM-ER).

The SLAM-ER uses Global Positioning System (GPS) navigation, and infrared imaging for terminal guidance, and can be used against stationary or moving targets. The weapon has a formidable reputation for accuracy, and achieved the best circular error probable (CEP) of any missile used by the US Navy. The SLAM-ER can be remotely controlled while in flight, and it can be redirected to attack another target after launch if the original target has already been destroyed, or is no longer considered to be a priority. The first two of an eventual 61 F-15Ks were delivered to Korea in October 2005, and the SLAM-ER has been in use by the RoKAF since 2006.

The Taurus KEPD-350E was selected by the RoKAF in 2013, and Korea ordered batches of 177 and 90. The KEPD-350 was designed to penetrate dense enemy air defences using very low level terrain-following flight. The missile was fitted with a two stage Mephisto warhead to attack hard and deeply buried targets. Mephisto was linked to a programmable multi-purpose fuze that used layer counting and void sensing technologies to permit the penetrator to be detonated at a pre-selected floor within the target building or structure.

Both the SLAM-ER and the KEPD-350 are used by the RoKAF's Boeing F-15K Slam Eagle strike fighters, and Korea has now allocated $690 million of funds to develop its own stand-off missile.

Neither the SLAM-ER nor the KEPD-350 have proliferated in the region, though the US Congress approved a potential sale of the SLAM-ER to Taiwan in 2020, and the KEPD-350 has been offered to meet a Japanese requirement to defend its remote southwestern islands (including the Senkaku Islands in Okinawa Prefecture, which are claimed by China as the Diaoyu Islands) in the face of a growing Chinese threat. Japan's government referred to "the Japanese version of the A2/AD", intimating that the procurement of a new land attack missile was a response to China's deployment of cruise missiles. Both the KEPD-350 and the Lockheed Martin AGM-158B JASSM-ER (Joint Air-to-Surface Standoff Missile – Extended Range) are being evaluated for integration on the Mitsubishi F-2A and the Boeing F-15J MSIP (Multi-Stage Improvement Programme).

Otherwise, most of the air launched air-to-surface missiles in service in the region are dedicated anti-ship missiles, or shorter-range weapons, like the Raytheon AGM-65 Maverick and the AGM-154 Joint Standoff Weapon. Though equipped with sophisticated navigation and guidance systems, including a coupled GPS/INS and an infra-red seeker, JSOW is a relatively low cost, highly lethal glide-bomb rather than a missile, and any stand-off range is a function of release altitude and glide performance, though it can be used against land targets from outside the range of enemy point defences. This equates to a range of 15nm (28km) from a low altitude launch and up to 60nm (110km) from a high-altitude launch.

The baseline AGM-154A (JSOW) carries 145 BLU-97/B Combined Effects Bomb (CEB) submunitions, while the newer AGM-154C has an Imaging Infrared (IIR) terminal seeker and a two stage 500lb BROACH warhead, with a shaped charge penetrator and a follow through bomb.

Other interesting ASMs in use in the region include the Rafael Crystal Maze (also known as Raptor), a lightweight derivative of the AGM-142 Popeye developed for carriage by Indian Air Force Mirage 2000s. The weapon has an 80kg warhead and a range of 53nm (100km), and weighs in at just 2,425lb (1,100kg).

Anti-ship

In Indian service, the Crystal Maze is overshadowed by an emerging generation of indigenous weapons, and perhaps most notably by the BrahMos, claimed to be the fastest supersonic cruise missile in the world. The weapon was developed as a joint venture between India's Defence Research and Development Organisation (DRDO) and Russia's NPO Mashinostroyeniya, and is in service equipping the Su-30MKIs of No. 222 Squadron (Tigersharks), part of No.47 Squadron at Thanjavur AFS. BrahMos Aerospace has developed a hypersonic BrahMos-II variant, with a speed of Mach 7-8. This was expected to be ready for testing by the end of 2020.

India deploys a range of anti-ship missiles on different platforms. The Kh-35 is used by the MiG-29K/KUB, for example, while the AGM-84 Harpoon equips the Boeing P-8 Poseidon and the SEPECAT Jaguar IM, in the latter case displacing the BAE Sea Eagle. Sea Eagle may remain in use on the Sea King Mk.42B helicopter and the Ilyushin Il-38.

The Harpoon, however, is much more widely used – and has been acquired by Australia, India, Singapore, South Korea, and Taiwan, for carriage by tactical fast jets and by maritime patrol

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aircraft. More than 7,000 Harpoons have been delivered since the first missile was produced in 1977 - many of them ship- or submarine-launched. New anti-ship missiles are now starting to challenge Harpoon's dominance. Lockheed Martin's AGM-158C Long Range Anti-Ship Missile (LRASM) is a 300nm (560km) derivative of the AGM-158B JASSM-ER, with a multi-mode passive RF system, a new datalink and altimeter, and an uprated power system.

The LRASM will provide improved autonomous targeting capabilities compared to the Harpoon, with better performance and operational effectiveness. In February 2020, the US State Department approved a possible Foreign Military Sale of 200 LRASMs to Australia to equip its F/A-18E/F Super Hornets, and the $990 million sale was confirmed in June 2020, with deliveries scheduled from 2021. Singapore and Japan have also expressed interest in the missile.

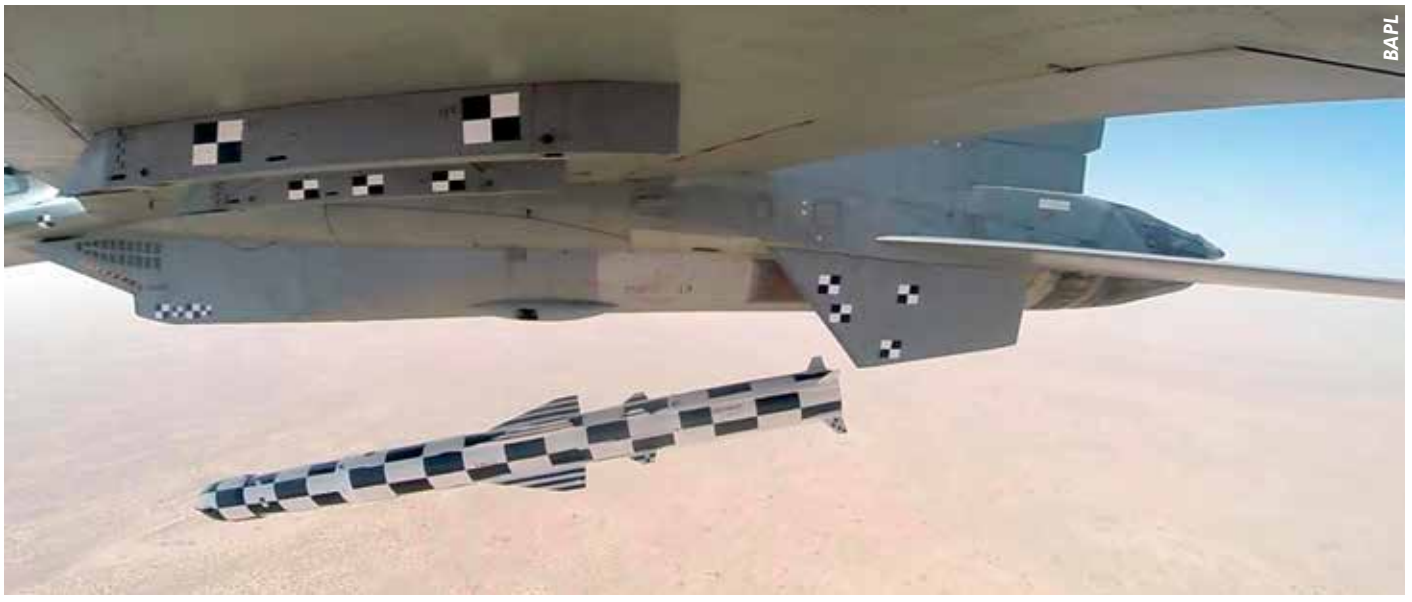
Another new anti-ship missile is the Joint Strike Missile (JSM), the product of a joint venture between Kongsberg and Raytheon. The JSM is rapidly becoming the anti-ship missile of choice for the F-35A, seems likely to be procured by Australia, South Korea and Japan. Kongsberg was awarded a contract to supply the Japan Air Self-Defense Force with initial deliveries of the joint strike missile In March 2019, for delivery from April 2021. Fit checks have reportedly also been undertaken on the F-15 Eagle and F/A-18 Hornet, but actual integration on these types would depend on a firm order.

A RoKAF's Boeing F-15K Slam Eagle strike fighter being fitted with a Taurus KEPD-350E.

Japan is also developing a new generation of indigenous missiles, and work is underway to double the range of the developmental Mitsubishi Heavy Industries XASM-3 supersonic anti-ship missile to more than 400 kilometres.

The production ASM-3 will be integrated on the F-2A, and will replace the older indigenous ASM-1 and ASM-2. Initial Operational Capability was originally planned for 2016, but this was delayed, slipping to 2018 before a major performance upgrade was set in train to address the weapon's relatively short 107nm (200km) range.

Efforts are already underway to produce more radical anti-ship missiles – with hypersonic performance and a host of advanced features, and influenced by weapons like Russia's Kh-47M2 Kinzhal air-launched ballistic missile, which combines Mach 10 speed and over 1,000nm (2,000km) range. AMR



An Indian Air Force Sukhoi 30 MKI test launches a BrahMos air-launched cruise missile (ALCM).

IAI ADDS ASW CAPABILITY TO THE MARITIME HERON

Addressing the increasing role of unmanned aerial systems (UAS) in maritime operations, Israel Aerospace Industries (IAI) has added new capabilities to the Heron family of UAS, preparing the drone to assume anti-submarine warfare (ASW) missions.

The new capability comprises two new payloads – a Sonobuoy Dispensing System (SDS) and Magnetic Anomaly Detector (MAD). This combination enables simultaneous detection and tracking of submarines in shallow and deep waters.

This capability relies on the Heron's key performance parameters – operations from remote locations, fly long missions at extended range and extended persistence over target areas, employing satellite data link, increased payload capacity, and operating simultaneously with multiple sensors.

IAI Elta Systems' ELM-2022U maritime radar provides the primary surveillance sensor on the platform. From a cruising altitude of 20,000 ft. This radar can see across 150 nm to the horizon. The high sensitivity of the radar enables detection and identification of all types of targets encountered at sea, from large vessels classified from a distance using inverse-SAR, to detecting elusive targets with low radar cross-section, such as rubber boats submarine periscopes.

Extending its ASW capability, IAI integrated additional sensors, including a Magnetic Anomaly Detection system and a payload that carries and releases acoustic sonobuoys. After dropping its payload, the Heron loiters over the area to receive and process the acoustic signals picked by the sonobuoys, providing an acoustic situational picture, enhanced by magnetic, radar, SIGINT, and visual sensor indications and tracks. This picture is transmitted to a coastal mission control center or a task force at sea, using the Heron's integral satellite and line-of-sight links.

The Heron gradually evolved to offer a robust, efficient, and flexible maritime operation from shore and sea. Centrally commanded to take off and land from remote shores, Herons extend missions over thousands of kilometers over blue water, using satellite links and handing over control to the operators at sea. With a dedicated mission package and performance capabilities unmatched by other MALE UAS, the Heron now supports both maritime surface and ASW mission capabilities, an order of magnitude better than ASW solutions utilizing manned platforms.

Schiebel

The VTOL S-100 Camcopter from Schiebel is a well established system that has growing prominence in the region, particularly due to its acceptance by the Royal Australian Navy.

NAVIES SURFACE INTEREST IN UNMANNED SYSTEMS

Unmanned systems manufacturers are finding a responsive market for their products among navies in the Indo-Pacific region.

by **Tim Fish**

The expanding use of unmanned systems by naval forces in the Asia-Pacific region is gathering pace. The ability of unmanned air (UAS), surface (USVs) and underwater (UUVs) or remotely operated or autonomous underwater vehicles (ROVs and AUVs) to provide a range of capabilities is being realised.

Some countries are investing heavily in unmanned platforms as a way of plugging a gap in Intelligence, Reconnaissance and Surveillance (ISR) or taking the man out of the minefield in mine countermeasure (MCM) operations. Meanwhile others require unmanned systems to provide coverage over large expanses of maritime territory as a cheaper alternative to expensive manned assets.

The capability of the systems being acquired depends largely on available budgets. At one end of the scale Indonesia, Malaysia, the Philippines and Vietnam have ordered the ScanEagle UAS from Boeing Insitu via a US Foreign Military Sale (FMS) request. Indonesia and the Philippines will get eight each, Malaysia 12, Vietnam six. It is unclear whether deliveries have been completed as Boeing and the US Navy refused to comment.

ScanEagle is a small fixed-wing UAS designed for long endurance naval ISR operations with an assorted array of sensors and uses a catapult for launch and a pole for recovery. It has been in-service for some time with various militaries including the US Navy and is cheap, proven and a reliable option for smaller countries on limited budgets.

The Philippines Air Force is also acquiring nine Hermes 900 Medium Altitude Long Endurance (MALE) UAS and three Hermes 450 tactical UAS from Israeli company IAI along with Skylark UAVs from Israel's Elbit Systems. This will provide a much-needed boost in

Australian Mine Warfare Team 16, operating the Bluefin 9 from a Mine Countermeasure Support Boat (MCMSB) during a Project Sea 1778 equipment application course at Pittwater, NSW in January-February 2020.

maritime ISR for the government in Manila.

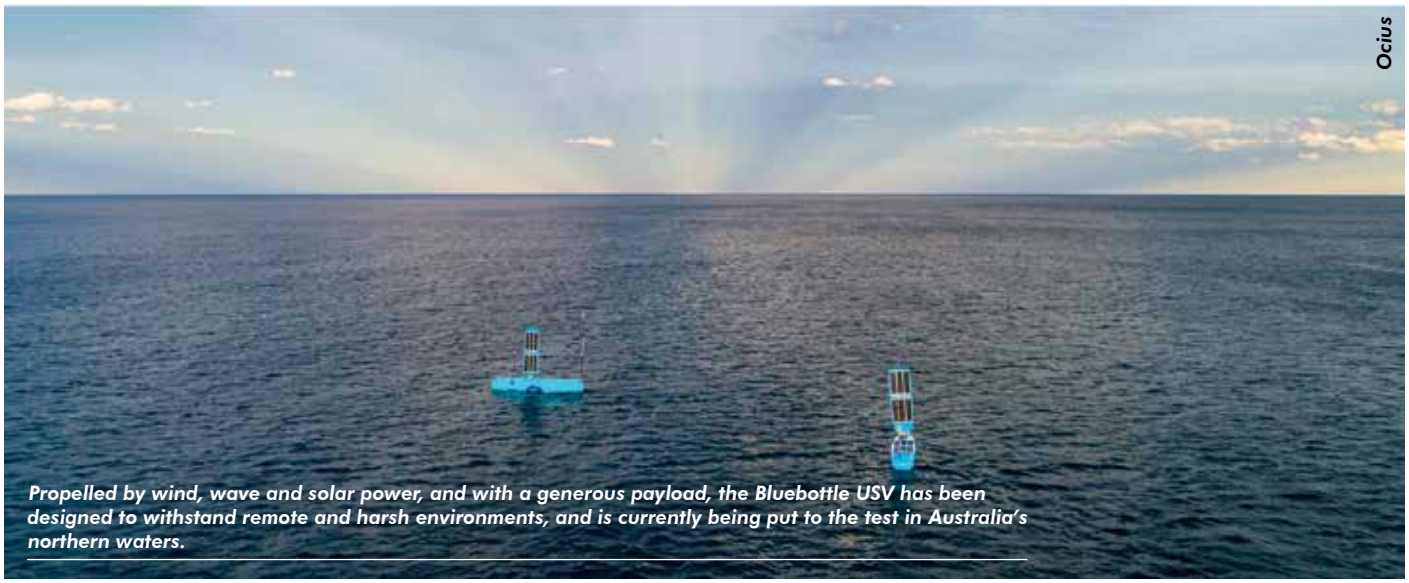
Malaysia is also pushing ahead with plans to enhance its maritime security capabilities releasing a tender that includes three medium-altitude long endurance (MALE) UAS as well as long-endurance unmanned aerial systems. This is part of Kuala Lumpur's 12th Malaysian Plan that sets out procurement for 2021-25.

Another popular UAS with a wealth of naval experience is the S-100 Camcopter rotary UAS from Schiebel. The company signed a contract with the Royal Thai Navy (RTN) in November 2019 and stated that the S-100 would be deployed in Thailand and on RTN frigates "to deliver land and sea based ISR operations. This is the first time the RTN will be using Vertical Take Off and Landing (VTOL) UAS for maritime operations."

Australia has requirements for naval UAS under SEA 129 Phase 5 Tactical UAS programme and both Schiebel and Insitu are involved in the trials phase providing the S-100 and ScanEagle respectively. The RAN has already acquired both platforms under the Navy Minor Project 1942 for its 822X Squadron that tests UAS. So far the squadron has completed trials from MV Sycamore the Anzac-class frigate HMAS Ballarat.

SEA 129 Phase 5 will provide the UAS solution for the RAN's new Arafura-class Offshore Patrol Vessels (OPVs) and ANZAC-class frigates. In August invitations to respond to the programme were announced. The RAN plans to introduce the systems through a series of block acquisitions to allow for future updates and technological innovations to be included. This initial invitation is for UAS for the initial block of capability from 2024-2028 and will be used to prove the system operationally and its further development. The Commonwealth will then down select the finalists that will then participate in a Request for Tender (RFT).

The second block that will follow from 2029-2033 will installed on the new Hunter-class frigates while a third block from 2034-2038 will include a technology refresh and adaptations to meet changes



Propelled by wind, wave and solar power, and with a generous payload, the Bluebottle USV has been designed to withstand remote and harsh environments, and is currently being put to the test in Australia's northern waters.

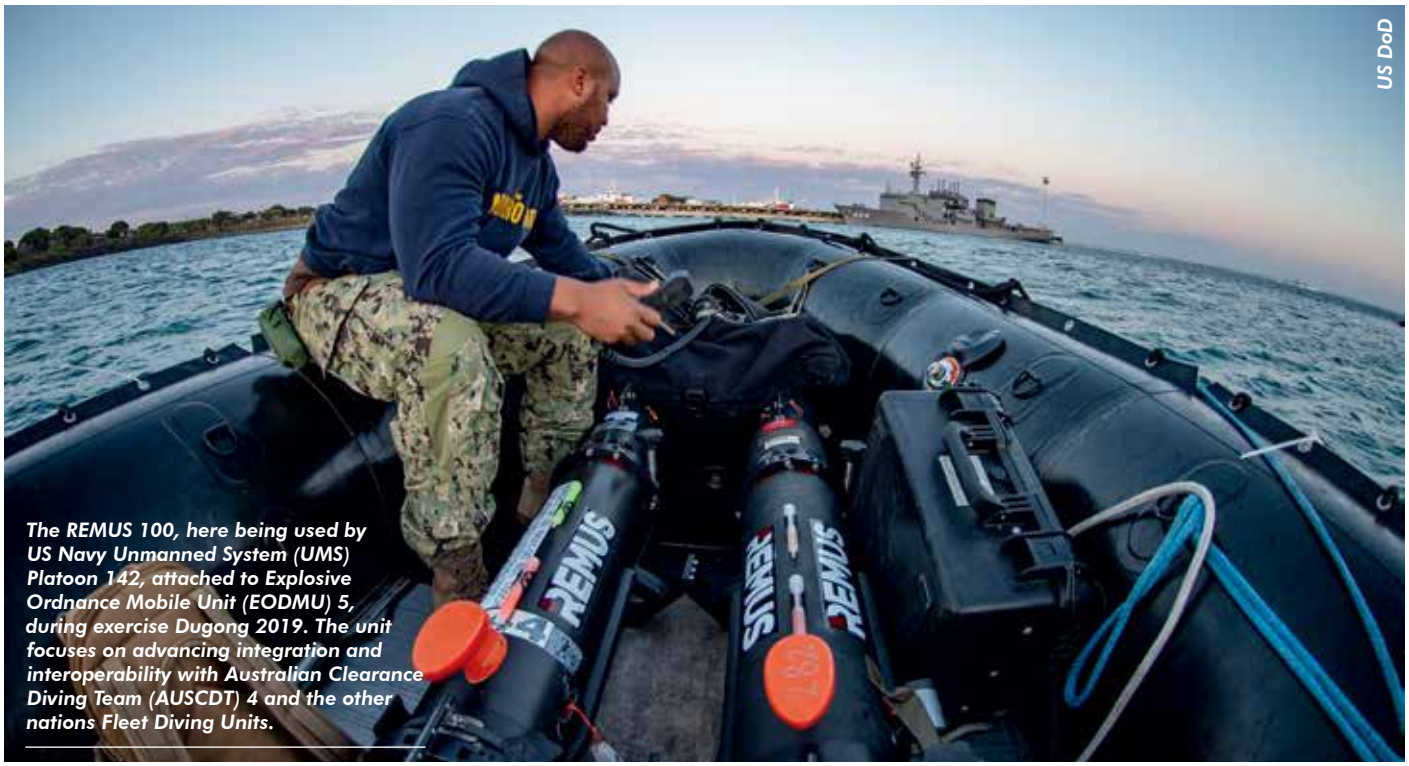
in operational requirements.

Australia is one of the countries in the region that is making a large investment in unmanned systems. As a large country with a considerable exclusive economic zone and wider regional interests, the use of unmanned systems to expand ISR and its maritime security presence is a cost-effective way of generating capacity.

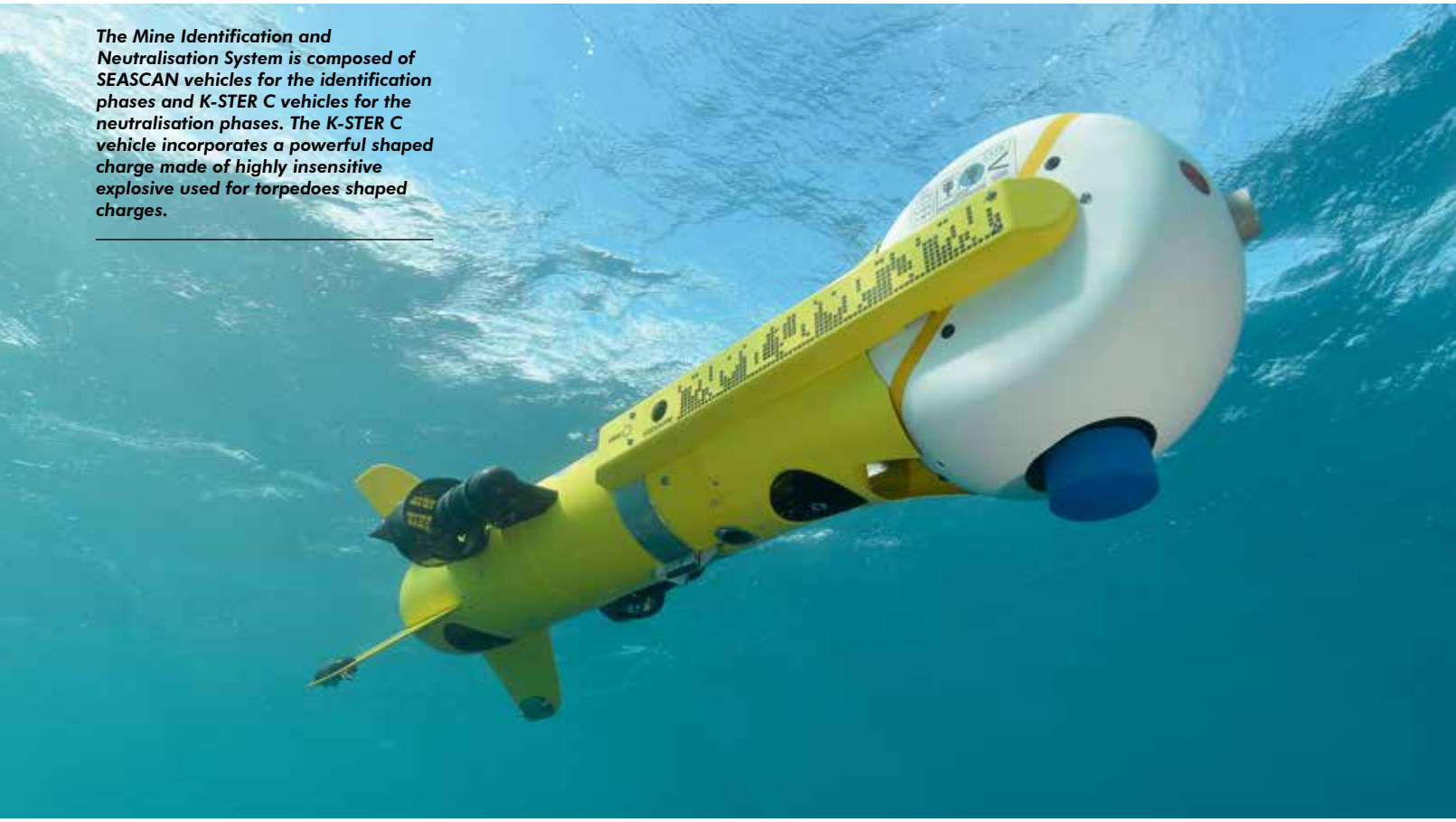
Unmanned mine hunting

This is of particular importance when it comes to Mine Counter Measure (MCM) operations where Australia is running three separate programmes. The first is SEA 1778 Phase 1 which aims to introduce a deployable MCM capability that can be taken on the RAN's amphibious ships on operations. General Dynamic Maritime Systems has been contracted to provide four Bluefin-9 and three Bluefin-12 AUVs for mine detection. These will operate alongside five 35ft (10.6m) USVs from Steber International. General Dynamics did not respond to requests for an update on its work but an initial operating capability (IOC) is expected in 2020 following the successful testing of systems by the Australian Mine Warfare Team 16 (AMWT-16) in February 2020.

Meanwhile Project SEA 1905 will introduce a range of unmanned systems – known as toolboxes – that will replace the RAN's Huon-class coastal minehunter (MHC) ships. These will be deployed from the new Arafura-class OPVs and two new MHCs based on the OPV design as an organic capability, but a lot will depend on how SEA 1778



The REMUS 100, here being used by US Navy Unmanned System (UMS) Platoon 142, attached to Explosive Ordnance Mobile Unit (EODMU) 5, during exercise Dugong 2019. The unit focuses on advancing integration and interoperability with Australian Clearance Diving Team (AUSCDT) 4 and the other nations Fleet Diving Units.



The Mine Identification and Neutralisation System is composed of SEASCAN vehicles for the identification phases and K-STER C vehicles for the neutralisation phases. The K-STER C vehicle incorporates a powerful shaped charge made of highly insensitive explosive used for torpedoes shaped charges.

develops. Gate One approval is expected in 2020. To further investigate USV capability, Australia's DST has provided funding of $4 million (AUS$5.5 million) to Ocius Technology to build and test its Bluebottle USV as a gateway platform to communicate with underwater assets such as AUVs.

Robert Dane, CEO of Ocius Technology, told AMR: "We're building five 'next-gen' Bluebottles to deploy out of Darwin in 2021 - to demo an intelligent networked 'squad' doing three different roles in three different Areas of Operation." Those three areas of operation are classified but Dane said the applications will be for "guarding an asset such as a port and oil rig; patrolling the EEZ; and anti-submarine warfare."

The third project is SEA 1770 to acquire a Rapid Environmental Assessment (REA) capability. Hydroid's Remus 100 AUV has been acquired for the Maritime Geospatial Warfare units that operate within four Deployable Geospatial Survey Teams with the RAN's Hydrographic, Meteorological and Oceanic Group. Tom Reynolds, senior director, Business Development, Huntington Ingalls Industries, Technical Solutions – which owns Hydroid – told AMR that while individual customers could not be named, Remus has been sold to 24 navies "including five navies in the Asia-Pacific region."

Meanwhile the Royal Australian Air Force (RAAF) is expected to receive the Northrop Grumman M-4C Triton UAS under Project AIR 7000 Phase 1B. The company initiated the construction of the first platform on 28 October. Australia has ordered three with up to six planned. The company is also providing four of its RQ-4 Block 30 Global Hawk high-altitude long endurance (HALE) UAS to South Korea under a $657 million FMS contract with the US signed in 2014. The first two were delivered at the end of 2019 and April 2020 with the remainder due by the end of the year.

Northrop Grumman believes that the first export of its MQ-8C Fire Scout will be to Japan. Japan is developing plans for unmanned naval systems procurement and is completing tests with the MQ-9B SeaGuardian. A spokesperson from General Atomics (GA-ASI), which manufactures the MQ-9B, told AMR that a series of validation flights for the Japan Coast Guard with SeaGuardian started on 15 October. The flights will "validate the wide-area maritime surveillance capabilities of Remotely Piloted Aircraft Systems (RPAS) for carrying out JCG's missions, from search and rescue to maritime law enforcement." He added: "These flights follow successful MQ-9 maritime patrol demonstrations in the Korea Strait in 2018 and the Aegean Sea in 2019. The current flight series features the MQ-9B SeaGuardian, capable of all-weather operations in civil national and international airspace."

Elsewhere the GA-ASI spokesperson said that RPAS from GA-ASI "is being considered under the FMS route between the Indian and US governments". India is looking for about 10-12 systems and the SeaGuardian is under consideration. However, despite approval from the US Government for an export in 2017 a sale has not been concluded as India has ambitions to develop its own UAS, although it has struggled to bring new platforms to production. A new 440lb (200kg) rotary UAV (RUAV) from Hindustan Aeronautics (HAL) that


ECA Group

was unveiled in 2019 is expected to begin testing in 2021. India wants 10 UAS to be deployed from its warships. Meanwhile IAI signed a Memorandum of Understanding (MoU) with HAL in early 2020 to develop UAS such as the Heron and Searcher.

In the underwater domain India released Requests for Information (RFIs) in 2018 for a High Endurance Autonomous Underwater Vehicle (HEAUV) and a new USV, although beyond this it is unclear if any programmes have been initiated.

ECA Group has delivered its Mine Identification and Neutralisation Systems worldwide including to Singapore. K-ster has been tested with the Venus 16 USVs that have been delivered by ST Electronics to prove a new MCM system. Singapore already has the Protector USVs from Rafael for base protection, but these will be used for coastal defence. Meanwhile the Republic of Singapore Navy has also embarked on its own unmanned systems development with a new MCM USV that employs a towed synthetic aperture sonar (T-SAS) from Thales.

China also has plans to speed up the development of its maritime unmanned systems. Although there is little public information about its projects, a new VTOL UAS mock-up (similar to the Fire Scout) has been seen on the deck of the People's Liberation Army Navy's (PLAN) Type 075 Landing Helicopter Dock. The WZ-9 Soaring Dragon HALE and BZK-005 MALE UASs have also been seen near airbases over the past five years. The SD-40 Sea Cavalry has flown from a Type 052C destroyer and China has already developed the CH-family of UAS and exported them. Meanwhile it is reported in Chinese media that there are plans for an extra-large UUVs (XLUUV) in the future to counter US prototype developments.

The unmanned revolution in Indo-Pacific navies will progress at different speeds depending on the resources available but it is clear that all countries will be acquiring these capabilities for the future. Whether in-country development, the purchase of expensive or cheap systems, the growth of unmanned systems in all domains will escalate. AMR

Iskander-E (Tactical Ballistic Missile System)

ROSOBORONEXPORT AT ARMY 2020 FORUM IN RUSSIA

Rosoboronexport JSC (part of the Rostec State Corporation) presented to its foreign partners weapons for all segments of the global arms market at the Army 2020 International Military-Technical Forum at Kubinka near Moscow.

This year, the Army Forum was the first major event for the global defense industry following the lifting of restrictions caused by the COVID-19 pandemic. The Forum provided a signal to the global arms market to recover and gave an impetus to the further development of military-technical cooperation with foreign countries. This was a great opportunity for Russian defense companies to show their readiness to increase deliveries of high-tech products and expand their geographic footprint.

For several years, the Army Forum has become not only one of the most representative Russian exhibition projects, but also one of the most authoritative international venues for discussing issues of military and military-technical cooperation. Rosoboronexport is one of the main sponsors and active participants of the event.

Among the key features of the Army Forum are the exceptional visibility and comprehensive nature of the exhibition. The combination of static displays and live demonstrations makes it possible to better assess the advantages of the presented weapons, military and special equipment, and civilian products. For this purpose, three Land Forces, Naval and Air Force demonstration clusters are used.

The exhibition was enable the Forum guests to appreciate Rosoboronexport's comprehensive approach to ensuring the security of the countries concerned. The Company offers its partners to build a balanced system that combines various types of weapons and military equipment, modern communications/control/robotics technologies, situation control and information protection systems.

Five past Army Forums have confirmed that Russian weapons and military and dual-use equipment attract particular attention of specialists from many countries. Through military and military-technical cooperation with Russia many States see the path to ensure their security and sovereignty.

The list of products that Rosoboronexport show at the Army Forum sites covers all

segments of today's market of weapons, military and special equipment.

Smerch

Multiple rocket launcher system with 9A52-2 LV

The Smerch multiple rocket launcher (MRL) system is designed to engage critical area targets whose vulnerable elements are unsheltered and sheltered manpower, soft-skinned, light-armored and armored vehicles of motor-rifle and tank companies, artillery, tactical missile and air defence units, helicopters on the landing areas, destroy command posts, communications centers and military-industrial installations.

Components:

- combat assets (launch vehicles (LV), transporter/loaders, various trajectory-corrected rockets);
- controls facilities (unified command staff vehicles);
- weather support facilities (radio direction finding/weather system);
- maintenance facilities (repair and locksmith workshop to repair artillery armament);
- training aids and special arsenal equipment (9F840 training set, 9F827 training aids, 9F819 special arsenal equipment set).

The launch vehicle provides firing, survey control, ground navigation with data display on the electronic map, and automated launch tube cluster laying on the target. All this provides high survivability of the LV through reduced time of staying at a fire position. In urgent fire position displacement mode, the LV is capable of leaving the fire position within 1 min. For operations in bad weather and at night, the crew is provided with increased comfort.

A wide range of trajectory-corrected rockets has been developed for the Smerch MRL. All the rockets share the same design and differ from each other only in the type warhead used (cluster warhead with fragmentation submunitions, separable and non - separable HE warhead, thermobaric warhead, cluster warhead with shaped-charge/fragmentation submunitions, cluster warhead with sensor-fused submunitions). Range of fire - from 20 up to 120 km.

Main characteristics

Rocket caliber: 300 mm

Weight, loaded LV with crew, not more than: 43,7 t

Smerch - 2 (Multiple Rocket Launcher System with 9A52-2 LV)

Crew: 4

Number of launch tubes: 12

Salvo time, not more than: 40 s

Max speed: 60 km/h

Iskander-E

Tactical ballistic missile system

The Iskander-E tactical ballistic missile (TBM) system is designed to effectively destroy high-value pinpoint and area targets in the tactical depth of enemy troops. It is capable of handling missions in all types of ground activity on all theaters of operations in any weather, day or night, with a high probability of combat mission accomplishment in conditions when the enemy actively uses traditional and precision guided weapons, missile defence and air defence systems. In addition, no launching site preparation and survey support as well as launch weather support are required.

The main advantages of the missile system:

- high firepower of a missile attack through installation of two missiles on one launcher;
- effective engagement of a wide range of targets with one or two missiles through the use of advanced warheads, high missile accuracy and reliability;
- high effectiveness of missile strikes and speed in command through command & control automation;
- tactical mobility and maneuverability through the all-terrain cross-country capacity of combat vehicles and strategic mobility due to transportability of the system's components by all modes of transport;
- high growth potential of the missile system, including through improvement in warhead performance, missile strike accuracy and other areas.

Components:

- combat assets;
- command & control and information systems;
- maintenance and repair facilities;
- auxiliary assets;
- training facilities.

Main characteristics

Range of fire

max: 280 km

min: 50 km

Number of missiles

TEL (transporter/erector launcher): 2

TLV (transporter/loader vehicle): 2

Time to launch the first missile

ready-to-launch position: 4 min

march: 16 min

Interval between launches: 1 min

Transportability: rail, sea, and air transport

Assigned service life: 10 years

Operating temperature range: ± 50 °C

TE-2-02

Multipurpose electrically-driven remote-control homing torpedo

Mission

The TE-2 multipurpose electrically-driven remote-control homing torpedo is designed to engage submarines, surface combatants and other targets when fired from submarines and surface ships in

TE-2-02 (Multipurpose Electrically Driven Remote-Control Homing Torpedo

autonomous and remote-control modes.
Features
The TE-2 torpedo can be employed in ocean areas with water salinity of 30-35 ppm and water temperatures from 0°C to +25 °C.
The torpedo features a three-beam anti-ship homing system, absence of an acoustic proximity fuze, and use of an active proximity electromagnetic fuze, which detonates when the torpedo passes near a surface combatant or submarine.
The TE-2 torpedo is being developed in three variants:
- TE-2-01 with mechanical data input;
- TE-2-02 with electric data input;
- TE-2-03 with electric data input via a control and launch console.

Main characteristics
Caliber: 534,4 mm
Length
torpedo with command wire coil (for submarine-launched): 8288 mm
torpedo w/o command wire coil (submarine- and ship-launched): 7828 mm
Weight
torpedo with command wire coil: 2450 kg
torpedo w/o command wire coil: 2400 kg
explosive charge: 250 kg
Average speed to full range (water salinity of 35 ppm and water temperature of +15°C)
mode I: 45 ± 2 knots
mode II: 32 ± 3 knots
Range
mode I: 15000 m
mode II: 25000 m
Submarine engagement depth: periscope depth to 350 m

UGST

Multipurpose deep-sea self-homing torpedo
Mission
The UGST multipurpose deep-sea self-homing wire-guided torpedo is designed to engage enemy submarines, surface ships and vessels, and stationary targets.
Composition
- hardware/electronic module with active-passive and wire guidance systems, and a propulsion control system;
- warhead section;
- fuel tank section;
- power plant section;
- tail section;
- command wire coil.

Features

The UGST torpedo is fielded with surface ships and submarines, equipped with 533mm torpedo tubes. A 7.2-m long basic modification of the torpedo can be included into the arsenal of carrier ships fitted with Russian-standard torpedo tubes, whereas a 6.05-m modification can be launched from NATO-standard torpedo tubes. The torpedo interoperability with carrier ship systems is provided by setting up software of the system unit during customization of the given ship project. Solutions for its integration with carrier ships currently upgraded are developed envisaging delivery of a special interface pre-launch preparation panel for entering data into the torpedo before launch.
Main characteristics
Caliber: 534,4 mm
Length: 7,2 (6,05) m
Weight
torpedo: 2200(1880) kg
explosive: up to 300 kg
Speed
mode I: 50 knots
mode II: 35 knots
Target engagement depth: 8-500 m
Submarine launch depth: up to 400 m
Homing system reaction radius
for submarines: up to 2,5 km
for surface ships: up to 1,2 km
Surface ship wake indication time: up to 350 s
Fuse reaction radius
for submarines: 2 m
for surface ships: 6-8 m
Remote control wire length
torpedo reel: up to 25 km
towed reel: up to 5 km

PAKET-E/NK with anti-torpedo ammunition
Small size anti-submarine system
Effective anti-submarine defence
Capable of engaging a submarine and attacking torpedoes
- Anti-submarine and anti-torpedo defence;
- Integration of detection and engagement systems;
- Adaptability;
- Autonomous combat operation.

PAKET-E/NK is unparalleled. The system consists of a control system, a special sonar station, two modular launcher units with small size thermal torpedoes and anti-torpedoes.
This composition ensures simultaneous engagement of an attacking submarine and torpedoes. Dimensions of the system provide for simple adaptation to ships with different displacement. PAKET-E/NK is simple in combat use and during routine maintenance.
PAKET-E/NK is an effective anti-submarine defence system that combines attack and defence capabilities.

Main characteristics

Caliber (torpedo/anti-torpedo): 324 mm
Torpedo effective range: 10000 m
Anti-torpedo effective range: 100-800 m
Speed of torpedo: 30-50 kts.
Speed of anti-torpedo: 25 m/sec
Torpedo guidance system: acoustic, active-passive
Anti-torpedo guidance system: acoustic, active-passive
Guidance system range for torpedo/anti-torpedo: 2500/400 m

DVIDS

The cancellation of the Special Operations Forces (SOF) biennial training component of Exercise RIMPAC 2020 means that Asian SOF units will miss out on gaining experience of multinational operations with their US counterparts, as shown here during a previous RIMPAC in July 2018 at Bellows Air Force Station, Hawaii.

COVID SETBACK FOR SOF TRAINING

Special operations training programmes across the Indo-Pacific region have been significantly hampered by the ongoing COVID-19 pandemic.

by **Andrew White**

Special operations force (SOF) sources there have indicated to *Asian Military Review* how bi- and multi-lateral training efforts have been either postponed or cancelled as a direct result of COVID-19. Such restrictions come at a time when SOF units continue to demand improving levels in cooperation and interoperability in order to plan and conduct joint special operations. However, SOF units are refocusing on unilateral training opportunities in order to maintain currency to conduct the full spectrum of special operations.

One of the most high profile examples of this came during the biennial Rim of the Pacific (RIMPAC) exercise. Scheduled to be run across the island of Oahu, Hawaii, RIMPAC 2020 had planned to bring together the greatest number of Indo-Pacific SOF elements from across the wider region with participants including US Army Special Forces; South Korean Navy SEALs; Brazil's GRUMEC; India's MARCOS; Peru's Naval Special Warfare; Chile's COMFUES; The Philippines NAVSOG; and Japan's Special Boarding Unit.

Due to take place across multiple training locations on Oahu and off the coast including Joint Base Pearl Harbor Hickam, Marine Corps Base Kaneohe Bay and Bellows Air Force Base, the exercise would have provided an additional opportunity for participating SOF elements to enhance levels of cooperation and interoperability.

Speaking to *AMR*, service officials

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KOPASKA Naval Special Warfare operators from Indonesia continue to conduct uni- and bilateral training exercises to ensure maritime security in the Indo-Pacific.

from the US Special Operations Command Pacific (SOCPAC) explained how the exercise would have focused on enhancing the "command and control of SOF forces within RIMPAC; multinational interoperability training; direct action raids; and maritime/dive operations".

SOCPAC also confirmed how RIMPAC 2020 had been scheduled to include 'Ship in a Box' training; special insertion by helicopter, military free fall insertion, small boats and submarines; in addition to visit, board, search and seizure (VBSS) operations at sea.

The cancellation of the exercise served a significant blow to Indo-Pacific SOF units seeking to benefit from training serials with US SOF in particular. The next SOF-specific RIMPAC exercise is scheduled to take place in 2022.

In May 2020, South Korean SOF leadership made the decision to postpone or cancel its remaining multi-lateral training programmes in 2020 due to the ongoing pandemic. As AMR went to press, the decision had yet to be revised.

China trains for SOF-on-SOF

The People's Republic of China continues to press ahead with unilateral special operations training despite international travel restrictions associated with the pandemic.

In August 2020, People's Liberation Army SOF participated in a maritime counter-terrorism (MCT) exercise at a location along China's coast. Designed to enhance PLA SOF's ability to conduct SOF-on-SOF engagements, the exercise saw PLA SOF units employing civilian heavy lift surface vessels as motherships to launch and recover helicopter assault forces.

Such a mothership concept, which is also being pursued by the likes of US and UK special forces, falls in line with the National Defence Transportation Law published by the People's Republic of China in 2016, which earmarked the utility of commercial ships to support

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Australian Army

Chief of Army Lieutenant General Rick Burr (right) opened the Defence Special Operations Training and Education Centre (DSOTEC) in November 2019. The new DSOTEC structure brings the Parachute Training School, now ADF Parachuting School, and the Special Operations Training and Education Centre, now ADF School of Special Operations, in line with other defence training establishments.

special operations.

Defence sources explained to *AMR* how this concept would significantly extend the ability of PLA SOF to reach some of the more remote disputed island chains in the South China Sea (SCS) including the Spratlys and Paracels.

Similar special operations exercises continue to be conducted by state actors across the Indo-Pacific which remain fearful of foreign intervention. The South Korean SOF, in August 2019, conducted the "East Sea Territorial Protection Exercise" around the Dokdo/Takeshima Islands, the ownership of which is disputed with Japan.

Elsewhere, PLA SOF also conducted a special operations training exercise in the area of the Tibet Military Command. The exercise, which was conducted in June 2020, followed a high-profile engagement conducted between Chinese and Indian border forces in Ladakh.

An official statement published by the Chinese Ministry of Defence confirmed how the unilateral training exercise conducted in the Nianqing Tanggul mountain range, had included the support of close air support, artillery and electronic warfare teams. Specifically, SOF operators conducted special reconnaissance tasks as well as insertion/extraction and target acquisition at high altitude.

Similarly, Indian SOF continue to build their own capabilities following the event in Ladakh. Examples include a Joint Combined Exercise Training (JCET) opportunity with US Army Special Forces which was conducted in the US despite the ongoing COVID-19 pandemic.

Conducted at Joint Base Lewis McChord in Washington State, the JCET provided Indian Army Para SF operators with the opportunity to practise urban warfare serials. Similarly, India's paramilitary unit, the NSG, also hosted US SOF as part of a bilateral training opportunity in Hyderabad in the third quarter of 2020.

Similar focus of protecting strategic

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Australian DoD

An Australian Army MRH-90 Taipan helicopter from 6th Aviation Regiment approaches a Sydney ferry, as part of a Special Operations Command maritime counter-terrorism training activity on Sydney Harbour, on Wednesday, 24 June 2020.

waterways across the Indo-Pacific to ensure maritime security was also demonstrated throughout 2020 by Indonesian SOF.

In July 2020, the Indonesian Navy's SOF component, KOPASKA, participated in a training package in the Strait of Dom, West Papua, as part of a wider effort to ensure maritime security across the area of responsibility.

With a focus on small unit special operations, the exercise saw KOPASKA conducting sub-surface insertions into target areas using combat dive teams in addition to amphibious direct action missions by rigid hull inflatable boats and other surface vessels.

The exercise was preceded by a joint training opportunity between KOPASKA and the Indonesian Navy at Damar Island. Designed to enhance levels in cooperation and interoperability between both force components, the exercise saw the execution of beach assault operations; hostage rescue serials; and interdiction missions, with SOF units supported by helicopters and high speed interceptor craft.

Indonesian Army SOF from the KOPASSUS Special Warfare Command had also been scheduled to revive bi-lateral training opportunities with the US Special Operations Command over the course of 2020.

The decision followed a decision by the US State Department in 2019 to revive relationships with KOPASSUS following concerns of humanitarian rights violations.

In May 2019, former US defence secretary Patrick Shanahan visited Indonesia to meet with counterparts to discuss future training opportunities. However, such cooperation was put on hold due to the COVID-19 pandemic.

As *AMR* went to press, no decision had yet been made regarding the reinstatement of bilateral training opportunities.

SOCOMD

The Australian government has established a dedicated training organisation to support emerging

requirements of the Australian Special Operations Command (SOCOMD).

The Defence Special Operations Training and Education Centre (DSOTEC) was established in November 2019, co-located at the headquarters of the 2nd Commando Regiment at Holsworty Barracks in New South Wales.

With a remit to "conduct individual special forces recruitment, selection, training, and education to meet force generation, trade, and professional development requirements" for SOCOMD, the DSOTEC is also described by official literature as "central to ensure that Australia special forces are fit for the future".

The decision to stand up the DSOTEC comes at a time when the SOCOMD is bracing itself to respond to the forthcoming publication of a report into alleged warcrimes in Afghanistan in the early to mid 2000s.

"This evolution reflects the changing strategic environment and capability requirements to conduct Special Operations. Through this time we have seen the principles of Special Forces reaffirmed to include quality not quantity; joint ways of operating; command at the highest appropriate level for optimum effect; and an ethos of relentlessly pursuing excellence," service officials announced at an opening ceremony of the DSOTEC.

"We also know that effective special operations are about people, and these can't be grown quickly. These attributes grow from solid fundamentals and strong foundations built in the 'raise, train and sustain' system that enable the flexibility and agility essential to prosecute Special Operations," it was added.

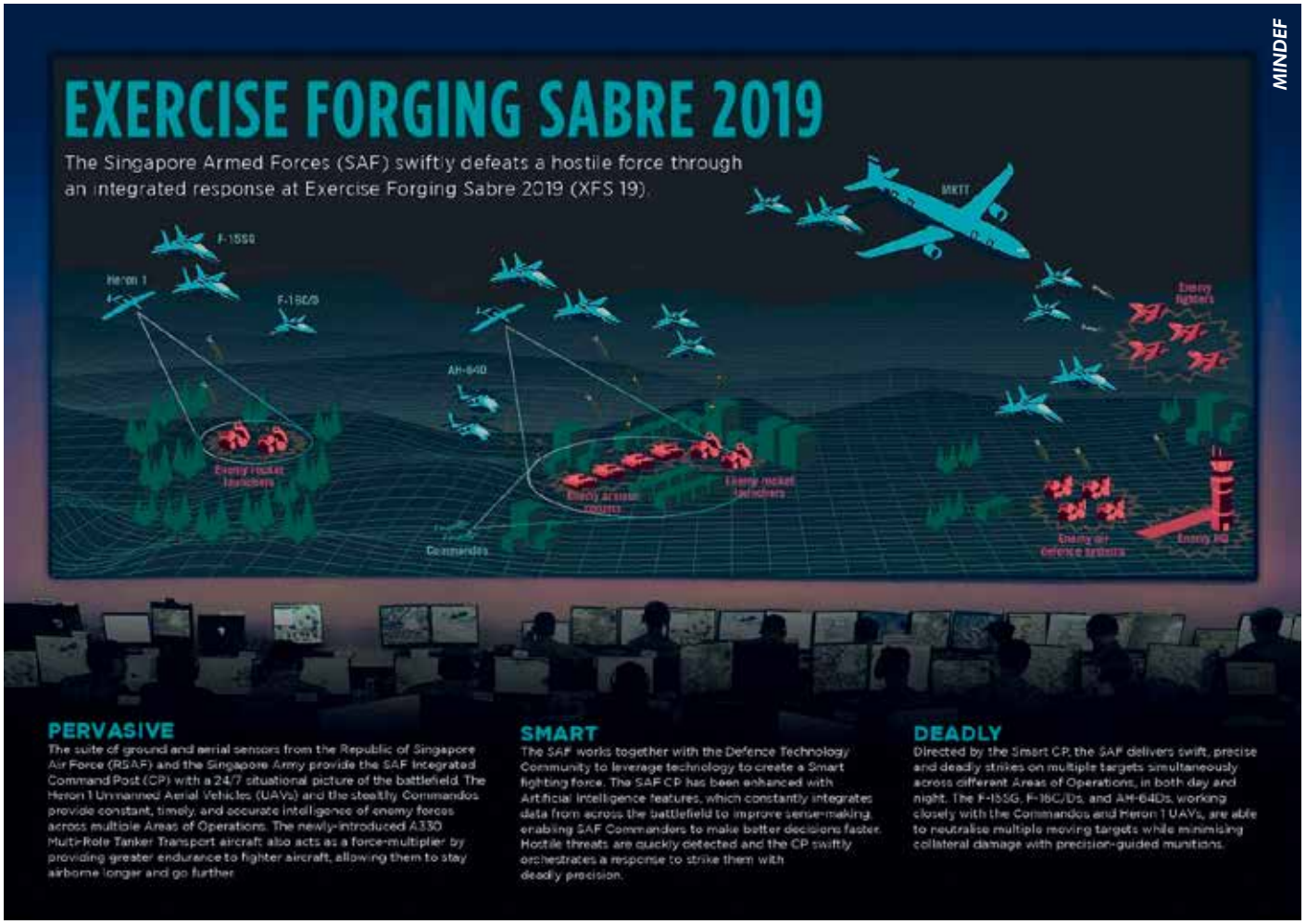
Finally in Singapore, the country's Special Operations Task Force (SOTF) remains focused on uni- and bi-lateral training opportunities in order to "step up readiness" to respond to emerging threats across the Indo-Pacific, according to service officials.

The SOTF is set to benefit from the Singapore Armed Forces Training Institute (SAFTI) City complex- a 88ha site developed to enhance urban warfare training.

The training site, which began to be constructed in June 2019, will feature a total of 80 building structure some of which are as high as 12-storeys, allowing SOTF assault teams to practise special operations in dense urban environments.

The complex is also set to accommodate a bus terminal and railway stations, in addition to subterranean structures.

A first phase of the SAFTI City is expected to be completed by 2023 which will allow SOTF to transfer a lot of specialist training from the smaller Murai Urban Training Facility. AMR



AI-enabled exploitation systems will enable military and homeland security forces to better utilise the data captured by UAVs for wide area surveillance and targeting.

EYES IN THE SKY

Roaming UAVs ease airborne border and coastal surveillance

by **JR Ng**

Enduring territorial disputes, illegal immigration, transnational crime, and domestic and international terrorism in Asia-Pacific continue to drive regional interest in the protection of long and often porous land and maritime boundaries.

While the imperative to monitor national borders is well understood, the reality on the ground for most regional governments is that it is practically impossible to entirely secure the vast land and coastal stretches that separates them from each other.

The size of these boundaries for the largest countries can be staggering. India has over 15,106km (9,386 miles) of shared land borders with seven other countries – with at least three being actively disputed – and 7,516km (4,670 miles) of coastline (including island territories), while Thailand in mainland Southeast Asia has over 4,800km (3,000 miles) of land boundaries with four other countries and over 3,200km (2,000 miles) of coastline.

The traditional approach to border surveillance includes monitoring by fixed cameras, ground sensors, security and patrol vehicles, and manned aircraft. However, there is a growing interest to field unmanned aerial vehicles (UAVs) to boost situational awareness for deployed personnel and vehicles suspicious activity along treacherous terrain and to get a closer look at areas that may be inefficient or unsafe for patrol.

Moreover, larger and more capable UAVs configured specifically for long-endurance missions are increasingly being seen as potential surrogates for costly and resource-intensive manned aircraft or troop deployments. Analysts note that UAVs typically have the advantage over their manned counterparts in these areas: time on station; cost per flight hour; lower risk

to human life; and manned-unmanned teaming efficiencies.

Dublin-based market research company Research and Markets noted that the Asia Pacific UAV market will grow at a 2020-2026 compound annual growth rate (CAGR) of 13.8 percent with an addressable cumulative market value of $37.42 billion, largely driven by supportive government and military initiatives across the region as the geopolitical situation continues to deteriorate.

Small but effective

Sensor technology advances mean small tactical UAVs such as the Boeing-Insitu ScanEagle, which is being delivered to several Southeast Asia countries, can now perform land or maritime surveillance tasks previously only possible with larger aircraft.

The ScanEagle UAV is just 1.6m (5.2 feet) long with a wingspan of 3.1m (10ft) and has a maximum take-off weight (MTOW) of around 48 pounds (22 kilograms). Designed to accommodate either a heavy fuel or gasoline engine, the air vehicle is designed to stay aloft for periods of over 24 hours carrying a range of payloads including high-definition electro-optical (EO) or medium-wave infrared (MWIR) sensors, dual imaging EO/IR systems, as well as a growing range of novel sensors.

The UAV is launched from a trailer-mounted pneumatic catapult when operated on land, and a compact low-pressure pneumatic catapult when deployed on board ships. Recovery during maritime surveillance would require the SkyHook system, which secures the UAV in mid-air.

The Republic of Singapore Navy (RSN) has deployed the ScanEagle since 2011 aboard its upgraded Victory-class missile corvettes, which provide the ships with an organic offboard intelligence, surveillance, and reconnaissance (ISR) capability. The service's success in the type is now being emulated by the naval and maritime forces of at least three other regional countries.

Under the US-sponsored Maritime Security Initiative (MSI), Indonesia, Malaysia, the Philippines, and Vietnam are each in the process of receiving donations of newbuild ScanEagle UAVs to boost their respective maritime patrol capabilities.

In mid-2019 it was announced that Boeing-Insitu had received a $47.9 million contract to supply 34 of these platforms to Indonesia, Malaysia, the Philippines, and Vietnam. The Philippines had earlier benefited from a transfer of six ScanEagle 2 UAVs from the United States in May 2018 and is operated by the Philippine Air Force (PAF) 300 Air Intelligence and Security Wing (AISW).

Working smarter, not harder

Smaller tactical-class UAVs such as the ScanEagle are being improved over time with more capable and 'smarter' payloads, which employ machine learning (ML) or even artificial intelligence (AI) technologies to assist the operator in exploiting the vast amounts of data that modern sensors can capture. AI powered by faster processors and in some instances further aided by on-board graphics processing units (GPUs) enable real-time on-board data analysis or 'edge processing', which is seen as a more efficient and secure technique of ISR as opposed to streaming data in real-time to remote servers or storing them in the UAV for post-processing after recovery.

For instance, Insitu has partnered with Overwatch Imaging who have integrated a customised TK-5 Firewatch smart tactical mapping payload designed to provide real-time wide-area,

IAI's Heron 1 UAV has been used for extended surveillance of long borders.

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Small UAVs such as the ScanEagle can cover large swathes of land with specialised payloads.

high-resolution imagery intelligence for a broad range of applications.

According to a joint statement, the TK-5 Firewatch payload can map an area of over 50,000 acres per hour with resolution much greater than high-altitude or space-based multi-band imaging systems, and features ideal image data and onboard processing capability to enable faster identification and delivery of precision geospatial intelligence at large scale.

The TK-5 Firewatch payload can autonomously collect high-definition imagery in visible, near infrared, and thermal infrared spectral bands simultaneously, and performs on-board analysis using GPU-accelerated processors and advanced computer vision software to provide wide-area image maps for situational awareness, change analysis, and response planning. Smart algorithms, taking advantage of advancements in the field, can process signals and images at rapid speed and can detect anomalies with greater accuracy than human beings.

The ability of UAVs to collect highly detailed images and sensor data quickly also brings about its own challenges. It is also equally important to analyse this information quickly and accurately for effective decision making. High-resolution, high-frame-rate video and image capture also require high-bandwidth communications networks for real-time data sharing while data processing requirements have also increased, calling for high-performance computing systems to process image data and to run complex image analysis algorithms.

Clever Herons

The Republic of Singapore Air Force (RSAF) is also leveraging on AI technology to enhance the effectiveness of its primary ISR platform, the Israel Aerospace Industries (IAI) Heron 1 medium altitude long endurance (MALE) UAV. The service's Heron 1 UAVs were declared fully operational in March 2017 and are operated by the 119 and 138 Squadrons. These have been deployed to monitor the island state's sea approaches, and are understood to have be used to observe intruding Malaysian government vessels during a port limit dispute in late 2018.

At Exercise Forging Sabre later in the same year, the Defence Science and Technology Agency (DSTA) debuted an indigenously developed command-and-control (C2) system that integrates the Heron 1's video feeds into an augmented reality display and supported by advanced video analytics software.

"Using advanced graphics rendering technology, static geographical data such as landmarks, road names, building types, [and] vegetation are overlaid on top of the real-time video captured by

China's AVIC is developing a 'smart' rotary wing UAV for high-altitude border patrols, evidently with an eye on the disputed Sino-Indian boundaries.

the UAV," said DSTA in a statement. The agency further noted that the integrated display can reduce the cognitive load of the operators and the time they need to orientate themselves to the latest ground situation picture.

"Previously, videos captured by the UAV had to be manually correlated and marked out on a separate static map display," it added.

A more advanced version of the C2 system was demonstrated at the next edition of Forging Sabre in 2019, with the UAV tasked with performing co-operative lasing to support other airborne and ground-based assets to detect, track, and designate multiple moving targets.

According to the Ministry of Defence (MINDEF), the exercise was the first demonstration of artificial intelligence (AI)-driven decision support software called the Automatic Target Detection (ATD) and Target Look Ahead (TLA) video analytics, which are capable of marking and classifying targets – usually performed manually by RSAF operators – according to their threat level automatically, based on various factors such as the type of weapons they might be carrying.

DSTA engineer and ATD development team member Joshua Lim was quoted by media as saying that the idea for the system came from the realisation that some processes could be automated to help reduce the cognitive burden on personnel. However, he noted that the processing had to be performed without slowdown to ensure that decision makers receive the most up to date video imagery.

High-altitude solutions

The ongoing military standoff at Sino-Indian border has seen China and India developing and fielding specialised equipment that can function effectively in the extreme altitudes that troops and security forces on both sides operate in.

For example, the Aviation Industry Corporation of China (AVIC) is developing a new version of its AV500 rotary wing vertical take-off and landing (VTOL) UAV that has been designed specifically for such extreme environments. The company announced on 21 May that the prototype AR500C had been test flown at its dedicated UAV research and development facility northeastern Jiangxi Province.

The AR500C features a lightweight the carbon fibre reinforced polymer airframe, a more powerful engine, and a new three-bladed main rotor that enables it to attain a service ceiling of 21,980ft (6,700m) when deployed from terrain at altitudes of 16,400ft (5,000m) above sea level. AVIC also said the UAV can operate for up to five hours and achieve a top speed of 92 knots (170km/h).

To reduce operator workload, the UAV features extensive 'baked-in' automation such as automatic take-off and landing, automatic hovering, waypoint-based semi-automatic navigation as well as real-time flight re-planning. Other features include AI-driven image and video exploitation tools to speed up sense-making of captured raw data, as well as smart health and usage monitoring functionality to ensure that it performs reliably in those extreme conditions. AMR

Singapore has incorporated indigenously developed AI tools for its Heron 1 UAVs.

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TARANTO 'STRINGBAG' LESSONS REVISITED

By Ben Ho

In November 80 years ago, the British launched an audacious operation that heralded a new era in naval warfare. On the night of 11-12 November 1940, the Royal Navy executed Operation Judgement whereby aircraft from the aircraft carrier HMS Illustrious attacked key elements of the Italian fleet moored at Taranto, marking the first use of carrier aircraft against battleships. When the smoke had cleared, three of the six Italian warships at port had sustained heavy damage, and the Regia Marina subsequently transferred its assets at Taranto to Naples to shield them from further attacks. What is also noteworthy about Operation Judgement was the use of the venerable Fairey Swordfish biplane – just 21 of them – for the attack.

This aircraft was obsolete when World War Two broke out. Nevertheless, it soldiered on throughout the conflict, making a name for itself in various naval operations, most notably the disabling of the German battleship Bismarck in March 1941. Tellingly, the Swordfish's performance attributes severely lagged that of its contemporary monoplane equivalents. To illustrate, its maximum speed of 124 knots (230 kilometres per hour) compares unfavourably against the 178kts (330km/h) Nakajima B5N 'Kate' of Japan. The fabric skin, struts and braces lent credence to its nickname of 'Stringbag', although in reality it was because it was likened to a housewife's string shopping bag due to the varying amount of stores/weapons it could carry.

However, given that there was no other option to attack Taranto, the British Admiralty took a gamble with the Swordfish with the attack being successful. Paradoxically, its slow speed enabled it to manoeuvre around barrage balloons, while its fabric skin cover made anti-aircraft shells pass through it without causing serious damage.

Coming back to the present day, the United States military could learn an important lesson from Operation Judgement, in terms of innovating the current force to mitigate some of the shortfalls that it is facing. There are currently doubts over the survivability of American carrier strike groups in the face of modern anti-access/area-denial (A2/AD) capabilities. For instance, there is much talk about US carrier aircraft lacking the range to strike at an adversary without exposing their motherships to threats. The US Navy (USN) has taken steps to address this capability gap with the upcoming MQ-25 Stingray unmanned aerial tanker, but it will take some years before it enters active service. Reinstating the mothballed Lockheed S-3 Viking to serve as an aerial tanker is a sensible measure being put forward to mitigate this A2/AD conundrum, as is the proposal to retrofit the Raytheon SM-6 surface-to-air missile to the Boeing F/A-18 Hornet to enhance its counter-air capabilities. In the same vein, introducing the airborne early warning-and-control variant of the Bell Boeing V-22 Osprey is one way to enhance the survivability of US amphibious forces against access-denial threats. Seemingly heretical ideas, such as that of converting merchant ships into cruise-missile shooters, should also be assessed. In an operationally challenging and uncertain milieu like today's, all options should be considered, as cliched as it may sound.

What is viable about such proposals is that they are not about the introduction of entirely new capabilities – a process that is invariably drawn out and expensive – but about making do with what is at hand. In a nod to this line of reasoning, the National Security Strategy which Washington released in late 2017 contends that "(w)here possible, we must improve existing systems to maximise returns on prior investments". Similarly, A Design for Maintaining Maritime Superiority, the USN's latest strategic document, notes that due to budgetary pressures in the foreseeable future, "(we) will not be able to 'buy' our way out of the challenges we face", adding that "the budget environment will force tough choices but must also inspire new thinking".

The modern US military has gone down this path of innovation and improvisation before, with one good example being the transformation of four Ohio-class strategic submarines into cruise-missile platforms. Modifying the SM-6 surface-to-air missile to have a ship-attack capability is another. At the end of the day, while it is well and good to have new platforms and systems, there is a need to, in the words of former Chairman of the Joint Chiefs of Staff Joseph Dunford, "get the right balance between today's capabilities and tomorrow's capabilities so we can maintain that competitive advantage". AMR

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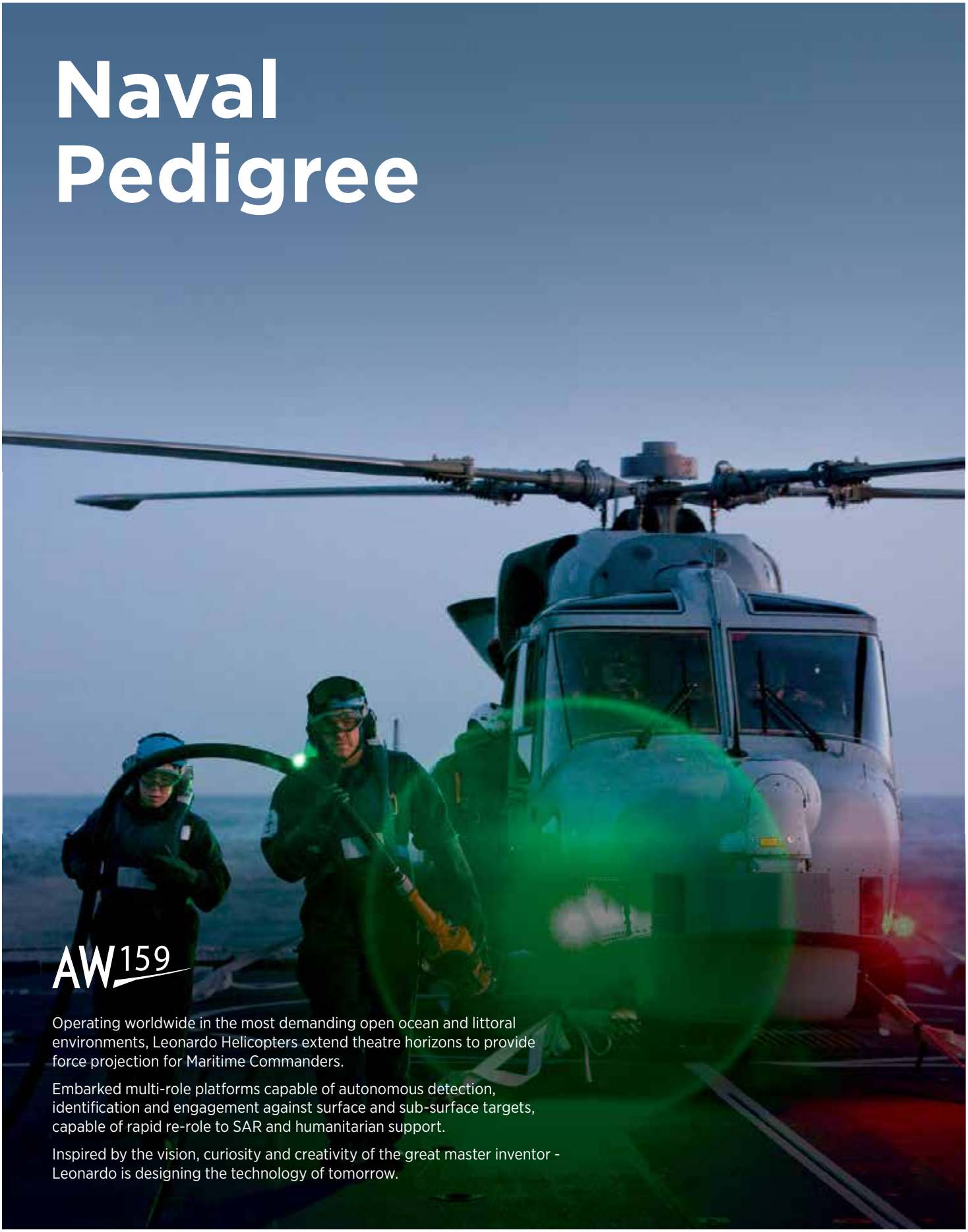

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