

Combined ESD/ MDM Special Issue

- Satellite Protection Systems Examined
- Lessons Learned in Ukraine Electronic Warfare
- The Transformation of the Hungarian Defence Forces

- Counter-UAV Technologies
- Microdrone Developments
- The Hidden Supply Chains of European Armies

Politics • Armed Forces • Procurement • Technology

KC-390 MILLENNIUM

MISSION ACCOMPLISHED

AFTER AN EXTENSIVE TEST CAMPAIGN THE KC-390 MILLENNIUM IS CERTIFIED FOR FULL OPERATIONS.

From the outset, the KC-390 Millennium was designed to set a new benchmark in the medium-size military transporter segment. Developed with support from the Brazilian Air Force (FAB) and Brazilian Government, the largest and most complex aircraft ever built in the southern hemisphere has gone through a rigorous and challenging testing program, including 3,500 prototype flight test hours and close to 85,000 hours of lab tests. In March 2023, it received the coveted Full Operational Capability certification from the Brazilian Military Certification Authority (IFI – Institute of Industrial Development and Coordination), with the platform meeting or exceeding all requirements. This seal of approval, which is extremely difficult to attain, confirms the KC-390 Millennium is ready for full operational duties in all missions and showcases to the world its class-leading reliability, flexibility and performance.

#C390UnbeatableCombination embraerds.com



CHALLENGE. CREATE. OUTPERFORM.

Word from the Editor



The Calm Before the Storm

With most of April now behind us at the time of writing, much attention has turned to the anticipated Ukrainian counteroffensive, with some social media sources even claiming that the counteroffensive has already begun. These claims have broadly been based on a 19 April comment made by Ukrainian Deputy Minister of Defence Hanna Malyar, who stated in an interview with Ukrainian TV that "it is incorrect to speak narrowly about a counteroffensive. Because it is a huge complex of various actions and measures that the Armed Forces of Ukraine are currently carrying out."

As such, it would seem that some social media sources have interpreted Malyar's comments perhaps more liberally than intended, but even so some limited actions commencing now would not be particularly surprising. The counteroffensive has been fairly widely anticipated for some time now, not least because it was the reason behind many Western armoured vehicle donations earlier in the year. It was fairly well understood that some time would be required for equipment to be delivered and crews trained in its operation, pushing the likely start date of a counteroffensive into the springtime.

The range of likely dates was narrowed down further with the recent leaks of classified Pentagon intelligence documents, which included several references to timescales required for equipping and training Ukrainian combat brigades for the offensive. With this information in hand, the attack was broadly expected to begin around early May. Indeed, this would seem the most plausible date range given the information available. However, the reality may be slightly more complex.

What Should We Expect?

Although the counteroffensive may 'begin' around early May, this does not necessarily mean that all of Ukraine's combat brigades will all be immediately committed to quickly take back territory. Thinking back to the highly successful September 2022 counteroffensive around Kharkiv, during which Ukraine made their impressive territorial gains, this advance required some setup time. The attack around Kharkiv was preceded by Ukraine first telegraphing their intention to attack Kherson, followed by several days of Ukrainian offensive around Kherson, during which they made limited progress. Finally, when it became clear that Russian forces were committed to defending Kherson, the rapid counterattack around Kharkiv commenced. The counteroffensive is likely to begin with Ukrainian forces first probing the Russian lines for weaknesses prior

to the main attack. It is entirely possible that this phase could last anywhere from several days to several weeks, and may potentially cover a very wide front. Following this, the Ukrainian forces would select one or more directions of attack and commit the required forces needed to advance along these lines.

Russian forces have evidently also been anticipating a Ukrainian counteroffensive, and have prepared lines of mines, trenches, dragon's teeth and other tank obstacles. All of these will pose a challenge for Ukrainian forces attempting a breakthrough, and combat engineer units will need to play an important role in the success of such an operation. Given the presence of these defences, expectations for a rapid victory are probably overly-optimistic, and any Ukrainian gains are more likely to be hard-won.

A Note on Air Defence

An important factor which may prove problematic is Russia's potential to exploit its air power to prevent advances on the ground. According to the leaked DoD documents, Ukraine has either already run out of or was slated to soon run out of several different kinds of air defence missiles, particularly various Soviet-design missiles, which it cannot easily obtain from the West. This relative lack of munitions may prove problematic if Russia still possesses sufficient aerial platforms or PGMs to blunt the counteroffensive.

While Ukraine's allies are supplying alternative GBAD systems, many of these have slightly different strengths and weaknesses compared to the Soviet or Russian systems they are replacing. For instance, one of the major strengths of many soviet systems, including Strela, Osa, Tor, Buk, and even at the higher end with S-300P/S-300V, is their relatively high mobility and the speed with which they can go from road march to ready states. While the West has produced some fairly mobile GBAD systems, these have tended to be MANPADS-based, operating against short-range, low-tier threats. By contrast, medium and long-range Western systems have typically been less mobile than their Soviet/Russian equivalents. A system such as an I-HAWK, for instance, would be expected to be noticeably slower to reposition and make ready compared to something like a Buk. Recent years have seen the emergence of Western GBAD launcher designs which lean more in the direction of mobility – examples include the NASAMS 3 HIML, the IRIS-T-SLS Mk III, and I-Dome, but many of these have yet to fully mature.

An additional point is that many Western GBAD systems lack radar masts, making it somewhat easier for a determined opponent to figure out the optimal locations for an opponent to position their air defence systems along any route of advance. As such, care will be required when using such systems to support an advance, since the further and faster friendly forces advance, the more frequently these systems will need to reposition to keep pace with the force they are protecting.

ARMAMENT & TECHNOLOGY

- 10 Space is No Sanctuary Doug Richardson
- 16 Kick Out the Jams Thomas Withington
- 20 Micro-Drones: **Miniature Reconnaissance Assets** for the Modern Battlefield Sidney E. Dean
- 24 Reimagining War How 'Centaur' Warfighting Will **Change Warfare Forever** John Antal
- 29 Counter-UAV Technology and **Options of the US Armed Forces** Sidney E. Dean
- 35 Major Hellenic Defence **Acquisition Programmes** Sidney E. Dean

INDUSTRY & MARKETS

- 40 Back in Business Tim Guest
- 45 Ammunition Suppliers from **Central and Eastern Europe** Martin Smisek
- 51 Spain's Defence-Industrial Capabilities Robert Czulda

VOICES FROM INDUSTRY

55 Why Mainstream 5G Won't Stand the Test of Time on the Battlefield Macy Summers, President and CEO of Blu Wireless Inc.

SPOTLIGHT: HUNGARY

- 56 The Transformation of the Hungarian Defence Forces Lieutenant General Dr. Romulusz Ruszin-Szendi
- 62 Hungary's Modernisation Plans Mark Cazalet
- 65 Hungarian Infantry Tactical Mobility Kristóf Nagy

н. **SECURITY POLICY**

- 68 The Phantom Supply Chains of European Armies Juan M. Chomón Pérez and Craig Hymel
- 72 The South Caucasus in the Shadow of the War in Ukraine Dr. Gayane Novikova
- 75 **Malaysia Confronts Challenging Defence Environment** David Saw
- 79 Taking Control of the Situation Tim Guest

COLUMNS

- 1 Word from the Editor
- 3 Masthead
- 4 ESD Spotlight
- 9 Firms & Faces

Masthead

European Security & Defence

Issue 5/2023, May 2023 ISSN 1617-7983 · www.euro-sd.com

Published by

MITTLER Mittler Report Verlag GmbH A company of the TAMM Media Group

Publisher and Editor-at-Large: Stephen Barnard (sb)

Editor-in-Chief: Mark Cazalet (mc)

News Editor: Peter Felstead (pf)

Editorial Staff: Rolf Clement (rc, Political Affairs), Waldemar Geiger (wg, Infantry, Industry), Wolfgang Gelpke (wge), Gerhard Heiming (gwh, News, Land Forces), Rolf Hilmes (rh, Army Technology), Lars Hoffmann (lah), Hans-Uwe Mergener (hum, Naval Forces)

Copy Editor: Christian Kanig (ck)

Regional Correspondents

Belgium/EU/NATO: Joris Verbeurgt (jv), Brazil: Roberto Guimarães de Carvalho (rgc), Denmark: J. Bo Leimand (jbl), France: David Saw (ds), Georgia: Beka Kiria (bk), India: Suman Sharma (ss), J C Menon (jcm) Israel: Tamir Eshel (te), Italy: Luca Peruzzi (lp), Japan: Shinichi Kiyotani (sky), The Netherlands: Jaime Karremann (jk), Poland: Grzegorz Sobczak (gs), Portugal: António Brás Monteiro (abm), Regional Correspondents, Russian Federation: Sergey Kirshin (sk), Yury Laskin (yl), Spain: Esteban Villarejo (ev), Taiwan, North & East Asia: JD Kitsch (jdk), Turkey: Korhan Özkilinc (kÖ), UK: Christopher Foss (cf), Tim Guest (tg), Ukraine: Alex Horobets (ah), Reuben F Johnson (rfi) USA: Sidney Dean (sd), Chet Nagle (cn)

Layout:

AnKo MedienDesign GmbH, Germany

Production:

Lehmann Offsetdruck und Verlag GmbH, 22848 Norderstedt, Germany

Office Address:

Mittler Report Verlag GmbH Beethovenallee 21, 53173 Bonn, Germany Phone.: +49 228 35 00 870, Fax: +49 228 35 00 871 info@mittler-report.de, www.mittler-report.de

Managing Director: Peter Tamm

Editorial Director: Lars Hoffmann (lah)

Authorised Signatories: Waldemar Geiger, Lars Hoffmann

Advertising, Marketing and Business Development

Achim Abele Phone: +49 228 25900 347 achim.abele@mittler-report.de

Stephen Barnard Phone: +49 228 35 00 886, Mobile: +44 7984 033154 stephen.barnard@mittler-report.de

Stephen Elliott Phone: +49 228 35 00 872, Mobile: +49 1590 173 0346 stephen.elliott@mittler-report.de

Exhibition Management and Advertising Administration: Renate Herrmanns Advertising Accounting: Florian Bahr

Subscription/Reader Service:

PressUp GmbH, PO Box 70 13 11, 22013 Hamburg, Germany Phone: +49 40 38 66 66-319, Fax: +49 40 386666-299 Email: mittler-report@pressup.de

European Security & Defence, ©2023 Mittler Report Verlag GmbH

All rights reserved. No part of this publication may be reproduced without prior written permission of the publisher in Bonn.

Cover Photo: Long-exposure image shows the flight path of a SpaceX Flacon 9 rocket, which was successfully launched from the Vandenberg Space Force Base on 14 April 2023. Its payload included the SCORPIO Electronic Intelligence (ELINT) payload developed by Elettronica (ELT), which was placed into Low Earth Orbit (LEO). Photo: SpaceX

Annual subscription rate: €113.00 incl. postage

Reduced annual subscription rate for distribution in Germany: €95.00 incl. postage

European Security & Defence



Published monthly, EUROPEAN SECURITY & DEFENCE (ESD) is the leading defence and security trade journal in and for Europe.

Organised in four dedicated sections of interest – Politics, Armed Forces, Armament & Technology, and Industry – every issue responds to the information requirements of the European and global defence and security community.

We have the readers. Print and digital.

 MITTLER REPORT VERLAG GMBH
 info@mittler-report.de

 53173 Bonn · Germany
 www.mittler-report.de

Index of Advertisers

Abeking & Rasmussen	99
Diehl Defence	27
DNV	121
DSEI	39
Embraer	2nd Cover
ESG	29
Eurosatory	81
EVPÚ Defence	23, 47
Hirtenberger	61
IDEF	77
Index	71
Inertial Labs	21
Koehler	84, 149
Leonardo	37, 43
LITEF	125
Mercedes-Benz Defence Trucks	35
MSPO	49
Naval Group	4th Cover
Nurol Makina	59
Rheinmetall	65
thyssenkrupp	95
WB Group	25
Weibel	33
Xponential	53

■ BAE Systems Awarded Follow-on Funding to Further Tempest Development

(pf) The UK Ministry of Defence (MoD) has awarded a contract extension worth GBP 656 M (EUR 742 M) to BAE Systems to progress the concept work and technology for the Tempest next-generation combat aircraft, BAE announced on 14 April 2023. "The new funding will build on the ground-breaking science, research and engineering already completed under the first phase of the contract delivered by UK Tempest partners BAE Systems, Leonardo UK, MBDA UK and Rolls-Royce," BAE Systems stated in a press release.

The initial contract, worth around GBP 250 M, was announced in July 2021 and officially marked that start of the concept and assessment phase of what was then the UK's Future Combat Air System (FCAS)

Photo: BAE Systems



programme. However, the FCAS programme, in which Italy came on board as a partner, was in December 2022 merged with Japan's F-X effort to develop a sixthgeneration fighter to form the trilateral Global Combat Air Programme (GCAP).

Under this latest contract the UK Tempest partners, working in close collaboration with the MoD, will now progress the maturity of more than 60 cutting-edge technology demonstrations, digital concepts and new technologies, BAE noted. These are critical to the UK's sovereign defence capability and will help shape the final requirements – in conjunction with GCAP partners in Japan and Italy – for the combat air platform. The UK MoD is still aiming for Tempest to enter service with the Royal Air Force by 2035.

The GCAP/Tempest platform is designed to be an innovative, supersonic stealth

fighter equipped with cutting-edge technologies, including state-of-the-art sensing and protection capabilities. "This will make the aircraft one of the world's most advanced, interoperable, adaptable and connected fighter jets in service, delivering battle-winning next-generation weapons to protect the UK and its allies," BAE stated.

"The next tranche of funding for future combat air will help fuse the combined technologies and expertise we have with our international partners – both in Europe and the Pacific – to deliver this worldleading fighter jet by 2035, protecting our skies for decades to come," UK Defence Secretary Ben Wallace was quoted as saying in the BAE press release.

Richard Berthon, the UK MoD's Director of Future Combat Air, was quoted as saying, "Today, as planned, the UK MoD is releasing the next tranche of funding for future combat air. This shows that the UK is committed to working with international partners to deliver a next-generation fighter jet for 2035.

"We are facing a growing threat from our adversaries, who are investing in combat air and air defences of their own. By investing in GCAP, we will stay ahead of these intensifying and proliferating threats, and provide a highly credible deterrent capability for decades to come."

Finland Becomes 31st Member of NATO

(pf) Finland officially became the 31st member of NATO on 4 April 2023 in a ceremony that immediately preceded a two-day meeting of the alliance's foreign ministers in Brussels.

The ceremony, in which the Finnish flag was raised for the first time outside Nato's Brussels HQ with Finnish President Sauli Niinisto and his country's defence and foreign ministers, Antti Kaikkonen and Pekka Haavisto respectively, looking on, was appropriately held on NATO Day, which is commemorated in capitals across the alliance every year on 4 April.

Speaking in advance of the accession ceremony on 4 April, NATO Secretary General Jens Stoltenberg declared, "On this very day, in 1949, the Washington Treaty, NA-TO's founding treaty, was signed in Washington and it is hard to imagine a better way of celebrating our anniversary than to have Finland becoming a full member of the Alliance."

Finland's accession to NATO more than doubles the length of border that Russia now has with the alliance, with Finland's



1,340 km border with Russia now added to that of Estonia (294 km), Latvia (214 km) and Norway (198 km), along with Poland and Latvia's borders with the Russia exclave of Kaliningrad (232 km and 275 km respectively).

This is effectively the opposite of what Russian President Vladimir Putin was trying to achieve when he ordered the Russian invasion of Ukraine on 24 February 2022: an outcome summarised by Stoltenberg on the eve of Finland's accession when he stated, "President Putin went to war against Ukraine with a clear aim to get less Nato. He's getting the exact opposite."

Putin's miscalculation was that, in attempting to create a buffer zone against NATO by thwarting any chance of Ukraine joining the alliance, Russia's bloody belligerence would simply convince Finland and Sweden that adhering to neutrality was no longer an option. Finland and Hungary simultaneously handed in official letters of application to join NATO on 18 May 2022, less than three months after Russia invaded Ukraine.

While Sweden's accession to NATO remains held up by objections from Turkey's President Recep Tayyip Erdoğan over allegations that Sweden is sheltering dissidents that Turkey considers terrorists, Erdoğan waived any similar concerns in relation to Finland at a press conference in Istanbul on 17 March 2023.

Moscow's response to Finland's accession to the alliance was predictably hostile, with Kremlin spokesman Dmitry Peskov telling journalists that it was an "aggravation of the situation" that will force Russia to "take countermeasures to ensure our own security, both tactically and strategically". Peskov said Russia would "keep monitoring the situation and the deployment of NATO infrastructure and weapons on the territory of Finland", adding that "response measures will be taken accordingly".

Stoltenberg told reporters earlier that NATO troops would only be stationed in Finland with the country's consent.

Russia May Be Pressing 1950s-vintage T-54/55s Back Into Service

Footage has emerged on social media showing 1950s-vintage T-54/55 main battle tanks (MBTs) being transported by rail from Russia's Far East, suggesting Moscow might be having to dig deep into its stored reserves to replenish battlefield losses in Ukraine.

According to a 21 March 2023 posting by the exiled Russian open-source Conflict Intelligence Team (CIT), which is the source of the reporting, "the filmed train has recently departed from the town of Arsenyev, Primorsky region, where the 1295th Central Tank Repair and Storage Base is located".

According to CIT research, the Arsenyev base has relatively modern T-80BV and T-72B MBTs, a significant amount of old T-62M(V) tanks, as well as the T-54/55s. CIT noted that it had already documented shipments of T-62M(V) MBTs from Arsenyev; indeed, as of 22 March 2023 the Oryx blog, which details visually verifiable equipment losses in Ukraine, lists Russia as having lost 73 T-62 variants in Ukraine, mostly T-62Ms. However, this is the first time that evidence has emerged that Russia is bringing T-54/55s back into service. By contrast, there is no sign of Russia's latest MBT, the T-14 Armata, beyond parades in Red Square since 2015. In 2016 the Russian Ministry of Defence announced that it had signed a contract for a test batch of 100 T-14 Armatas to be delivered by 2020, but modernisation of Russia's current tank inventory subsequently took precedence, while Western sanctions imposed against Russia since its annexation of Crimea in 2014 and subsequent invasion of Ukraine may have thwarted T-14 production in areas such as electro-optics.

The first prototype of the T-54 was produced in 1945, although the T-54/55s seen leaving Arsenyev probably date from the 1950s/1960s and Russia's T-54/55s will have been upgraded a number of times throughout their services lives. Nevertheless, these are MBTs that would have been out of date in the 1980s and will be no match for even some of the older MBTs being gifted to Ukraine.

Ten new PzH 2000 SPHs Ordered for German Army

(pf) Ten new PzH 2000 tracked 155 mm self-propelled howitzers (SPHs) have been ordered for the German Army by the Federal Office of Bundeswehr Equipment, Information Technology and In-Service Sup-



port (BAAINBw), manufacturer Krauss-Maffei Wegmann (KMW) announced on 30 March 2023.

According to a BAAINBw press statement, the value of the contract is around EUR 184 M for an initial 10 PzH 2000s, although the deal includes options for up to 18 additional SPHs in three batches of six. The newly ordered SPHs and potential follow-on orders will backfill for the 14 PzH 2000s that Germany supplied to Ukraine last year. They will also feature certain upgrades, with the BAAINBw stating that "various obsolescences are also eliminated as part of [the] procurement". Delivery of the first four new PzH 2000s to the German Army is scheduled to take place in 2025, with the rest to be delivered in 2026, according to the BAAINBw.

The PzH 2000 first entered German service in 1998. According to the International Institute for Strategic Studies' *Military Balance 2023*, 109 PzH 2000s are currently in active German service.

TOS-1As to Russia's VDV Could Indicate Their Role in Future Offensive, Says UK Defence Intelligence

(pf) The Russian Airborne Forces (VDV) in Ukraine are being bolstered with the supply of thermobaric weapons, according to a UK Defence Intelligence update on 11 April 2023.

"As of 3 April 2023 Russian media reported the transfer of TOS-1A thermobaric multiple launch rocket systems to Russian airborne forces (VDV)," the update stated. It noted that the TOS-1A system "is typically operated by Russia's specialist Chemical, Biological and Radiological Protection Troops in Ukraine and has not



previously been formally associated with the VDV", adding that the transfer "likely indicates a future role for the VDV in offensive operations in Ukraine".

The TOS-1A is a 220 mm 24-barrel multiple rocket launcher mounted on a tracked T-72 tank chassis. Because it is capable of firing rounds armed with highly destructive thermobaric warheads, it is designated in Russian as a 'heavy flamethrower system'. The TOS-1A has already been deployed by the Russians in Ukraine, with the Oryx website, which tracks equipment losses in Ukraine, recording half a dozen such systems destroyed, damaged or captured as of mid-April.

The VDV, UK Defence Intelligence noted, suffered heavy casualties in the first nine months of the war in Ukraine, which would have been a period in which Russian commanders were still banking on their elite and best-trained units being able to prevail against the defending Ukrainian forces. In the opening days of the war VDV forces suffered heavy losses in their failed attempt to take Hostomel Airport in northern Kyiv in a heliborne assault, while VDV paratroops attempting to secure Vasylkiv Air base in Kyiv Oblast were also encircled and defeated.

According to BBC News Russian and the independent Russian Mediazona news website, 1,522 VDV deaths had been documented by 12 February 2023.

Romania Announces Plans to Procure the F-35

(pf) Romania has decided to press ahead with acquisition of the Lockheed Martin F-35 fifth-generation fighter. The decision was announced following a meeting on 11 April 2023 of the country's Supreme National Defence Council, which is led by Romanian President Klaus Iohannis.

While the agenda of the meeting focused mainly on the security situation in the Black Sea region, a summary of the meeting on the council's website noted that "the achievement of robust, credible, interoperable, flexible and efficient air defence operational capabilities, intended both to fulfil the commitments assumed as a result of NATO and EU membership as well as to deter a possible aggression, is the essential condition for fulfilling the objectives of the defence policy of Romania".

The summary then added, "The process of modernization of the air force will continue with the purchase of the latest-generation F-35 aircraft. These aircraft, equipped with a wide range of advanced sensors, the ability to exchange encrypted informa-

5

European Security Spotlight Defence



tion in real time with both air platforms and ground-based defence systems, the ability to actually manage the operational picture of the battlefield, as well and with high-precision intelligent munitions, allow achieving and maintaining air superiority: a mandatory condition for ensuring sovereignty in the national airspace and, if necessary, for its defence.

"In this sense, the members of the Council approved the concept of achieving the operational capability of air defence with fifth-generation multi-role aircraft."

No mention of numbers was made – and this is, of course, the very first stage of the acquisition process – but an ESD source in Romania suggested the Romanian Air Force (RoAF) would be looking to introduce the F-35 into service around 2030.

Since Romania joined NATO in 2004 the RoAF has long aspired to operating the F-35, even when its frontline combat fleet still consisted of MiG-21 Lancers.

The RoAF's current combat aircraft inventory consists mainly of 17 refurbished ex-Portuguese Lockheed Martin F-16AM/ BMs (14 single-seat AMs and three twinseat BMs), which were acquired between October 2016 and March 2021. An initial operational capability with the first 12 of these aircraft was declared in March 2019. With the last of the RoAF's MiG-21s (six Lancer Bs and 16 Lancer Cs) due to be withdrawn in May, the Romanian Ministry of National Defence stated in December 2021 that it planned to acquire 32 ex-Norwegian F-16s to add to its current Falcon fleet.

While previously there was always some question as to whether Romania could afford to buy F-35s, Russia's February 2022 invasion of Ukraine spurred the Romanian government to declare in October of that year that it would increase defence spending to 2.5% of GDP (it was 1.86% of GDP in 2021).

Romania is likely to spend up to USD 8 Bn (EUR 7.3 Bn) on defence in 2023. Romania's 2022 budget allocated RON25.9 billion (USD 6.14 Bn) to defence: a 14% nominal increase on 2021.

■ US to Supply M1A1 rather than M1A2 MBTs to Ukraine to Get Them Into Theatre Quicker

(pf) The United States will supply refurbished M1A1 Abrams main battle tanks (MBTs) to Ukraine rather than new-build M1A2s to get the tanks delivered to theatre more quickly, the US Department of Defense (DoD) stated on 21 March 2023. The US DoD originally announced in January 2023 that 31 M1A2 MBTs would be delivered to Ukraine. These would have been newly built tanks delivered direct from manufacturer General Dynamics Land Systems and paid for using funds from the US government's Ukraine Security Assistance Initiative. However, "officials had speculated it would take about a year to make that happen", according to a US DoD press release.

Instead, excess hulls already in the US inventory will be refurbished and refitted to the M1A1 standard and can be delivered to Ukraine by this autumn.



"Since we've made this announcement [to deliver M1 MBTs to Ukraine], we've been committed to exploring options to deliver the armoured capability as quickly as possible," said Pentagon Press Secretary US Air Force Brigadier General Pat Ryder during a press briefing on 21 March. "After further study and analysis on how best to do this, DoD, in close co-ordination with Ukraine, has made the decision to provide the M1A1 variant of the Abrams tank, which will enable us to significantly expedite delivery timelines, and deliver this important capability to Ukraine by the fall of this year."

The general noted that the M1A1 has "a very similar capability" to the M1A2 and added, "This is about getting this important combat capability into the hands of the Ukrainians sooner rather than later." The M1A1 Abrams has the same basic armament as the M1A2, including an M256A1 120 mm smoothbore main gun, an M240 7.62 mm coaxially mounted machine gun, and a .50 cal (12.7 mm) heavy machine gun and M240 7.62 mm machine gun mounted on the turret roof. The main changes in the M1A2 are certain 'fightability' improvements, including an improved commander's weapon station, a commander's independent thermal viewer, an inter-vehicular information system, a position/navigation system and a number of survivability upgrades.

Gen Ryder also said that a training plan for Ukrainian personnel was also underway. "We will ensure that the Ukrainians receive the necessary training on these tanks in time for them to be delivered," he said.

On 20 March the Pentagon announced the latest round of security assistance for Ukraine, worth about USD 350 M (EUR 324 M). This includes, among other things, ammunition for already-supplied High Mobility Artillery Rocket Systems; high-speed anti-radiation missiles; AT4 anti-armour weapon systems; grenade launchers, small arms and associated ammunition; and riverine patrol boats.

The US DoD stated on 21 March that, since the beginning of Russia's invasion of Ukraine on 24 February 2022, the US government has committed more than USD 32.5 Bn in security assistance to Kyiv.

Manufacturing Begins of British Army Boxers

(pf) The manufacturing of Boxer armoured vehicles for the British Army under the United Kingdom's Mechanised Infantry Vehicle (MIV) programme officially started at the Hadley Castle Works (Telford) site of Rheinmetall BAE Systems Land (RBSL) on 27 March 2023, the company announced the same day.

The event is a significant milestone for UK industry because, as RBSL pointed out in its press release, the last time production of an armoured vehicle began at Hadley Castle Works was in 1986 with the production of the British Army's Warrior infantry fighting vehicle (IFV) fleet. While manufacture of the first production Terrier armoured engineering vehicle began in January 2010, that was at BAE Systems' former Scotswood Road site in Newcastle.



6

"RBSL is proud to be regenerating this armoured vehicle capability and contributing to the Land Industry Strategy, marking a new chapter in vehicle manufacture for the UK defence industry," Colin McClean, RBSL Managing Director, was quoted as saying in the press release. "Not only will the delivery of Boxer provide the British Army with a complete step-change in capability to meet their MIV requirement, it will also protect vital engineering and manufacturing skills as a sovereign capability to the UK and we are incredibly proud to be a part of this milestone, alongside our partners in WFEL."

The GBP 2.3 Bn (EUR 2.62 Bn) MIV contract was awarded by the UK Ministry of Defence to ARTEC – a joint venture between Rheinmetall Landsysteme, Rheinmetall Defence Nederland BV, and Krauss-Maffei Wegmann (KMW) – in November 2019. The Boxer programme will deliver more than 600 vehicles to the British Army, with production subcontracted equally between RBSL, which is a UK-based joint venture between Rheinmetall and BAE Systems, and Stockport-based WFEL, which is a subsidiary of KMW.

RBSL says it has invested GBP 40 M in its 29-acre Telford site,

including the installation of system integration labs, which will support both Boxer and the British Army's Challenger 3 main battle tanks through life with updates and upgrades; new cranes, welding equipment and surface treatment facilities; and new test facilities, including a 1.6 km test track and what RBSL claims is the largest turret test rig in Europe.

"Over the last two-and-a-half years our employees have been working hard to prepare us for 'M Day' – Manufacturing Day," said McClean. "We have developed new manufacturing capabilities, state-of-the-art facilities, tools and IT infrastructure, and we have invested heavily in our people through recruitment, specialist training and development, ensuring we have the right, high-performing team to deliver our future.

"RBSL has a proud heritage of working with the British Army and remains the design authority for almost all of the UK's in-service armoured vehicle fleet. The Boxer MIV programme builds on that relationship and marks a new chapter in vehicle manufacture for the UK defence industry."

Embraer Pitches NATO-compliant A-29 to Air Forces in Europe

(pf) Embraer has launched a NATO-configured version of its A-29 Super Tucano turboprop light attack aircraft/trainer, the company announced at the LAAD 2023 defence exhibition in Rio de Janeiro on 12 April 2023.

Known as the A-29N, the new variant is initially focused on meeting the needs of European air forces and includes new equipment and features to fulfil NATO operational requirements, such as a new datalink and single-pilot operation.

These features will expand the aircraft's potential mission set, for example by allowing it to be used for Joint Terminal Attack Controller (JTAC) training. The A-29's training devices will also be upgraded to accommodate virtual, augmented, and mixed-reality training scenarios.



"This is a new stage in the operational life of the A-29 Super Tucano," Bosco da Costa Junior, President and CEO of Embraer Defense and Security, was quoted as saying in a company press release. "We see many application possibilities for the A-29N at the moment. Several European countries have shown interest in specific aircraft capabilities that we have now introduced with this version."

With more than 260 units delivered worldwide, the A-29 is in service with several air forces. Brazil is unsurprisingly the largest user, with around 80 A-29A/ Bs in service of 99 originally ordered. As well as also being in service with the air forces of Chile, Colombia, the Dominican Republic, Ecuador, Honduras, Indonesia, Lebanon, Mauritania, Nigeria and the Philippines, the A-29 was evaluated by the US Air Force under its eventually cancelled Light Air Support (LAS) programme. The US government had also delivered around 19 A-29s to the Afghan Air Force by the time of the Taliban takeover of Afghanistan in August 2021. A number of these aircraft were evacuated to Uzbekistan and Tajikistan, with no A-29s known to be in service with the Taliban's Islamic Emirate Air Force.

Developed to be versatile, the Super Tucano can perform a broad range of missions, including light attack, armed surveillance, air interception/policing, counter-insurgency missions, and advanced turboprop training. It can operate from remote and unpaved runways on forward-deployed operational bases with little support, with Embraer also touting its low operating costs and high availability rates (above 90%).

The A-29's effectiveness as a trainer is also enhanced by its ability to simulate combat missions and upload and download flight data.

Given the A-29's versatility, Embraer appears to be banking on a NATO-compliant Super Tucano finding favour with some of the more recent alliance member nations who might be looking to build a flexible and affordable air component with a fleet that can offer training, light attack and other capabilities in the same platform.

NATO Deputy Sec-Gen Underlines Importance of Black Sea Region as Tensions There Remain High

(pf) NATO Deputy Secretary General Mircea Geoană has underlined the strategic importance of the Black Sea region for Euro-Atlantic security as tensions there remain high.

In an address to the Black Sea Security Conference of the International Crimea Platform in Bucharest on 13 April 2023, Geoană stated, "The Black Sea region has been the focus of Russia's aggressive buildup and actions for more than two decades now. And the illegal annexation of Crimea in 2014 and the portions of the Donbass [were] just, if you want, the start-up.

"This is also influencing the Western Balkans. It's influencing also our Georgian friends. It's influencing our Moldovan friends. It's influencing our friends in Bosnia and Herzegovina. And this is why Russia's irresponsible and hostile behaviour in the broader Black Sea region is deeply affecting the security of the entire Alliance," said Geoană.

"So in Madrid last year, when our leaders approved the Strategic Concept stating the strategic importance of the Black Sea, this is not just a piece of paper; this is a fundamental belief and action by our Alliance," Geoană asserted.



Geoană went on to note that NATO has doubled the amount of multinational battlegroups it has fielded since Russia invaded Ukraine in February 2022. The alliance's forward presence in eastern Europe was first deployed in 2017 with the creation of four multinational, battalion-sized battlegroups in Estonia, Latvia, Lithuania and Poland led by the United Kingdom, Canada, Germany and the United States respectively. After February 2022 the alliance reinforced those existing battlegroups and established four more in Bulgaria, Hungary, Romania and Slovakia. Geoană said that, having established these new battlegroups, NATO would be "bringing them up to brigade level as needed".

"We continue, and we will continue, to support Ukraine," he said. "We have stood by Ukraine since the independence of this country back in 1991. Over the last year, Allies have provided unprecedented support for Ukraine's right to self-defence, with EUR 65 Bn of military aid. ... NATO will stand by Ukraine for as long as it takes. And we will support your long-term path to Euro-Atlantic integration."

Meanwhile, tensions in the Black Sea region between Russia and the NATO allies supporting Ukraine remain high, exacerbated in particular by the aggressive tactics of Russian pilots. On 14 March 2023 a US MQ-9 Reaper unmanned aerial vehicle had to be ditched in international waters southwest of Crimea after being struck by a Russian Su-27 fighter that was harassing it.

The recent mass leak of highly classified US military documents has also revealed that an incident over the Black Sea on 29 September 2022, which involved the release of a Russian air-to-air missile (AAM) in the vicinity of a patrolling Royal Air Force (RAF) RC-135 Rivet Joint electronic surveillance aircraft, could have been much more serious than previously thought. The documents appear to show that, rather than being an accident as originally reported, the RC-135 was deliberated targeted by a Russian Su-27 pilot after he misunderstood an order from a radio operator. The RC-135 and its crew, which could have numbered around 30 personnel, were only saved when the AAM misfired, according to the documents.

On 13 April Jack Teixeira, a 21-year-old airman working in the intelligence wing of the Massachusetts National Guard, was arrested as the source of the US intelligence leaks.

The veracity of the leaked documents has not been corroborated by the UK Ministry of Defence (MoD), but The Times reported on 14 April that the documents suggest that on 11 January and 22 February 2023 Russian aircraft again responded to RAF Rivet Joint flights, which by this point were escorted by RAF Typhoon fighters. Approached by ESD on 14 April, the MoD declined to confirm this, however.

Raytheon Receives USD 1.2 Bn Contract to Deliver Patriot to Switzerland

(pf) Raytheon Technologies has been awarded a USD 1.2 Bn (EUR1.1 Bn) Foreign Military Sales (FMS) contract from the US Army to provide Switzerland with the Patriot air defence system, Raytheon announced on 3 April 2023.

The contract includes five Patriot fire units and a quantity of Guidance Enhanced Missiles (GEM-Ts), which provide an improved ability to defeat tactical ballistic missiles, cruise missiles or enemy aircraft.



Acquisition of the Patriot system is part of an overhaul of Switzerland's air defences through the country's Air2030 programme, under which on 30 June 2021 Switzerland selected Patriot alongside the Lockheed Martin F-35 Joint Strike Fighter as the country's new fighter. A USD6.25 Bn contract for 36 F-35As was signed in September 2022, while the FMS of Patriot to Switzerland was approved by the US State Department in November 2022.

With this sale Switzerland becomes the 17th Patriot export customer and the eighth European country to choose the system as the backbone of its air defences.

Australian Tomahawk request progresses



(pf) Australia's intention to buy up to 220 RGM-109E Tomahawk cruise missiles from the United States was approved on 16 March 2023 by the US Defense Security Cooperation Agency, which estimated the deal to be worth USD 895 M (EUR 830.54 M).

The purchase, which still awaits approval from the US Congress, would consist of up to 200 Tomahawk Block V all-up rounds (AURs) and up to 20 Tomahawk Block IV AURs.

The Tomahawks in this sale would be carried by the Royal Australian Navy's (RAN's) three Hobart-class air warfare destroyers, although this weapon system is also likely to arm Australia's future SSN-Aukus class of nuclear-powered attack submarines (SSNs) being built with US and UK assistance under the Aukus Pact. The Tomahawk already arms the US Virginia-class SSN, of which the RAN will acquire at least three under the latest Aukus plans.

Also included in the sale is support for all three segments of Australia's Tomahawk Weapon System (TWS), to include the AURs, the Tactical Tomahawk Weapon Control System (TTWCS) and the Theater Mission Planning Center (TMPC).

The Block V Tomahawk, delivered from 2021, is a modernisation of the Block IV with navigation and in-flight targeting improvements; the Block Va is able to strike moving targets at sea, while the Block Vb has a joint multi-effects warhead that can strike more diverse land targets. While the RGM-109E Block IV has a maximum range of around 1,667 km (900 n miles), the Block V has a classified range that exceeds that.

The UK Royal Navy is currently the only operator of the Tomahawk cruise missile, although, in addition to Australia, Japan also intends to acquire the system.

Stating that it is "vital to the US national interest to assist our ally in developing and maintaining a strong and ready selfdefense capability", a DSCA statement said, "The proposed sale will improve Australia's capability to interoperate with US maritime forces and other allied forces as well as its ability to contribute to missions of mutual interest. By deploying the Tomahawk Weapon System, Australia will contribute to global readiness and enhance the capability of US forces operating alongside them globally. Australia will use the enhanced capability as a deterrent to regional threats and to strengthen its homeland defense."

The prime US contractor for the sale will be Raytheon Missiles and Defense, based in Tucson, Arizona.

Firms & Faces

Pietro Mazzei Appointed as New President and CEO of Rheinmetall Canada



(pf) Pietro Mazzei has been appointed as President and Chief Executive Officer of Rheinmetall Canada by the Rheinmetall board, the company announced in a press release on 3 April 2023. Mazzei has been a

member of Rheinmetall Canada's executive committee and has headed its

Electronic Solutions/C5ISTAR business line since 2016.

Prior to joining Rheinmetall Canada, Mazzei spent more than 25 years with CAE Inc in various strategic roles, including several years internationally.

Mazzei succeeds Stéphane Oehrli, who held the position as CEO of Rheinmetall Canada since 2017.

Rheinmetall Canada is headquartered in Saint-Jean-sur-Richelieu, Quebec, and specialises in the design and integration of surveillance solutions, vehicle systems, autonomous solutions, and remotely controlled weapon systems.

Antonio Bueno Appointed President of GDELS



(pf) Antonio Bueno has been appointed presiie dent of General Dynamics European Land Systems (GDELS), the company announced on 11 April 2023. Bueno replaces Alfonso Ramonet, who has retired.

Bueno has been vice president Finance, Information Technology and chief financial officer of GDELS since

June 2019 after serving as vice president, Armoured Vehicles & Artillery, and managing director of GDELS Santa Bárbara Sistemas. He holds a degree in Business Administration and Management from the University of Oviedo and completed the Executive Development Program at the Booth School of Business at the University of Chicago.Ramonet joined GDELS Santa Bárbara Sistemas in 1990. He was appointed managing director of Santa Bárbara Sistemas in 2006 and promoted to chief operations officer of GDELS in 2010. Since December 2011 Ramonet has served as president of GDELS and vice president of General Dynamics.

Under Ramonet's leadership, GDELS focused on the 'One Company' culture. He integrated a collection of sites into a unified business with a joint engineering, marketing, production, and human resources strategy and expanded GDELS' home market footprint to seven countries. Ramonet said:

"Antonio Bueno and I have been working together since 2005," said Ramonet. "He is a highly skilled professional who knows the GDELS organisation very well and has earned its full respect. He, supported by the GDELS team, will do an excellent job and continue serving our customers and all stakeholders".

Bueno was quoted as saying, "I thank Alfonso Ramonet for his vision and leadership and look forward to capturing new opportunities with our formidable GDELS team. Together we shall further strengthen our unique position as a transatlantic partner in Europe by reliably and compellingly supporting our customers and partners with evermore innovative military mobility solutions."

Roberto Cingolani becomes CEO of Leonardo



Photo: Leonardo

g o v e r n m e n t appointed Roberto Cingolani as CEO of statecontrolled defence company Leonardo on 12 April 2023. C i n g o l a n i 's appointment, which must be approved

(gh) The Italian

by shareholders, will see him succeed Alessandro Profumo, who is retiring after serving two terms since 2017.

Cingolani started out as a scientist at the Max Planck Institute for Solid State Research in Stuttgart from 1988 to 1991. He then became a physics professor at the University of Lecce (now Salento) in the 1990s, a visiting professor at the University of Tokyo and then Virginia Commonwealth University in the United States between 1997 and 2000, returning to a professorship at the University of Salento from 2000 to 2005.

From 2005 Cingolani headed the Istituto italiano di tecnologia (IIT) in Genoa before

becoming chief technology and innovation officer at Leonardo in 2019. He then embarked on a political career that led to him becoming Minister of Environmental Transition. After the change of Italian government in 2022, Cingolani continued to serve as an energy advisor.

AM Knighton to be UK's new Chief of the Air Staff

(pf) Air Marshal Sir Richard Knighton is to be appointed as the UK's next Chief of the Air Staff in the rank of air chief marshal, succeeding Air Chief Marshal Sir Mike Wigston in June, Defence Secretary Ben Wallace confirmed on 31 March 2023.

AM Knighton is currently Deputy Commander Capability and People at Air

Command, where he is responsible for the strategic planning and delivery of all aspects of Royal Air Force (RAF) capability.

Perhaps as a sign of the times, AM Knighton will be the first engineer to lead the RAF; before now a pilot has always led the service.

AM Knighton joined the RAF in 1988 and spent his early career working as an engineer officer in a range of operational and staff appointments on Nimrod, Tornado F3 and Harrier aircraft.

In 2007 AM Knighton was promoted to group captain and became Deputy Assistant Chief of Staff Strategy and Plans at Air Command at RAF High Wycombe. He joined RAF Wittering as the Logistics Force Commander two years later and also served as the station commander at RAF Wittering.

AM Knighton has held a range of staff appointments in the UK Ministry of Defence, Air Command and in equipment acquisition and support. He has thus been closely involved in strategic and capability planning for the RAF. The air marshal has also been the Assistant Chief of Air Staff, where he was responsible for the strategic coherence and co-ordination of the RAF and for planning the RAF100 centenary programme.

While AM Knighton has not served on deployment to either Afghanistan or Iraq during his career, he brings with him a reputation as an effective operator, with his particular skillsets viewed as most appropriate for leading the RAF in the 21st century.



9

Space is No Sanctuary

Doug Richardson

Modern military capabilities are becoming increasingly dependent on satellites, from communications to navigation, to reconnaissance and intelligence. This situation makes the space domain a crucial battleground in the future, and is incentivising the development of both offensive and defensive capabilities in this sphere.

Sixty years ago, a group of computer Susers at the Massachusetts Institute of Technology developed a primitive computer game that they dubbed Spacewar!. Run on the Digital Equipment Corporation PDP-1, a computer with a clock speed of 187 kHz, and only 9 Kb of memory, it featured two torpedo-armed spaceships under the control of rival players and able to dogfight while manoeuvring in the gravity well of a star located at the centre of the screen. Today, Spacewar! is a distant landmark in the history of computer games, but in the real world the techniques for space warfare have been explored by at least four nations. Satellites used for tasks such as communications, reconnaissance, and early-warning could be major targets in any future conflict.

US DoD Joint Publication 3-14 2018 titled Space Operations warned that adversaries were "developing, testing, and fielding capabilities in an attempt to deny the United States the advantages gained from space. Our adversaries' progress in space technology not only threatens the space environment and our space capabilities but could also potentially deny us an advantage if we lose space superiority."

Military satellites are not the only potential target. On 27 October 2022, a senior Russian foreign ministry official warned that as a result of military exploitation of commercial space systems such as SpaceX Starlink communications satellites and Maxar imaging satellites, these spacecraft "may become a legitimate target for retaliation."

A Hostile Environment

Space is, and always will be, a hostile environment that challenges the spacecraft designer. It poses problems such as tem-

Author

Following an earlier career in engineering, **Doug Richardson** is a defence journalist specialising in topics such as aircraft, missiles, and military electronics.



On 21 February 2008, the US Navy Aegis cruiser Lake Erie launched a single modified SM-3 missile which successfully engaged a defective US National Reconnaissance Office radar-imaging spacecraft.

perature-control, radiation, the absence of atmospheric pressure, residual atmospheric drag, spacecraft electrostatic charging, and the risk of meteoroid impact, or impact with man-made space debris. Although electromagnetic interference has the potential to disrupt spacecraft operation, this would be unintentional. However, intentional man-made threats include antisatellite (ASAT) weapons, lasing and other forms of directed energy attack, as well as cyberattacks.

The simplest form of ASAT weapon is the direct-ascent interceptor. After launch, these missiles fly suborbital trajectories that result in them intercepting a target spacecraft – a technique that requires a detailed knowledge of the target's orbit

and current position. There are two potential kill mechanisms. One relies on directly striking the target, relying on the interceptor's mass and speed to create an impact that will at a minimum cause massive damage to critical components, and at best totally shatter its victim. The other approach uses a proximity-fuzed explosive warhead, and will remain effective if the attacker has less accurate knowledge of the target's position. Both types of attack will create large debris fields which can be a hazard to other spacecraft, and increase the risk of a 'Kessler syndrome' scenario occurring, which would impede space exploitation for all.

Orbiting inspectors

An alternative engagement method involves placing a dedicated interceptor spacecraft into an orbit similar to that of the target. This allows the interceptor to make a slow approach to observe the other spacecraft. Images of the latter could show optical ports, antennas and sensors, features that would suggest the target spacecraft's intended purpose.

To test the technology needed to allow one small unmanned spacecraft to close in on another, the US Air Force Research Laboratory gave Boeing a contract to develop the XSS-10 (eXperimental Small Satellite 10), a microsatellite weighing only 28 kg. Launched by a Delta II vehicle on 29 January 2003, the XSS-10 was released from Delta II's second stage about 16 hours after lift-off. It then used its built-in guidance system (which included a television camera) to manoeuvre itself close to the spent second stage. The XSS-10 then backed away from the stage, and repeated the approach twice more. Under a follow-on project to demonstrate autonomous rendezvous and proximity manoeuvres, Lockheed Martin built a 125 kg spacecraft designated XSS-11. Launched by a Minotaur rocket on 11 April 2005, it spent more than 18 months in its primary orbit, before being manoeuvred into a graveyard orbit.



This artist's rendition shows two US Geosynchronous Space Situational Awareness Program (GSSAP) satellites in orbit.



The spent Delta-K second stage of a Delta II rocket was photographed in orbit in January 2003 by the XSS-10 satellite that it had just launched.

Until 2014, the existence of a US satelliteinspection system able to perform rendezvous and proximity manoeuvres in geosynchronous orbit was classified, but the programme was publicly disclosed in February of that year. Built by Orbital Sciences, the Geosynchronous Space Situational Awareness Program (GSSAP) satellites are controlled by operators at Schriever Air Force Base in Colorado.

Launched into in drift orbits just above or below Geostationary orbit (GEO) or Geosynchronous orbit (GSO), GSAAP satellites are able to position themselves close to selected non-US spacecraft, then use optoelectronic sensors to observe these, so that ground-based intelligence analysts can assess the target's likely role. It has been speculated that GSSAP spacecraft may also carry electronic intelligence (ELINT) receivers able to monitor radio transmissions to and from the satellite being observed. Given their method of use, GSSAP satellite are likely to carry a large enough quantity of propellant to allow frequent orbit adjustments and station-keeping manoeuvres. During a press briefing in September 2015, Gen. John Hyten, commander of Air Force Space Command, revealed that the first two GSSAP satellites to be launched had been temporarily taken out of test mode to make observations of specific objects in GEO/GSO. "The users that requested the information are extremely pleased with the pictures we gave them," he stated, describing them as "truly eye-watering".

Since US military satellites have been monitoring other inhabitants of GEO/GSO since the 1990s, it is hardly surprising that Russia and China have joined this orbital ballet, using their own specialised satellites to observe US spacecraft. For example, soon after China's Shiyan-12-01 and Shiyan-12-02 satellites reached geostationary orbit early in 2022, the US manoeuvred its GSAAP-3 to take a close look at the newcomers, which responded by conducting counter manoeuvres during which Shiyan-12-02 is reported to have positioned itself in a good location to observe the US satellite.

Potential Means of Attack

Given its slow approach speed, an orbital interceptor will be unable to use kinetic impact in order to obtain a kill. The easiest solution might be to equip the interceptor with a warhead, or with a rocket-powered sub-missile that it can fire at the target. An alternative kill mechanism might be some form of chemical spray that could damage optical windows, solar panels, or antennas of the victim.

Robotic Arms – a Cause for Concern?

Some spacecraft designed for rendezvous missions are also being fitted with robotic arms. Working under a contract from the US Space Force, Northrop Grumman is developing a spacecraft fitted with a robotic arm that could be used to repair or relocate other satellites. Due to make its debut in 2024, the Mission Robotic Vehicle (MRV) is equipped with a robotic arm, and will be able to install propulsion packs on failing or failed satellites.

Sometime in 2026 or later, NASA plans to launch OSAM-1 (On-orbit Servicing, Assembly, and Manufacturing-1), a spacecraft equipped with robotic arms and all the tools and equipment needed for a planned repair mission intended to refuel the Earthobserving satellite Landsat 7. In orbit since 1999, Landsat 7 was not built with refuelling in mind, so OSOM-1's ground-based engineers will direct one of robotic arms to use the tools needed to cut away the satellite's multi-layer insulation thermal



This artwork shows how NASA's On-orbit Servicing, Assembly, and Manufacturing 1 (OSAM-1) spacecraft (bottom) will grapple Landsat 7 before giving the latter a fresh supply of fuel.

credit: USAF



Light from three green lasers is sent skywards from facilities at the Starfire Optical Range on Kirtland Air Force Base, New Mexico. Deformable optics are used to minimise optical distortions caused by the Earth's atmosphere. The Starfire lasers are used for research, but similar technology might allow the creation of a laser-based weapon for direct attacks against satellites.

blanketing, then expose and unlock the propellant fill/drain valves so that these can be accessed by a refuelling hose.

Servicing existing satellites, or removing life-expired examples from GEO/GSO are useful activities, but the ability to manoeuvre one satellite close to another or even to connect up the two has obvious military applications. The technology that makes one class of mission possible also enables the other. Although a valuable tool for use on satellite-repair missions, a robotic arm gives a spacecraft the potential ability to conduct a docking manoeuvre against a non-cooperative target, or even to render the latter inoperable by inflicting damage by degrading or disabling individual components of its victim such as solar panels, antennas, or optical ports.

Directed Energy – the Multi-Shot Threat

Often ground-based, directed-energy weapons use high-powered beams of laser or microwave energy to damage or destroy the targeted spacecraft. Their effect is scalable, so that the damage inflicted to the victim can be either temporary or permanent. Interceptor satellites are essentially single-shot systems, but a directed-energy weapon would be capable of engaging multiple targets.

In an April 2022 presentation to the US Senate Armed Services Committee, General James H. Dickinson, the Commander of US Space Command noted that "Russia also has several ground-based low-power lasers designed to temporarily blind US missile warning and imagery satellites, and high-power lasers developed to damage US satellites." He also warned that China has "multiple ground-based laser systems of varying power levels that could blind or damage satellite systems."

Hacking the Satellites

In May 2022, Secretary of State Antony J. Blinken reported the US assessment that Russia had launched cyberattacks against commercial satellite communications networks in late February of that year in order to disrupt Ukrainian command and control during the early stages of the Russian invasion if Ukraine. This activity had disabled very small aperture terminals in Ukraine, but had also affected tens of thousands of terminals outside of Ukraine, he claimed.

Protecting the spacecraft

Some of the potential methods of defending satellites from attack are similar to those used to protect aircraft and UAVs from attack – manoeuvrability, passive and active countermeasures, and stealth. Spacecraft manoeuvres might be used to create problems for the enemy's targeting system. Speaking at the 2019 Aspen Security Forum, former Secretary of the US Air Force Heather Wilson revealed that the Boeing X-37B unmanned recoverable spacecraft can fly at altitudes low enough to allow the use of atmospheric drag to change its orbital parameters in order to temporarily confuse the space-surveillance systems of other counties.

In a 2015 documentary on the US CBS TV channel, General John Hyten, at that time head of Air Force Space Command, was asked if US military satellites could manoeuvre to counter an anti-satellite weapon. "It depends on a huge number of variables", he replied. "It depends on the satellite. It depends on the mission. It depends on when [the satellite] was built, depends on how old it is. It depends on when we know the threat is coming."

Given the high level of secrecy associated with many types of military spacecraft, almost nothing is known about their configuration and payload. While most if not all will use thrusters for orientation and orbital positioning, the capacity of their propellant tanks, and thus the degree of potential manoeuvrability available for defensive purposes is unknown. In the case of highvalue space assets such as large reconnaissance, sigint, and early-warning spacecraft that are expected to have a long service life, it might be possible use an orbital-repair capability to top up the thruster propellant stock, or to attach a module containing decoys and obscurant launchers. A New York Times article published on 3 November 1987 claimed that "Future spy satellites will be capable of being refuelled, dramatically extending their range and lifespan."

KH-11 imaging satellites use a hydrazinepowered propulsion system when making orbital adjustments, and it has been suggested that this could have been refuelled during classified missions by the Space Shuttle. The Block III satellites (KH-12) have a reported lifetime of 15 years, which may have been made possible by larger fuel reserves and unmanned refuelling missions.

Potential Countermeasures

If an incoming direct-attack interceptor has achieved lock-on, this could be broken by the deployment from the satellite of a cloud of obscurant, while the release

Credit: NAS

of several decoys could create problems when the attacker tries to regain lock. Another way of defending satellites would be to equip these with electronic and optical countermeasures intended to jam or spoof enemy kill vehicles, or even to use kinetic shoot-back weapons based on unguided or guided projectiles. An alternative approach would be to mount such hardware on separate guardian satellites, or even to use guardian satellites able to rapidly reposition themselves between the enemy threat system and the satellite the guardian is protecting.

Is Stealth the Answer?

Stealth technology is being applied to military spacecraft – a concept described in a 1963 memorandum which the US National Reconnaissance Office declassified in 1997. This document described the need for a satellite featuring a "reduction in radar and optical cross-sections below the detection threshold" and stated that "as no vehicle to ground transmissions are permissible, any ground command system envisaged must operate without verification of commands received."

As part of its celebration of the 40th anniversary of the first successful mission of a Corona spy satellite, in August 2000 the US National Reconnaissance Office (NRO) honoured 10 individuals who had played a major role in creating the US space-based reconnaissance capability. One of these was Dr. Edward Purcell, whose main contribution "involved methods to make these vehicles, if not invisible to radar, hard to observe with radar." During the 1980s a special security classification named 'Zirconic' was set up to control access to information on US programmes involving stealth satellites.

Radar cross-section and visual detectability are largely dictated by the size of the basic structure of the spacecraft and of its external components such as solar panels or antennas. But there is very little information in the public domain on how a satellite's signature might be minimised. In some ways the situation is similar to that of half a century ago, when the existence of first-generation stealth aircraft was known, but there was almost no accurate information on how signature reduction had been achieved.

Clues to possible methods for creating a stealthy spacecraft have been given in several US patents. A 1994 patent filed by Teledyne Industries (now Teledyne Technologies) proposed using a large inflatable cone-shaped balloon made of Mylar or Kapton coated with a film of radiation reflecting material such as gold or aluminium, which would be mounted



Solar arrays are large and easily damaged, as the results of an accidental collision between the Spektr module of Russia's Mir space station and the Progress M-34 unmanned freighter on 25 June 1997 demonstrated.

on a rotating arm on the body of the spacecraft. This arm could be moved into position to conceal the satellite when such measures were needed, with the balloon intended to deflect radar energy and light away in harmless directions. According to the patent, this was intended "to suppress the laser, radar, visible and infrared signatures of satellites to make it difficult or impossible for hostile enemy forces to damage or destroy satellites in orbit". At times when the satellite needed to observe targets on the ground, the device could be moved out of the way of the spacecraft's sensors.

Another scheme based on inflatable hardware was patented by Bigelow Aerospace in 2005. This combined a multi-layer inflatable shell with a core able to house missionspecific payloads, an attitude-control device, a power source, and a controller. The shell could incorporate radar absorbing materials and/or geometries that reflect radar waves at angles that make detection of the craft



This diagram from a US Patent awarded to Teledyne Industries shows how a movable arm (40) could position a conical anti-radar shield (10) in the general direc¬tion of a threat if an attack on the satellite (12) seems imminent, then move it back to a parked position when the satellite is ready to resume its normal functions.



India became the third country to demonstrate ASAT capability when it launched its Ballistic Missile Defence (BMD) Interceptor missile to engage a target satellite in Low Earth Orbit (LEO) on 27 March 2019.

difficult, but may also have radio or microwave characteristics that allow specific radio frequencies to pass through the shell without substantial attenuation, allowing the mission payload to transmit and receive information. The shell could also incorporate a window to be used by optical equipment inside the craft such as a camera. The shell could be coloured as to make visual detection more difficult, while its shape would conceal the function of the spacecraft.

Stealth in action

Press reports in 2007 claimed that in November 1990, the US had used the space shuttle Atlantis to launch a highly-classified satellite designed to rendezvous with Russian and other satellites in GEO/GSO. Reported to be optically stealthy, and to have the nickname 'Prowler', it was said to have the ability to home on its target autonomously rather than relying on data and commands sent by its ground-based users. Once in position close to a satellite, 'Prowler' was credited with the ability to capture visual imagery of the target, measure its size and RCS, and detect the radio frequencies that the target used.

The US is thought to have used stealth technology in a classified programme with the reported codename of 'Misty'. This designation has been associated with satellites launched on 28 February 1990 and 22 May 1999. Following both launches, groundbased amateur observers were initially able to track the satellite, but shortly afterwards could find only a group of smaller multiple objects. Since it is unlikely that both satellites had suffered from catastrophic failure, it is possible that these satellites had released multiple decoys before moving off towards their operational orbit. Although a followon stealth satellite programme was reported in 2004, shortly after becoming the United States Director of National Intelligence in 2007, vice admiral Mike McConnell was understood to have cancelled it, but this has never been confirmed.

Large Constellations – a Novel Solution

If the would-be attacker is faced with only a relatively small number of satellites that need to be targeted, only a modest number of ASAT weapons will be required. So an obvious countermeasure is to significantly increase the number of satellites, forcing the other side to increase the quantity and/or size and cost of its threat systems.

One simple way of complicating the situation for a would-be attacker is to deploy a larger number of similar satellites to in order to perform missions. A less-expensive defensive measure might be avoid the use of multi-mission satellites, and deploy a larger number of separate mission-specific spacecraft which operate in parallel to provide the same total capability. This approach is known as disaggregation.

Set up in March 2019, the US Space Development Agency (SDA) favours the use of large satellite constellations based on low-cost spacecraft. It envisages a network of satellites in low-earth orbit that would be deployed in layers tasked with different military capabilities such as reconnaissance, surveillance, global navigation, and communications. These individual spacecraft would be interlinked by a secure command and control network using laser-based communications.

Mass-produced and comparatively inexpensive due to the use of commercial satellite technology, these networked satel-



DARPA's Blackjack programme is intended to develop and demonstrate the critical elements for a global high-speed network of satellites deployed in low Earth orbit (LEO). A constellation of this complexity would be difficult target for a non-nuclear ASAT attack.



On 23 October 2022 India's LVM3 launch vehicle carried a total of 36 One-Web communications satellites into low Earth orbit. The total weight of the combined payload was 5,796 kg, and the individual spacecraft were dispensed over a period of 1 hour and 15 minutes.

lites would total more than 1,000 by 2026, so would be numerous enough to saturate the capabilities of the ASAT weapons deployed by potential opponents. Individual satellites would be relatively short-lived, so the production programme would use spiral development to steadily improve their capabilities.

Following its realignment underneath the US Space Force, on 23 January 2023 the Space Development Agency (SDA) renamed its National Defense Space Architecture (NDSA) to the Proliferated Warfighter Space Architecture (PWSA).

Speaking during a Space Symposium 365 event in February 2022, Space Systems Command Executive Director Joy White stated that as a result of growing concerns over evolving on-orbit threats, Space System Command had set 2026 as the target date for delivering "maximum operational capability" in the form of new, more resilient space systems.

Each of the planned tranches of the PWSA is essentially one generation. Planned for Fiscal Year 2022 (FY22), Tranche 0 is seen

as the minimum viable product able to demonstrate the feasibility of the PWSA in terms of cost, schedule, and scalability. Tranche 1 in FY24 will be expected to provide an initial warfighting capability in terms of regional persistence for tactical data links, advanced missile detection, and beyond line-of-sight targeting.

Tranche 2 in FY26 will expand the system to provide global persistence. In March 2023, the SDA released a request for industry feedback on a tranche 2 low Earth orbit Tracking Layer architecture able to provide global surveillance and targeting for missile warning, missile tracking, and missile defence. Information was sought regarding "mature infrared payloads for space-based sensing, constellation architecture(s), resiliency methods, and mission data processing parameters". Contract award was planned for FY24, leading to first launches in mid-FY27.

Tranche 3 in FY28 is expected to include better sensitivity for missile tracking, better targeting capabilities, additional positioning, navigation and timing (PNT) capabilities, plus advances in blue/green laser communications and protected RF communications. Tranche 4 (FY30) should incorporate whatever additional capabilities have been identified as being needed to meet current or future threats.

The SDA uses the term 'layer' to indicate a particular function of the architecture, but this function may not have its own dedicated constellation of satellites. Some layers will deliver capabilities with sensors, processors or other technologies hosted on another layer's satellites. An example of this approach is the Battle Management Layer whose software and processing capabilities will be hosted on most or even all PWSA spacecraft.

The Tracking Layer and Custody Layer will provide sensing functions for advanced missile threats and time-critical land and maritime targets, but will be connected to the Transport Layer – a network of communication satellites that connect to one another and to other space vehicles and ground stations via optical inter-satellite links (OISLs). Threat indications and targeting data will be transmitted to the ground in real time.

The growing use of large constellations of Low Earth Orbit (LEO) telecommunications satellites has changed the way that these spacecraft are launched. Iridium's constellation of more than 80 satellites involved missions in which a single launch vehicle carried ten satellites, but this was eclipsed in May 2019 when SpaceX began to use its Falcon 9 launch vehicle to orbit 60 satellites at a time. While using a launch vehicle weighting hundreds of tonnes may be a viable method of orbiting such a large number of satellites simultaneously, a similarly-sized missile able to release a similar number of ASAT kill vehicles would not be a viable weapon for use against a numerically-large satellite constellation.

SRO

Credit

Secrets of the 'Black' World

Given that details of the KH-7 Gambit photo-imaging satellite remained classified until 2011, more than four decades after the system was taken out of service, it is likely that details of systems such as Misty will remain 'under wraps' for several decades more, especially information relating to its low-observable features. Russia and China are likely to be equally cautious is releasing this class of information, so the full story of ASAT systems, satellite inspectors, stealth spacecraft, and the orbital game of move and counter-move is unlikely to be told in the foreseeable future. Yet from available information it seems clear that the cosmic arms race is already well under way.

Kick Out the Jams

Thomas Withington

UAVs are helping define the tactical battle on the ground in Ukraine. The country needs low-power jamming technology to use against these threats which can be sourced domestically.

very war has its signature weapons. The First World War famously had the tank and aircraft, the Second World War U-Boats and the atomic bomb. America's tenyear involvement in the Vietnam War made the helicopter famous against a soundtrack of some of the finest music the world had ever heard. The 1982 Falklands conflict made the anti-ship missile infamous. Nine years later, the Persian Gulf War witnessed Scud missiles and precision-guided weapons enter the popular lexicon.

The Ukraine War is barely a year-old and already Unmanned Aerial Vehicles (UAVs) are gaining similar visibility. Both Russia and Ukraine are enthusiastic UAV users, exploiting the capabilities of these platforms to the full to gather Intelligence, Surveillance and Reconnaissance (ISR) information. Widespread UAV use by the Russian armed forces also points towards the Electronic Warfare (EW) systems Ukraine's supporters must supply if they are to help the country defeat Russia.

Russia's land forces, which include the army along with her airborne forces and naval infantry, employ UAVs for a host of missions including ISR gathering. UAVs also support EW, carrying jammers and Communications Intelligence (COMINT) payloads. The Russian Army uses UAVs to help artillery fire control. Ukrainian sources have told the author their employment to help Russian gunners has proven especially devastating. As Russian military experts Dr. Lester W. Grau and Charles K. Bartles note in their seminal 2016 work The Russian Way of War, that Russian Army artillery performs an array of missions. Known as the Missile and Artillery Troops, they are tasked with delivering conventional and tactical nuclear ordnance. The army uses Self-Propelled Howitzers (SPHs) and towed guns with calibres of 122 mm and 152 mm. These achieve

<u>Author</u>

Thomas Withington is an independent electronic warfare, radar and military communications specialist based in France.



Russian Army artillery fire has proven particularly effective in Ukraine, helped in no small measure by UAVs locating targets and collecting battle damage information.

ranges of between 3 km (1.9 miles) and 33 km (20.5 miles). Rockets engage targets beyond these ranges at circa 40 km (24.9 miles) and beyond.

The army's principle manoeuvre units in the form of its tank/motorised rifle brigades/ divisions usually have four organic artillery battalions. A Multiple-Launch Rocket System (MLRS) battalion will be joined by two SPH battalions and an anti-tank artillery battalion. The latter typically engage enemy armour at ranges of up to 10 km (6.2 miles). The brigades and divisions will also have an organic mortar battery. This engages targets at up to 13 km (8.1 mile) range. Russian Army Battalion Tactical Groups (BTGs) are typically smaller than the formations discussed above, and they tend to have one self-propelled howitzer battalion.

Doctrinally, as Bartles and Grau write, artillery missions include annihilation, destruction, neutralisation/suppression and harassment. Annihilation inflicts sufficient attrition on one or more targets until it has no combat effectiveness and cannot be reconstituted or repaired to have combat effectiveness. Destruction attrits a target to the extent that it can be repaired or reconstituted but not without significant expense in resources and time. Neutralisation inflicts attrition to the extent where the target temporarily loses combat effectiveness. Finally, harassment exerts psychological pressure on the target, an example would be fires against enemy troops in defensive positions. Russian Army counter-battery fire is aided by two types of Weapons Locating Radars (WLRs) routinely deployed organically to ar-



The Russian Army artillery 1L219M Zoopark-1M weapons locating radar is a valuable prize for the Ukrainian military. An example was documented captured by Ukraine in September 2022.

tillery units. These include the C-band (5.25 - 5.925 GHz) 1L219M Zoopark-1M and Kuband (13.4 - 14 GHz/15.7 - 17.7 GHz) 1L271 Aistenok. These have respective ranges of 15 km (9.2 miles) and 750 m (2,460 ft).

As the war in Ukraine shows, UAVs play an important part in assisting artillery. As Bartles and Grau note "(t)he advent of UAVs heralds a new age of Russian artillery, providing real-time accurate targeting, fire adjustment and post-strike assessment." They add that, as of 2016, the Russian Army was assigning one UAV company to each manoeuvre brigade/division. Although the company is not attached to the formation's artillery battalions, it provides fire control support to these units. The advent of UAVs in Russian Army manoeuvre units helps improve fire precision while reducing ordnance expenditure. UAV video feeds let gunners rapidly adjust their fire based on the battle damage they have, or have not, inflicted.

UAV Types

The Russian Army uses a wide array of different UAVs, but the authors state that the Orlan-10 and Granat-1 are most frequently used to support army artillery. The Orlan-10 provides surveillance at up to 110 km (59 NM). It has a 16-hour endurance and a service ceiling of 5,000 m (16,000-feet). Open sources say these UAVs are typically equipped with conventional and thermal optronics. Smaller UAVs like the Granat-1 provide short-range reconnaissance up to 15 km (8.1 NM). These aircraft feed their imagery into the various Kapustnik-B, Kharkov, Mashina-M, Reostate and Spektr artillery fire control systems equipping artillery battalion and battery command centres.

Radio networks connect these respective command and control systems.

Moreover, open sources have documented the use of civilian drones by the army to aid ISR collection. An article entitled 'Russian UAVs: What has Gone Wrong?' written by Dr. Pavel Luzin, an expert on Russian politico-military matters published in November 2022 by the Jamestown Foundation thinktank in Washington DC said the army had received DJI Mavic civilian UAVs donated by Russian civilians. Luzin continued that the Islamic Republic of Iran has also been an enthusiastic supplier. The extent to which these latter aircraft are assisting Russian Army artillery is unknown, although it is likely they do.

UAV operators are thought to be collocated with artillery battalion Fire Direction Centres (FDCs) and subordinate battery Command Observation Posts (COPs). Orlan-10s may provide imagery to the FDCs on account of their range. Smaller aircraft like the Granat-1 will share their imagery with the COPs. The Granat-1 may help fire control for shorterrange units like the anti-tank battalions and mortar batteries. Meanwhile, the Orlan-10 may provide similar support to MLRS, towed artillery and SPH battalions.

Russian gunners use terrain features around a target to determine its position as precisely as possible. Bartles and Grau argue that precision is less of a concern for annihilation or destruction missions. They continue that the fidelity of Russian Army digital maps make it possible to fix the target's position with impressive accuracy solely using this approach. Furthermore, gunners maybe able to derive the target's position accurately using the UAV's own Position, Navigation and Timing (PNT) data. The aircraft will determine its position using a Global Naviga-



Russian Army soldiers prepare an Orlan-10 UAV for a sortie. The force has been an enthusiastic user of UAVs to assist artillery fire control.

tion Satellite System (GNSS) signal receiver, and this may be supplemented by an Inertial Navigation System (INS). Gunners could determine the target's latitude and longitude in relation to the aircraft's position. If the aircraft directly overflies the target, it may be possible to derive precise coordinates. UAVs can also use laser rangefinders to derive precise coordinates. The risk here is that laser warning receivers equipping targets like armoured vehicles may alert the crew that they are being illuminated. Finally, two or more UAVs maybe used to triangulate a target's position. Unlike the previous method, this approach is entirely passive.

Vulnerabilities

Artillery has pride of place in the Russian Army, with Josef Stalin reportedly referring to it as the 'God of War'. It is also nicknamed 'The Last Argument of Kings' in Russian military folklore. A United Nations estimation of civilian casualty figures published in July 2022 said that most of the civilian casualties recorded thus far in the war had been caused by artillery. From Ukraine's perspective, it is imperative to destroy, degrade and damage Russian Army artillery to the fullest extent possible. As well using counter-battery fire the Ukrainian Army needs to attack Russian artillery command and control. This can be achieved in part by attacking the UAVs that Russian gunners depend on. It is also vital to jam the radio communications networking the artillery battalions and batteries.

A cursory search on the internet reveals a wide array of Counter-UAV (C-UAV) systems, some of which have already been deployed to Ukraine. Sources in the Ukrainian theatre of operations shared with the author that Ukrainian land forces need backpack C-UAV jamming systems for dismounted troops. Russian artillery engages Ukrainian targets at, or immediately behind, the tactical edge. This is done with mortar and anti-tank fire at ranges of between 3 km and 12.8 km (8 miles). The sources continued that UAVs are routinely used to spot Ukrainian targets in the forward edge of the battle area. Target coordinates are sent back to the artillery COPs and FDCs and the targets engaged. Likewise, UAVs will also provide battle damage imagery. Depriving Russian gunners of situational awareness is imperative, and this can be achieved by jamming the UAVs.

UAVs typically depend on three distinct radio signals: A radio link connects the UAV's operator on the ground with the aircraft, across which the former sends commands to the latter. This link also lets the aircraft share details of its behaviour with the operator like altitude, speed, bearing, fuel and oil levels, and system health. The author has learned that the UAV to Ground Control Station (GCS) link for the Orlan-10 routinely uses frequencies of 930 MHz. A second radio link allows the UAV to transmit still or video imagery to GCS or to other users who need this information. Civilian UAVs tend to use frequencies of 2.4 GHz and 5.8 GHz for aircraft control and to relay imagery. Other frequencies of 3, 4, and 8 GHz are routinely used for similar transmissions.

Most UAVs will also rely on receiving PNT signals from a GNSS constellation to help navigation. Russian Army UAVs use the country's GLONASS constellation for this. The constellation transmits signals on a range of frequencies from 1.201 - 1.605 GHz. The UAVs may also have GNSS receivers tuned to US Global Positioning System GNSS frequencies of 1.164 - 1.575 GHz. These receivers may also be tuneable to the PNT signals from the European Galileo and People's Republic of China's Beidou constellations. Both these use frequencies of circa 1.1 – 1.6 GHz. Russian forces have not been given access to the encrypted signals provided by Galileo and GPS. These are reserved for military use by US and allied nations, and European nations supporting Galileo. Whether China has granted access to any encrypted Beidou signals remains unknown. Encrypted GNSS is important as it provides some resistance to jamming. Basically, the aircraft's GNSS receiver will ignore all GNSS-like signals lacking the encryption. These radio links are three potential vulnerabilities. Disrupting the link between the aircraft and GCS can prevent it being flown properly. Some UAVs have inbuilt mechanisms by which the aircraft automatically lands or returns to its point of origin as a safety feature if it loses the radio link with the operator. Likewise, losing GNSS signals may have a similar effect. Some aircraft may have back-up INSs which help to navigate the aircraft, but which do not depend on GNSS signals. This is the case for the Shahed-136 loitering munitions the Islamic Republic of Iran has supplied to Russia. Although these can use GNSS they have an INS in case this gets jammed or if the signal is unavailable. The third point of vulnerability is the radio link conveying video or still imagery. Jamming this immediately blinds any artillery units using the aircraft for fire control.

"The acute need now is for jamming systems" that can engage these UAVs, the Ukrainian sources added. "If we have enough systems, this can help reduce our losses because the Russians are using UAVs for artillery reconnaissance." Any jamming systems must be highly portable, ideally



Shahed-136 loitering munitions supplied to Russia by Iran use an inertial navigation system to avoid them losing their way should their GNSS receivers be jammed.

carried by an individual dismounted soldier. They need to cover the frequencies used by Russian UAVs for the radio links discussed above and for frequencies which are not in the public domain.

The sources continued that one crucial attribute for these jamming systems is for them to transmit low-powered jamming signals. Some C-UAV jamming systems provide a 'bubble' of jamming around a potential target. This is designed to prevent the UAV getting within a set distance of that target. Such an approach is useful for protecting a sport event or a moving convoy of vehicles, however, the author has been told this approach is less effective in Ukraine. Even with a bubble of jamming around a target, a UAV may still stand-off at an unaffected range and gather imagery of the target with its powerful optronics. These jammers transmit comparatively high-power jamming signals, which ensures a uniform level of jamming around the target. The Russian Army has deployed several tactical signals intelligence platforms in the Ukrainian theatre. Systems like the R-330Z Zhitel and RP-377LA tactical communications intelligence and jamming platforms can detect and jam transmissions on frequencies of 3 MHz – 2 GHz. This would be sufficient to detect high-powered jamming signals directed against Russian UAVs. By detecting these signals, the R-330Zh could then geolocate the jammer and its operator.

Electromagnetic Empowerment

Ukrainian forces at the tactical edge need C-UAV jammers generating low power



The heat is on! A Russian Army R-330Zh Zhitel communications intelligence and jamming system burns after being struck somewhere in the Ukrainian theatre of operations. Such platforms may be especially efficient at detecting and geolocating high powered jamming systems.

but highly directional signals. Information on the UAV's location may be provided by the system if it has an integral Electronic Support Measure (ESM) that can pinpoint the UAV using its radio emissions. Otherwise, this information may be provided by ESMs elsewhere. Knowing the location of the UAV means that a low-power jamming signal can be aimed directly towards it. This avoids having to continually transmit a high-power signal to provide omnidirectional coverage. A low-power signal can be difficult to detect, but still highly effective in jamming the UAV's radio links. Ultimately, this technology would let Ukrainian troops protect themselves and other targets against Russian UAVs without revealing their location electronically.

The Ukrainian sources said they would like to receive help designing and producing their own jamming systems meeting these specifications. This makes sense, Ukraine has been at war with Russia since the latter's first invasion in 2014, and the Ukrainian armed forces have more experience of waging electronic warfare against their Russian adversaries than any other force. Hostilities have resulted in an exponential enhancement of Ukraine's defence electronics industry, and the country's EW systems are considered world-class.

Nonetheless, Ukraine's international support is far from assured. In 2024, voters in the United States will choose their president. In March 2023, Ron DeSantis, Florida's governor and a potential Republican presidential nominee, told the media he did not want to see further US entanglement in the war. Former president Donald Trump articulated a similar isolationist standpoint: "Our objective in Ukraine is to help and secure Europe, but Europe isn't helping itself ... They are relying on the United States to largely do it for them. That is very unfair to us." Trump is not known for his love of fact and veracity. The US is by far the biggest donor of materiel to the Ukrainian armed forces. However, as of February 2023, the European Union had provided USD 3.8 billion of military assistance, and a further USD 8.5 billion had been provided by European nations bilaterally. These figures were produced by the US Congressional Research Service, a non-partisan research organisation assisting US congressional committees and members of Congress. Nonetheless, some European support has previously looked shaky. The government of Germany's Chancellor Olaf Scholz dragged its feet in providing much-needed Krauss-Maffei Leopard 2 family main battle tanks to Ukraine. This included Leopard 2s not owned by Germany but in the hands of German allies, for which Berlin's permission is needed to export to third countries.



COMINT Consulting's Krypto500 and Krypto1000 communications intelligence systems have been supplied to Ukrainian forces since 2016.

It could make more sense for Ukrainian manufacturers to design and build the jammers, but with technical assistance from third parties. This would obviate the need to continually fight some of the domestic political battles for kit, such as those seen in Germany. In the EW domain, Ukraine's allies could supply know-how and hard-to-source items to help build systems locally. Sources in Ukraine highlighted Gallium Nitride (GaN) solid-state amplifiers as an example. These are indispensable for EW, radar and radio applications. The amplifiers take an electrical signal and turn it into a radio wave which, in the electronic warfare application, would be used to jam a system such as a UAV's radios. GaN is incredibly robust, handling high levels of electrical power because it can handle very high temperatures. These amplifiers would be essential for the precise, highly directional low-power jammers Ukrainian troops need on the frontline. The problem is that GaN technology is tightly controlled for military purposes from an export perspective. Both the US and the European Union have export controls in place on some GAN components. Would it be possible to loosen these to facilitate Ukraine's access to such technology? This would have to be balanced against the risk that such technology might end up in Russian hands if captured. Nevertheless, perhaps of balance can be struck if the political will is there?

Local production walks hand-in-hand with helping Ukraine build capacity in her domestic EW sector. Jim Kilgallen, president and chief executive officer of COMINT Consulting, recommends that the North Atlantic Treaty Organisation (NATO) and its members begin to "wean (the country) off the 24/7 signals intelligence collection we are providing." This is vital for the country's long-term vision as an eventual NATO member: "We need to help them start doing some of these things on their own," he says, adding that there is a recognition to this effect in the Ukraine EW sector.

Bureaucratic problems also exist. The US Army began supplying the company's Krypto500 communications intelligence system to Ukraine in 2016. Kilgallen says the Ukraine military "is trained on it, familiar with it and clamouring for more since the conflict started." Getting systems into theatre has not been easy. "Bureaucratic sloth and competing priorities have prevented them from gaining the additional licences (for the systems) they need." In 2022, Ukraine's Ministry of Defence made a formal request for additional licences to the United States' European Command (EUCOM). This was done with the support of the US Department of Defence's executive in charge of materiel acquisitions for Ukraine. As of the time of writing (March 2023) the request is "unfulfilled and still pending at EUCOM," Kilgallen said. To compound matters, he says that several Baltic countries have offered to send their Krypto500 and Krypto1000 systems to Ukraine and purchase replacements. Plans like these have been frustrated by US ITAR (International Traffic in Arms Regulations) strictures.

Ukraine can win the UAV battle and winning that battle will help win the war by blinding Russian artillery, but she needs the tools for the job. While supplies of UAV jamming equipment will be welcomed by the Ukrainian military, it is vital to help empower Ukraine's already impressive EW industry. This can be done by the provision of the components and know-how the country needs. This provision is dependent on clearing bureaucratic hurdles – a situation where the pen needs to be weaker than the sword.

Micro-Drones: Miniature Reconnaissance Assets for the Modern Battlefield

Sidney E. Dean

Very small unmanned aerial vehicles (UAVs) are providing even the lowest echelon infantry units with advanced situational awareness capabilities.

Various terms are used to categorise unmanned aerial vehicles (UAV) with a diameter of 2-50 cm: Very Small UAV, Micro-Drone, Micro UAV, Micro-UAV, Nano-UAV, or simply Micro Air Vehicles (MAV). Despite the disagreement over terminology, armed forces (a well as civilian public safety agencies) globally recognise their utility.



French concept for an insect-mimicking UAV.

For humanitarian and public safety missions, Micro-Drones can fly through the rubble of collapsed buildings or mineshafts to quicky search for survivors, or be inserted into pipelines and utility shafts to inspect their integrity. Militarily, the small, highly portable aircraft provide units down to the squad or fire team level - or even the lone-operative - with an integrated short range Intelligence, Surveillance and Reconnaissance (ISR) asset with capabilities previously restricted to medium and upper echelons. The data is relayed directly to the operator in realtime, enabling frontline tactical units to immediately act on that intelligence, be it by avoiding an ambush, calling in artillery strikes on beyond-line-of-sight (BLOS) targets, or planning a hostage rescue operation. In addition to optronic sensors, Micro-UAVs can be equipped with sensors to detect biological, chemical or radiological agents, or with Signals Intelligence (SIGINT) sensors to intercept enemy radio and cellular communications. In this context, MAVs can be equipped with modified cellular technology to gather communications data and transfer it to receiving stations. While Micro-UAVs are usually remote controlled, Artificial Intelligence (AI) permits autonomous operations over much of the mission profile.

MAVs have several advantages over other unmanned aerial vehicles. In tactical scenarios, their small size (and associated small acoustic and thermal signatures) makes them difficult to detect, enabling operators to gather intelligence and targeting data without warning the enemy. The smallest MAVs can be carried in an ammunition pouch, resulting in minimal extra burden to the soldier. The aircraft are controlled via hand-held consoles or via laptop, tablet or mobile phone apps, again minimising or eliminating any logistical burden. Given their size, they can enter into buildings or other enclosed or access-denied areas where other UAVs cannot go. Performance parameters of Micro-UAVs vary, especially with size.

'Larger' micro-UAVs typically fly at altitudes up to 125 m (although some go considerably higher), and can achieve speeds of 50 m/s (180 km/h). Smaller systems typically have more limited performance, but are inherently more difficult to detect. Very small UAVs are frequently designed to mimic flying animals, whether insects or birds. This makes their visual detection much more difficult.

Black Hornet PRS

The iconic MAV system is the Black Hornet Nano developed by Norwegian firm Prox Dynamics AS. Development began in 2008, with serial production commencing in 2012. The early PD-100 variant became one of the first micro-UAV to be widely fielded, and was used extensively by Western forces in Afghanistan. The Black Hornet Personal Reconnaissance System (PRS) is currently marketed internationally by Prox's parent company Teledyne FLIR Systems. The PRS is built around the Black Hornet 3 UAV, and is



The Black Hornet Micro-UAV.

considered the world's smallest highperformance ISR platform, providing dismounted soldiers with autonomous, mission-critical situational awareness. It is in service with the armed forces of the United States and several European nations, as well as global security partners, with more than 12,000 units deployed worldwide.

Measuring 16×2.5 cm and weighing 18 g including batteries, the UAV can easily be held between two fingers. It carries three zoom-capable cameras with complementary fields of view, and captures both motion video and high definition still imagery as well as audio. According to Teledyne FLIR, upgraded features found on the latest models include removable mission data SD cards, increased processing capability, improved user interface, robust chargers, and enhanced vision-based navigation. Teledyne FLIR emphasises that imagery is transmitted back to the operator via an encrypted data link with ranges up to 2 km, permitting surveillance and targeting of opposing forces at well beyond visual line-ofsight. The 25 minute operational window can be extended by replacing the battery in the field. FLIR now also offers the Black Hornet Vehicle Reconnaissance System (VRS). Armoured and mechanised vehicles can carry up to eight Black Hornet UAVs in an externally mounted carrier, permitting immediate BLOS reconnaissance without exposing the vehicle's occupants.

RQ-28A SSR

The RQ-28A short-range reconnaissance (SSR) system was selected as the Army's first quadcopter UAV in February 2022 following a competition comparing six different platforms. First units were fielded to the 75th Ranger Regiment in late-2022. The Army describes the SSR as an inexpensive, rucksack-portable, vertical take-off and landing (VTOL) small UAV capable of providing integrated ISR capabilities at the small unit level. The SSR is currently being treated as a platoonlevel asset. Low-rate initial production (LRIP) will encompass 1,080 units, to be delivered through the second quarter of Fiscal Year 2025.

The RQ-28A is produced by Californiabased SkyDio, and is based on the firm's X2D UAV, which was designed for the military market. The carbon-fibre and magnesium frame has been ruggedised for military applications. The four arms which support the rotors are folded for carriage. When folded the unit has LWH dimensions of 30×15×10 cm. Skydio states that the unit can be made mission ready within 75 seconds. Mission ready, it measures 66x56x20 cm (the size makes the X2D very borderline for the Micro-UAV category, but might explain why the drone's performance was deemed superior to its competitors). The unit weighs 1.3 kg and can accommodate a 150 g payload. The basic kit includes the drone, a games console-style controller, two batteries plus a charger, all packed in a ruggedised carrier. Reconnaissance sensors include six gimbal-mounted 4K60P HDR colour navigation cameras with 16× zoom, as well as a FLIR Boson 320 thermal lens with 8x zoom. The integrated Skydio 3D Scan mapping software package renders recorded imagery as 3D models for enhanced situational awareness. With a service ceiling of 3,700 m, an airspeed of 11.1 m/s (40 km/h), the RQ-28A can perform covert overwatch by circling a location of interest or following moderately fast moving targets. Encrypted reconnaissance data can be wirelessly transmitted to the operator in real time, and its maximum transmission range is 10 km. Alternatively, the data can be recorded for offline retrieval upon

the drone's return to the platoon. Battery life is 4.5 hours per charge, but maximum flight time per mission is 35 minutes.

ANAFI – USA MIL

One of Skydio's competitors for the SSR contract was French drone-maker Parrot. The firm has begun manufacturing its ANAFI drone in the United States. The variant optimised for military intelligence and reconnaissance operations is designated as ANAFI - USA MIL. The US-built system is also being marketed to European armed forces as well as to the US and Japanese coast guards. A variant geared to the needs of police and public safety agencies (ANAFI - USA GOV) is exported worldwide to support domestic security and disaster relief operations and to monitor critical infrastructure.

The UAV has been described as a 'flying cam-



Members of the British Army's Yorkshire Regiment pose with a US Army RQ-25A unmanned aircraft system during Project Convergence 2022.

era' with two 32× continuous zoom sensors for 21 MB still imagery and 4K video, and a FLIR Boson 320 long-wave infrared (LWIR) camera. The cameras can detect human-sized targets at a distance of 2 km, or read a license plate from an altitude of 130 m. At 1,500 m the resolution sufficient to discern details of around 10 cm in size, or details of 1 cm in size at





The ANAFI - USA military reconnaissance micro-drone.

150 m. Zoom is lossless, with up to 15× magnification. To maximise information value, the image management system can combine thermal and visual camera input into a single image.

The drone body and propellor blades are made of polyamide, reinforced with carbon fibre and streamlined using hollow glass beads. The broad rotor blades are inspired by the pectoral fins of humpback whales, and are optimised for superior lift performance as well as reduction of acoustic signature. The 500 g UAV takes off and lands in the hand of the operator. Unfolded, the aircraft dimensions are 28×37×8.4 cm. Flight endurance is 32 minutes per battery charge, and the system is sold with three interchangeable batteries to enable prolonged operations. The UAV's service ceiling is 5,000 m, its maximum flying speed is 15 m/s (54 km/h), and its maximum climb speed is 3.9 m/s (14 km/h). The UAV can operate between temperatures of -35 to +49 °C, and is protected against the effects of sand or moisture. The US Coast Guard considers the ANAFI - USA the only small drone with a consistent and reliable capability to conduct take-off and recoveries while under way in a marine environment. Its military customers include the British Royal Air Force, the Finnish Army, and the Spanish Navy.

In January 2021 the French military procurement agency DGA initiated Parrot's largest single order to date. According to the firm, the five-year contract for 300 Parrot micro-drones (plus support equipment) was later updated to 400 units. Deliveries began in June of 2021. Some 60% of the order are destined for the land forces (conventional and special operations), with the rest for the naval and air forces.

Spirit Coaxial UAV

The Spirit coaxial UAV system produced by Ascent Aerosystems represents a different architecture concept than the majority of Micro-UAV. The modular, tubular structure of the UAV body has basic dimensions of 25.7 cm in length and 10.6 cm in diameter, with an empty weight of 1.8 kg without battery or payload. When equipped with payload modules, the length increases depending on the payload, and after deploying rotors, the UAV has a blade tip-to-top diameter of 65 cm. Spirit exhibits significantly superior payload capacity compared to most micro-UAVs, with a combined payload and battery weight capacity of 4.3 kg.

Performance parameters also exceed most micro-UAVs. The direct drive with two brushless electric motors enables



The Spirit coaxial UAV.

top speeds of 27.8 m/s (100 kph) and a service ceiling of 5,000 m. Mission endurance varies from 16 to 53 minutes, depending on battery and payload selection. Multiple payloads can be stacked depending on mission requirements. The quick-twist payload attachment system allows easy mounting of modular sensor units. As described by the manufacturer, dual HDMI inputs support simultaneous use of two airborne sensors. The unit deploys from any type of terrain and operates in all climate zones, including desert and arctic. The Spirit UAV is under consideration by the US armed forces.

Lanius

Not all Micro-Drones are restricted to ISR missions. In November 2022 Israel's Elbit Systems introduced a small-scale loitering



Three Lanius Micro-UAV on a 'mothership' UAV.

Photo: XTIM

munition designated 'Lanius'. According to Elbit, the weapon system is designed for both tactical reconnaissance and for targeted killings in urban areas. Based on a civilian racing guadcopter, the highly manoeuvrable UAV achieves a top speed of up to 20 m/s (72 kph) outdoors. The Lanius' small lithium battery limits flight endurance to a maximum of seven minutes, placing significant operational restrictions on the system. This limitation is partially compensated for by the option of mounting up to three Lanius drones on a larger UAV 'mothership' which transports the Lanius closer to the site of interest. The Lanius can also land to monitor a point of interest – such as a doorway - and resume flight operations when a triggering event occurs.

Flight operations, beginning with takeoff, are mostly autonomous. This includes recognition of access points into structures. The drone's 30×30 cm dimensions permit almost unrestricted passage through open doorways and windows. Both outdoors and indoors, the drone's Nvidia Jetson AI uses the optronic sensor data and a simultaneous localisation and mapping (SLAM) algorithm to continually build and update 3D maps of the environment.

Assassination of combatant or highvalue targets is performed via a 150 g close proximity, high explosive charge. While the Artificial Intelligence software embedded in the Lanius can distinguish between armed and unarmed personnel, activation of the payload requires a direct command by a human operator via a hand-held interface. Control options include Wi-Fi and software-defined radio communications. The Lanius UAV can be deployed individually or as part of a drone swarm coordinated through the Elbit Legion-X system which enables joint operations by unmanned systems of the same or differing types, as well as manned-unmanned operations.

Biomimicry

From a distance, the smallest MAVs can be mistaken for insects. This is one of their prime advantages for covert reconnaissance applications, especially indoors. Some military agencies want to go further, developing true biomimetic capabilities. In June 2021 the US Air Force Research Laboratory (AFRL) – which has been at the forefront of biomimicry research and development – signed a non-exclusive patent license agreement (PLA) with California-based Airion Health LLC. The PLA authorises the firm to use

The French Defence Ministry's BioFly biomimetic UAV program is based on a 2014 concept design for a bird-shaped drone.

government-owned patents to develop a prototype biomimetic micro-robotic aircraft able to perform insect-like manoeuvres. The true innovation would be the use of flapping wings to achieve six degrees of flight (up, down, forward and back, left or right), since the flight pattern would be virtually identical to that of a living creature. According to a June 2021

AFRL statement, "controllable forces would be generated by the wings based on position and velocity profiles, resulting in time-varying wing upstrokes and downstrokes which, at times may be asymmetrical." In early 2022 the French Agence de l'innovation de défense (AID; ENG: Defence Innovation Agency) announced it would be funding the BioFly project aimed at developing stealthy ISR drones which imitate the flight of birds or insects. According to the AID, the use of flapping wings enables a multitude of flight possibilities (beaten, gliding, almost hovering) with combinations of multiple trajectories which cannot be replicated by fixed-wing or rotary UAV. The AID release stated that an operational BioFly would weigh circa 50 g and be remotely operated via smartphone. The project is being conducted in association with several academic institutes and the Marseilles-based XTIM SAS, a leading French producer of biomimetic systems.

However these particular projects develop, it remains only a matter of time before micro-UAVs which are virtually indistinguishable from birds or insects – even at close range – are developed.



Reimagining War – How 'Centaur' Warfighting Will Change Warfare Forever

John Antal

Warfare is changing, and it is important to understand why. The heart of this transformation is the technological convergence of micro-miniaturization, computing power, robotics, sensors, and Artificial Intelligence (AI). Of these converging elements, AI is the most active accelerator, as it enables humans to interact with machines in new and powerful ways. This interaction, called multidomain manned-unmanned teaming, is the integration of humans with machines.

he best systems," as described by Paul Scharre, a best-selling author of several books on robotic systems and AI, "will combine human and machine intelligence to create hybrid cognitive architectures that leverage the advantages of each. Hybrid human-machine cognition can leverage the precision and reliability of automation, without sacrificing the robustness and flexibility of human intelligence." This is the 'Centaur' approach which takes its name from a mythological creature that is half-human and half-horse, combining the best of both into a single creature. Likewise on the weapon system side, by merging both, the Centaur approach is the next step in multi-domain man-unmanned teaming and will separate winners from losers in the next war.

Centaur Warfighting is a multidomain manmachine teaming capability that is still in its infancy. It combines the skills of both humans and machines to improve warfighting capabilities. This requires the integration of cutting-edge technology like AI, robotics, and man-machine interfaces. With Centaur Warfighting, multidomain man-machine teams will coordinate across land, sea, air, space, and cyber domains, as well as with allied forces, in real time. Centaur Warfighters will have improved situation awareness (SA) to gain insights, make informed decisions, and act faster than ever before.

Three wars fought in the past three years show a trend toward increasing cooperation between man and machine, and ulti-

<u>Author</u>

John Antal, US Army (Retired) is a best-selling author and a thoughtleader in military affairs. He has written and spoken extensively about the art of war and the changing methods of warfare.



A 'Centaur' approach to human-machine teaming is emerging to meet the new disruptors of war.

mately the Centaur approach to warfare: the Second Nagorno-Karabakh War (2020), the Israel-Hamas War (2021), and the ongoing Russian-Ukrainian War (2022-?). In the first, Azerbaijan used robotic systems to set the conditions for a multidomain, joint, 44-day campaign that resulted in a decisive victory over Armenia. This war has been called the first war in history to be won primarily by robotic systems, specifically through the use of Unmanned Aerial Vehicles (UAVs) and loitering munitions. The second war occurred in May 2021 when Hamas attacked Israel with a storm of artillery rockets and attempted to use infiltration tunnels to bring the fight to the Israeli population. In response, the Israel Defence Forces (IDF) conducted a lightning counterattack that was synchronised by AI to win the conflict in 11 days. The Israelis claim that this was the first war in history to be won by AI, but it was truly a hybrid human-AI effort. The third conflict, the ongoing Russian-Ukrainian War (2022-?), foreshadows the power of new weapons and tactics, and adapting old weapons in new ways, across all domains, in a conflict of grinding attrition. In Ukraine, a nascent Centaur approach to war flies in the battlespace every day as Ukrainian and Russian fighters use small Unmanned Aerial Vehicles (sUAVs) to hunt each other.

From these three wars are derived nine 'disruptors' that exemplify how war has changed from only a few years before. A disruptor is a technique, tactic, or weapon that dynamically changes the methods of warfare. These are: the transparent battlespace; the first strike advantage; top attack; the trend towards autonomous systems; AI and how it is increasing the tempo of war; the kill-web; the swarm; visualising the battlespace; and decision dominance. Against the backdrop of these nine disruptors, how will the emerging Centaur approach impact the next war?

1. The Transparent Battlespace

Warfare today is a game of hide-and-seek, and the seekers are winning. Seeing enemy forces in real time, across the depth of the battlespace, is the most pressing disruptor of traditional warfare. In the past, armies could hide and stay out of range, engaging when the time was right. This is becoming increasingly difficult to do. Multi-domain capabilities, possessed today by even third-tier military powers, composed of layered sensors from the muddy ground to outer space, reveal every unmasked target in the battlespace. Creating a transparent battlespace is not a simple task, as it takes sophisticated systems, purpose, and planning, but this has already occurred in Nagorno-Karabakh



These are the top nine disruptors of modern warfare.

in 2020, Gaza in 2021, and in Ukraine in 2022-2023. Today, the US, NATO, Russia and China plan to do the same with layered multidomain sensor networks that provide real-time intelligence, surveillance and reconnaissance (ISR) information. In a transparent battlespace, unmasked forces face swift destruction by enemy fires.

A decisive factor in warfare, therefore, is to mask friendly forces. Masking is the full spectrum, multidomain effort to deceive enemy sensors and disrupt enemy targeting. New technologies can help friendly forces mask by deceiving the enemy's sensors with optical, thermal and electronic decoys, and disrupt the enemy's targeting kill-chain with electronic warfare and cyber-attacks that generate false-positive targets in the battlespace. A Centaur approach that connects commanders to sensor networks to see friendly forces as they appear in all domains, across the entire electromagnetic spectrum, in real time, will verify if units are masked.

We set standard with **FONET** now watch what we do with **FONET Wik2**

Designed to support command, control, communications, computers, cyber-defense, and combat systems integrations.

Complete system integration on a wide range of platforms.

Scalable and modular to support C2 framework system deployment from small units to battalion level and higher.







US Soldiers deploy a small unmanned aerial vehicle (sUAV) at the National Training Center at Fort Irwin, Ca. in 2022. Behind them is a robotic squad vehicle. The US Army is slowly creating a hybrid human-robotic force to win the next war.

2. The First Strike Advantage

The side that strikes first has the advantage. In a transparent battlespace, where every unmasked target is observed and can be hit, a first strike by long range precision fires can turn into a decisive advantage. The Azerbaijanis crippled the Armenians with a first strike during the Second Nagorno-Karabakh War (2020). During the Israel-Hamas War (2021), Israel did not strike first, but responded with a devastating AIenabled second strike that ended the war in 11 days. Russia's first strike on Ukraine in

2022, although hitting over 2,000 targets in the first week, was indecisive. To gain the greatest advantage, the first strike must be overwhelming.

It is easy to visualise NATO forces in the Baltics or other NATO nations bordering Russia suffering under a Russian first strike. We must consider the same in the Pacific region regarding China and prepare accordingly. In each case, a Centaur approach that seamlessly connects humans to networked robotic systems can help the defending forces mask from an enemy first strike and then synchronise an immediate coun-

Photo: US Navy



A small Unmanned Aerial Vehicle (sUAV) hovers during an exercise at Joint Base Lewis- McChord, WA on August 10, 2020, as part of the Offensive Swarm-Enabled Tactics (OFFSET) programme. Through OFFSET, the US Navy is partnering with Defence Advanced Research Projects Agency (DARPA) to develop autonomous swarming capabilities.

terstrike. Israel's reaction to Hamas's first strike is noteworthy, as the IDF responded swiftly, shielding population centres with the Iron Dome air defence system and then responding with an AI synchronised precision counterstrike, rapidly locating and destroying Hamas rocket launchers and attacking over 97 km (60 miles) of a massive underground tunnel labyrinth dubbed 'the Metro'.

3. Strikes from Above

Robotic, systems, especially UAVs and loitering munitions, are playing an increasing role in modern warfare, providing a relatively inexpensive, sense-and-strike capability that speeds up the kill chain.

These unmanned aerial sense-and-strike systems are hard to counter. They came of age during the Second Nagorno-Karabakh War, with the dramatic use of the Bayraktar TB-2 UAV as well as the Harop and Orbiter loitering munitions. In Ukraine, we have witnessed piecemeal attacks by all forms of UAV and loitering munition. These make dramatic videos, and have tactical effects, but they are not battle winners as they have not yet been employed en masse. Once connected to a sense-and-strike network, employed in mass numbers, and coordinated in a Centaur approach, that will change. To defeat UAVs and loitering munitions, there are four general categories of technologies: laser, microwave, electronic jamming, and kinetic attack. Laser weapons use directed energy to focus a beam of light to heat and burn up an incoming projectile or UAV. High Power Microwave (HPM) weapons use the power of directed microwaves to overload circuitry and fry electronic components to knock drones out of the sky. Electronic jamming interferes with the UAV's control, guidance, and targeting systems. Kinetic solutions include missiles that hit or explode near the target, or UAVs that fly toward the drone, launch nets, projectiles, detonate in the proximity, or simply ram the enemy system. An effective Integrated Air Defence System (IADS) must employ combinations of all four. As the threat from UAVs and loitering munitions increases, a fully autonomous counter drone system is something that NATO forces urgently need to develop and field. Tying all these systems together to operate

4. Becoming Autonomous

tlespace will require a Centaur.

Imagine a peer conflict in 2028. Warfare is hyper-accelerated. Sensors blanket the battlespace. If unmasked by optical, ther-

seamlessly to defend large areas of the bat-

mal, or other sensors, the enemy automatically locates and targets you. Networked, smart munitions are becoming increasingly intelligent. No longer needing GPS for positioning, navigation and timing (PNT), they are difficult to jam. To adapt to the speed of modern battle, militaries are moving to weapons with pre-programmed decisionmaking capabilities and more fully autonomous weapon systems.

The combination of AI with long-range precision fires will be revolutionary. Connected in a multi-domain sensor network, and enabled by AI-and its subsets, Machine Learning (ML) and Deep Learning (DL) these fully autonomous systems dominate the battlespace. ML automatically improves the AI as networked systems share information. DL imitates the workings of the human brain in processing data and creating patterns to select decisions based on the pattern recognition of layered data sets. This AI will operate as a 'neural network' forming a 'brilliant' fires system that will deliver highly accurate, long-range, and lethal fires in real-time. Long-range precision fires include many types of delivery systems (artillery, drones, balloons, and missiles launched from ships and aircraft). When these fires are linked to multi-domain sensor networks, as well as synchronised and optimised by and AI-enabled network, this combination will generate a kill-web to accelerate the precision and lethality of strikes.

5. AI and the Tempo of War

Speed is essential for waging war successfully. Operating faster than your opponent provides a winning advantage. Currently, all military forces operate human-centric killchains. A kill-chain is a sequential process that operates at human speeds and represents the sequence of events required to sense and strike enemy targets. Traditionally, Human In The Loop (HITL) or Human On The Loop (HOTL) centric, this involves identifying a target, deploying a weapon system to engage the target, launching the munition, destroying the target, and verifying battle damage after the strike: In short, find, fix, fire, finish, and feedback. Christian Brose, in his book titled "The Kill Chain," identified the kill-chain as a threestep process: gain understanding of what is happening, decide what to do about it, and take action (kinetic or non-kinetic). The traditional kill-chain can be slow, as the targeting system must pass through

multiple human operators before striking. Experimenting with new technology and procedures to speed up the kill-chain, the US Army executed a kill chain time of 20 seconds in September 2020 at Yuma Proving Ground in Arizona. This is extremely fast, but the goal is to speed up the kill chain further. To do that, you need an Alenabled sensor-to-shooter kill-web.

6. The Kill-Web

A Centaur-enabled kill-web is substantially different from a human-centric kill chain. The kill-web is commanded and employs an AI-enabled process to operate at machine speeds. This design rapidly synchronises the effects of many networked munitions in time, space and purpose. In this Centaur approach, the human sets the intent and the AI speeds up sensor-to-shooter timing exponentially. In a conference in 2019, US Missile Defence Agency Director Vice Admiral Jon Hill explained the need for a AI-enabled kill-web: "With the kind of speeds that we're dealing with today, that kind of reaction time that we have to have today, there's no other answer other than to leverage artificial intelligence." Ac-



Unmanned Ground Vehicle for Infantry Support



Robotic systems can now be controlled by the human mind using a Brain Machine Interface (BMI) connection. In February 2023, the Australian Army released a video demonstrating a human using a BMI and a Microsoft HoloLens controlling a robot with his mind, without voice or manual controls. This image shows an Australian soldier commanding a Quad-legged Unmanned Ground Vehicle. The demonstration was conducted by the Australian Army's Robotic and Autonomous Systems Implementation & Coordination Office (#RICO) is nested within our Future Land Warfare Branch.

cording to a 2021 US Army publication, Chinese Tactics, the Chinese view of "intelligentised" [Sic] warfare envisions the use of AI to enhance its military capabilities. China's military experts predict that lethal "intelligentised" weapons will be common by 2025.

7. The 'Super Swarm'

Swarming is a tactic that engages an adversary from multiple directions at the same time. Swarming is not new, but a 'super swarm', however, is a further evolution of the concept. Imagine hundreds of drones, operating in a swarm, controlled by a single Centaur where the swarm is directed by the human and AI directs the individual elements. The Centaur steers the super swarm and the AI engages to simultaneously attack multiple targets from different angles. The robotic systems in the super swarm act as 'intelligent agents' of a collective, performing actions to achieve goals which are set by the AI. The US Navy already proved this capability in 2017 during Low-Cost UAV Swarming Technology (LOCUST) programme tests. The programme involved AI-enabled Unmanned Aerial Vehicles (UAVs), including Raytheon's Coyote loitering munitions, in a network to collaborate, share information, sense, strike, and assess.

8. Visualise the Battlespace

Commanders observe, orient, decide, and act (the OODA Loop) by recognising the pattern the enemy has presented and applying a counter-pattern. If you can do this significantly faster than your opponent, the enemy will be unable to react to every act taken. Accelerating a human commander's OODA loop will require enhanced cognitive computer systems that can depict the multi-domain battlespace in real time with an All-Domain Common Operational Picture (ADCOP). A Centaur approach ADCOP projects relevant information, especially friendly and known enemy actions, in all five domains (land, sea, air, space, and cyber). Sharing this ADCOP with all pertinent commands in near real-time provides for effective and true mission command and will allow a commander to execute operations from anywhere there is connectivity to the network, not just at a command post.

The need for an ADCOP is urgent. Currently, the information needed for cross-domain manoeuvre is neither holistically displayed in all five domains, generated automatically, nor easy to comprehend. Traditionally, large headquarters display a Common Operational Picture (COP) on multiple screens cluttered with icons in layers of increasing complexity. Staff personnel working within these information silos create most of the data that appear on these screens, with the corresponding human time-lag. An All Domain Al-enabled ADCOP, depicting actions in real time, and allowing a commander to observe, orient, decide, and act in seconds, will revolutionise mission command. To accomplish this will require a shared understanding across the force, enabled by technologies that empower commanders to see the battlespace, rapidly consider courses of action, decide, and issue orders faster than the enemy.

9. Decision Dominance

Decision dominance is the ability to strip away the enemy leader's options and dominate their decision-making. Information warfare is a subset of decision dominance. Applying information warfare and all the previous disruptors more effectively than your opponent generates a situation where you truly dominate the enemy's ability to decide and act. A Centaur approach to mission command is required to produce decision dominance. As the warfighting tempo guickens, leaders must develop and maintain situational awareness faster than ever before. "Speed, range, and convergence give us the decision dominance," Army Chief of Staff, Gen. James McConville said in a 2021, "and decision dominance gives us the overmatch we need."

The next war will likely involve unprecedented cooperation between man and machine. On February 24, 2023, Applied Nano Materials published a scientific abstract by Shaikh Nayeem Faisal, et al., titled "Noninvasive Sensors for Brain–Machine Interfaces Based on Micropatterned Epitaxial Graphene," which demonstrated the viability of large-scale deployment of brain–machine interfaces (BMIs) for soldiers to command robotic systems with their minds. Soldiers would have a voicecommand-free communication to operate external devices through brain waves.

This is no longer a story from science fiction, but an actual capability that will only improve with further research and funding. The Australian Army's Robotic and Autonomous Systems Implementation & Coordination Office (#RICO) demonstrated this ability in February 2023 and released a video of a soldier using a BMI and a Microsoft HoloLens can control a robot with his mind. The potential to use BMI to command all types of robotic systems, including super swarms, is evident.

The next step in multidomain mannedunmanned teaming is a further blending of the best of man and machine, a Centaur approach. Western militaries, therefore, are at an historical watershed. If we do not learn from recent wars and understand the forces that are disrupting our traditional methods, we will not get a second chance.

Counter-UAV Technology and Options of the US Armed Forces

Sidney E. Dean

As the threat from unmanned aerial vehicles (UAV) grows, Counter-UAV (C-UAV or CUAV) capabilities are becoming a vital subsector of modern armed forces' air defence arm.

The ongoing war in the Ukraine has seen a significant deployment of unmanned systems by both belligerents. This development was presaged over the past decade by events in the Middle East, where Iraqi insurgents weaponised civilian UAVs, and Houthi rebels launched sophisticated long-range drone strikes against Saudi energy facilities. Globally, nation states are deploying UAVs across the size- and mission-spectrum, ranging from rucksack-portable personal reconnaissance systems to long-range, high-endurance surveillance and strike aircraft. Smaller drones are of particu-

lar concern. They are difficult to detect, can be deployed in large numbers (either dispersed to cover a wide area, or as a swarm to overwhelm defences), and are much cheaper than manned aircraft. All of these characteristics pose considerable challenges to the C-UAV mission.

The US armed forces (among others) have been developing and adapting their C-UAV strategy, tactics and hardware in order to stay ahead of the threat. Each service is pursuing tactics and weapon systems optimised to their own operational priorities. Since large UAVs tend to have a similar profile to manned aircraft, much of the targeted research is geared toward the Small UAV (sUAV) threat. This would encompass the first two of the five UAV groups classified by the US armed forces. Group 1 UAVs weigh less than nine kg, have an operating ceiling below 366 m, and a maximum airspeed of 51.4 m/s (100 knots). Corresponding figures for Group 2 UAV are a weight of 9-25 kg, 1,067 m ceiling, and 128.6 m/s (250 knots) airspeed. However, Group 3 or medium UAV (with a weight of <600 kg; 5,487 m service ceiling, and speed of <128.6 m/s (250 knots)) also remain a major concern, not least of all because of

AIRSPACE SECURITY TO THE POWER OF THREE

EFFECTIVE PROTECTION AGAINST DRONES - WHEN IT REALLY MATTERS

MISSION PROVEN AT EVENTS SUCH AS:

- + G7-Summit Elmau, June 2015
- State Visit of the U.S. President Hanover, April 2016
- + G20-Summit Hamburg, July 2017
- + ILA Berlin Air Show, April 2018
- "Tag der Deutschen Einheit" Berlin, October 2018
- NATO "HPEX 2019" Lithuania, May 2019
 Protection of multiple sport events 2021

GUARDIEN Countering drones

A cooperation of Diehl Defence, ESG and Rohde & Schwarz www.guardion.eu



A swarm of 40 simulated OPFOR UAVs deploy at the National Training Center at Fort Irwin, California.



L3's VAMPIRE C-UAV kit is optimised for pickup trucks.

their capability to carry significant lethal payloads.

To reduce redundancy, in 2019 the Pentagon appointed the US Army as the executive agent overseeing all Department of Defense (DoD) Counter sUAV (C-sUAV) programs. A Joint Counter-small Unmanned Aircraft Systems Office (JCO) was established in 2020 to coordinate with the joint service combatant commands and the office of the Undersecretary of Defense for Acquisition and Sustainment. The JCO director, US Army Major General Sean Gainey, has underscored the need for a layered, system-of-systems approach to C-UAV operations. No single capability could defeat the spectrum of threats, Gainey stated in February 2023.

Dedicated Air Defence Weapons

High-end air- and missile-defence systems such as Patriot are capable of intercepting UAVs. However, except for neutralising large, high-altitude or very fast unmanned aircraft, they are rarely the optimal choice. Small, low- and slowflying drones are difficult for high-end systems to locate and impact. As for medium-sized UAVs, there is a significant risk that an adversary would saturate the airspace with comparatively cheap drones in hopes that US forces would expend their stock of expensive air-defence missiles, leaving batteries depleted and illequipped to combat follow-on waves of cruise missiles or manned tactical aircraft. Smaller interceptor systems with lower operating cost are being developed for the C-UAV mission. L3Harris Technologies introduced one such system, dubbed the VAMPIRE (Vehicle Agnostic Modular Palletized ISR Rocket Equipment), at the November 2022 Association of the United States Army (AUSA) conference. The weapons kit, which took two years to develop, consists of a four-cell 70 mm rocket launcher and the WESCAM MX-10 stabilised infrared sighting system. The firm plans to further upgrade the weapon system by adding a radar. According to L3 Harris, the VAMPIRE kit can be mounted on most tactical or commercial-grade vehicles with a suitable flatbed, including pickup trucks. The C-UAV system is controlled by a single operator using a joystick and screen. The laser-guided Advanced Precision Kill Weapon System (APKWS) rocket uses an L3Harrisdesigned proximity fuze to destroy the target. VAMPIRE is considered a low-cost intercept weapon – depending on the variant, each APKWS costs USD 27,500. This is approximately the same cost as the medium-sized drone being intercepted, or roughly 1% of the cost of high-end interceptor missiles. The kit is currently being supplied to Ukraine's armed forces by redirecting units ordered under a US Navy prototype contract which predates the Russian invasion of Ukraine.

The US Army has chosen Raytheon's vehicle-mounted LIDS (Low, slow, small unmanned aircraft system Integrated Defeat System) as a near-term C-UAV solution. LIDS consists of Raytheon's Coyote unmanned aircraft (upgraded with an active radar seeker and warhead, and deployed as a de facto surface-to-air missile) and either the company's Ku-band Radio Frequency Sensor (KuRFS) multi-



Raytheon's LIDS C-UAV system can be palletised or vehicle-mounted.



A close-up of the BLADE prototype mounted on a wheeled tactical vehicle.

functional radar or its lighter equivalent, the Ku-720. Also integrated into LIDS are Northrop Grumman's Forward Area Air Defense Command and Control (FAAD C2) system, and an electronic warfare (EW) system made by Syracuse Research Corporation. The weapon system can be mounted on a tactical vehicle or provide point defence as a palletised system. It provides both kinetic and non-kinetic options to neutralise individual armed and reconnaissance drones up to Group 3 UAV as well as UAV swarms. The system's operational debut came in January 2023 when Coyotes downed two attack drones targeting a US outpost in southeastern Syria. The Army plans to equip two divisions with LIDS.

Small Arms Kinetic Weapons

Standard-issue vehicle-mounted and man-portable guns can be directed against medium-sized to small UAVs at close ranges. The greatest challenge here is acquiring the target. Vehicle-mounted automatic weapons benefit from extra sensors calibrated for the sUAV threat. The US Army is pursuing a variety of initiatives including the Ballistic Low Altitude Drone Engagement system (BLADE). The sensor suite can be integrated with the Common Remotely-Operated Weapon Station (CROWS) carried on a broad range of tactical vehicles. BLADE adds a targeting radar and fire control software to the optical sensors already included on the weapon station, significantly improving the CROWS-mounted machine guns chances of acquiring and destroying small, erratically moving targets. In October 2022 the Israeli firm Smart Shooter announced that the US Army had contracted to acquire the SMASH 3000 fire control system, which has also been evaluated by the US Navy, Marine Corps and Special Operations Command. The SMASH 3000 computerised fire control and optic system weighs 740 g and is mounted on standard assault and sniper rifles in place of other scopes or sighting aids. According to the manufacturer, when soldiers aim at a drone the SMASH 3000's "target acquisition and tracking algorithms [...] integrated with sophisticated image-processing software" automatically acquires the target. The processor anticipates the targets movements and continues to track it even as the UAV or the shooter moves. When the system locks onto the target the soldier is instructed to fire. SMASH 3000 is said to enable "one shot, one kill" engagement

of small UAVs at up to 200 m distance.

Photo:

Moving into the medium-calibre side of the spectrum, in October 2022, the Army announced that it was acquiring Northrop Grumman's XM1211 30mm High Explosive Proximity (HEP) round for deployment on the XM914 chain gun. The XM914 is mounted on a variety of wheeled tactical vehicles including Stryker vehicles. According to Northrop Grumman, the 30×113 mm rounds have been designed specifically to engage UAVs weighing between 9 to 114 kg. Each round is equipped with a radio frequency (RF) proximity fuze. Compared to impact-fuzed and even time-fuzed ammunition, proximity fuzed munitions are expected to significantly enhance lethality against both single and swarm UAVs.

Electromagnetic Weapons

The JCO views directed energy as promising for counter-swarm operations, once



In October 2022 the US DoD placed an order for DroneShield's handheld DroneGun MkIII EM C-UAV system.



Artist concept of the THOR microwave weapon technology demonstrator, on which the Mjölnir HPM prototype will be based.

the technology reaches maturity. All Electromagnetic (EM) weapons share the advantages of nearly inexhaustible 'magazines' and extremely low operating cost per shot. A variety of EM weapon concepts are under consideration for countering small to medium-sized UAVs. These weapons can be divided into three categories: radio-wavelength 'jammers', high power microwave (HPM) weapons, and high energy laser (HEL) weapons.

Jammers interrupt the connection between remotely-controlled drones and their operators, forcing the drone to either land or return to its launching point (which has the added benefit of revealing the enemy controller's position). High power microwave weapons can overload and destroy the microelectronics aboard UAVs. Both jammers and HPMs can cover a significant sector of airspace at any given time, and disable multiple targets simultaneously. On the negative side, HPM energy disperses relatively guickly, constraining effective range. Shielding and electronic countermeasures can also protect UAVs from both Jamming and HPM radiation.

Within the JCO construct, the US Air Force (USAF) has been given the lead role regarding electromagnetic and especially HPM weapons research. In February 2022 the Air Force Research Laboratory (AFRL) awarded Leidos, Inc. a contract to develop the Mjölnir, an advanced HPM C-UAV system. The project builds on an earlier technology demonstrator project designated THOR (Tactical High-powered Operational Responder) initiated in 2018. THOR was successfully tested by USAF against sUAV swarms, with primary testing taking place in New Mexico, and an expeditionary test which took place at an undisclosed location in Africa. Mjölnir

will be a smaller but more potent system than THOR (which was housed in a 6 m container), using the same technology but adding important advances in capability, reliability, and manufacturing readiness. "Mjölnir will focus on creating a detailed blueprint for all future [C-UAV HPM] systems with enhanced range and technology for detecting and tracking" drones, said Adrian Lucero, THOR program manager at AFRL's Directed Energy Directorate at Kirtland AFB, New Mexico. Leidos is expected to provide a Mjölnir prototype during FY 2023. Potential applications include defence of expeditionary military bases of all military services. Hand-held, man-portable directed energy weapons promise to offer a flexible approach to close-range C-UAV missions. In shape, size, weight and operation, weapons such as DroneShield's DroneGun resemble assault rifles or even large pistols. They generally require little training, and can be carried by infantry soldiers or military police in the field or on sentry duty. Batteries can be swapped out in the field, guaranteeing prolonged operational capability. Using high-performance directional antennas, they direct RF interference against UAVs. Disruption covers multiple frequencies simultaneously, and includes interference with guidance and satellite navigation channels, and also initiates immediate termination of video and data transmission from the UAV. A rotary dial on the weapon enables the selection of active jamming frequencies based on an assessment of the current threat. Major variants include the 7.3 kg DroneShield Tactical, and the DroneGun Mk 3 optimised for one-handed operation. Both are effective against a wide range of ISM bands as well as satellite navigation.





Concept image of the HELIOS 60 kW laser weapon system integrated aboard USS Preble.

Laser Weapons

The various armed services and the joint service Defense Advanced Research Projects Agency (DARPA) are all pursuing HEL weapons capable of engaging UAVs as well as other airborne threats, ranging from artillery shells to cruise missiles and manned helicopters. While 300 kW to 1 MW power output are considered necessary to defeat sophisticated targets, an output in the 50-100 kW range is considered sufficient for disabling UAV. Current systems have demonstrated that capability.

The US Army's Directed Energy Medium-Short Range Air Defense (DE M-SHORAD) system consists of an 8×8 armoured Stryker vehicle mounting a 50 kW class laser weapon. Named the 'Guardian', the system is suitable for the C-UAV and Counter-Rocket, Artillery, and Mortar (C-RAM) roles, as well as for engaging manned helicopters. A prototype platoon consisting of four vehicles is being fielded at Fort Sill, Oklahoma. The prototype platoon will be available for real-world deployments, but is primarily intended to inform the service's ongoing DE M-SHORAD development and evaluation program. Currently under the aegis of the Army's Rapid Capabilities and Critical Technologies Office (RCCTO), DE M-SHORAD is expected to transition to an acquisition program of record at the Program Executive Office (PEO) Missiles and Space in 2024.

Naval forces are pursuing the same general concepts as ground forces, with an emphasis on high-energy lasers (HEL) to either destroy UAVs or neutralise their sensors. Two leading naval projects are the HELIOS (High Energy Laser with Integrated Optical-dazzler and Surveillance) 60 kW laser and the ODIN (Optical Dazzling Interdictor, Navy). Both are shipboard weapons meant to defend the vessel against direct and indirect threats (such as target spotting for enemy ships) posed by UAVs. ODIN is conceived as a 'dazzler' to temporarily blind UAV sensors, while HELIOS aspires to physically down the unmanned aircraft. Helios combines a potentially destructive laser with a non-destructive dazzler to provide an array of options against UAVs and other threats.

The Navy's Fiscal Year (FY) 2023 budget request defined ODIN as a "near term... shipboard Counter-Intelligence, Surveillance and Reconnaissance" capability specifically intended to dazzle UAVs and other ISR platforms. The Navy has to date deployed ODIN on seven Arleigh Burke class destroyers, with an eighth unit planned in FY 2023. A prototype HELIOS



DRONES ARE BECOMING A BIGGER THREAT

Weibel Scientific's XENTA radar system brings new capabilities within detection range, classification, accuracy and resolution to enhance airspace safety and maintain commercial performance

Throughout the last couple of years, new stories of drone-related incidents and intrusions are hitting headlines around the world. From sightings over a nuclear power plant in Sweden to a collision with a tourist attraction in the UK and injuries caused by a falling drone in India, drone activities are increasingly compromising public safety. While some airspace incidents are public knowledge, there are likely to be many more in restricted airspace that go unreported. In the US alone, the US Federal Aviation Administration (FAA) recorded an average of 100 illegal drone activities per month in 2022, and that number does not include the dark numbers, that was never seen or reported. Additionally, the conflict in Ukraine has raised awareness of the risks associated with drones to an unprecedented level, both to the civil society as well as security and military operations. In general, threats from drones are becoming an ever-increasing security concern worldwide. Detection of drones is therefore an essential security function in many vital situations - such as critical infrastructure protection, monitoring of mobile perimeters and borders, and unmanned traffic management (UTM) systems.

Anti drone systems are used to detect and/or intercept unwanted drones and unmanned aerial vehicles (UASs). Hostile drones may be used to deploy explosives, smuggle contraband or gather intelligence on sensitive assets, and the proliferation of low-cost UASs has led to an increase in incidents. A wide array of anti-drone technolo-



gies are deployed to protect areas such as airports, critical infrastructure, large public spaces such as stadiums, and military installations and operational forces.

Traditional military and aviation radar systems, which are designed to pick up large aircraft, may struggle to pick up smaller drones, or to distinguish them from other objects such as birds. They may also find it difficult to deal with drones that move slowly or hover.

Modern drone detecting radar systems may use a variety of radar technologies, including ESA (electronically scanned array), staring radar, and micro-Doppler, depending on requirements for range, size of protection zone, number of simultaneous targets to track, and ability to deal with environmental clutter. These systems can provide 3D airspace tracking and utilize advanced signal processing techniques to accurately detect and classify drones.

COUNTER-UAS PERFORMANCE WITH WEIBEL'S XENTA C-UAS RADAR

As part of Weibel's business strategy, the company began years ago to develop a radar system specifically designed to counter the growing threat of UAS by refining and adding to their already proven technology from the air surveillance and tracking market. The Weibel Multi-Frequency Surveillance Radar XENTA-series is based on Continuous Wave (CW), Frequency Modulated CW (FMCW) and Multi-Frequency CW (MFCW) 3D Air Surveillance and Tracking Radar technology.

The dual capability surveillance radar comes in a version optimized for air defense in the Close in Defense to Short Range Air Defense (SHORAD) spectrum, as well as a lighter version primarily applied for detecting, tracking and classifying Low, Slow and Small (LSS) targets within the C-UAS & Critical Infrastructure Protection (CIP) spectrum.

The Weibel Counter-UAS radars, the XEN-TA-C series, has thus been developed to address the need of detecting, classifying and tracking all types of aerial targets, from fast moving targets, such as jets, to low, slow, and small (LSS) targets, such as fixedwing aircraft and drones.



The XENTA-C radars effectively distinguish hovering drones from ground clutter through detection of micro-Doppler generated by the rotors of the drone, enabling detection and classification even for drones with zero speed.

Weibel's drone detection radars are available with different transmitter output powers, depending on specific range requirements. Performance of the XENTA-C radar against different types of drone targets has already been proven with success. A XENTA-C radar is able to detect and track a DJI Phantom 4 drone beyond 7 kilometers and classify beyond 5 kilometers.

The XENTA-C radars features a selectable configuration of 30-60° elevation 3D coverage, and 120-240W output power with a 360-degree coverage through rotation, designed for surveillance and tracking in stationary or on-the-move operations in complex clutter environments.

ABOUT WEIBEL SCIENTIFIC

Danish Weibel Scientific is the global leader in the market for advanced Doppler radar systems. For more than 40 years, the company has sold cutting-edge radars around the world for use in space, aerospace, as well as air and missile defence systems. Weibel has delivered more than 5,000 radars to over 40 countries. To ensure high-quality logistics support, Weibel designs and builds all critical units in-house. In-house design and manufacturing mean that with the exception of standard components, Weibel is independent of sub-suppliers for the manufacturing of both prime equipment and spares. In this way, they are able to offer fast and guaranteed through-life support.

For more information, please visit www.weibelradars.com



A DroneHunter F700 deploys a net to ensnare a quadcopter, as seen from the target's perspective.

was installed on the Arleigh Burke class destroyer USS Preble in 2022 for fleet testing and sustainment, with the evaluation phase set to run through FY 2027.

Airborne Systems

Combat aircraft deploy air-to-air missiles to intercept large and medium un-



An Anvil interceptor drone (black) attacking a sUAV target. Anvil collides with the target, destroying it through kinetic force.

manned aircraft. However, this is not practical for combatting smaller UAVs. There have been proposals for aircraft to be armed with laser or HPM weapons for the C-UAV role, but the technology is not considered sufficiently mature. Instead, a significant focus is currently placed at the lower end of the spectrum, adapting or designing 'friendly' UAVs for the shortrange C-sUAV role.

Fortem Technologies' DroneHunter F700 has been tested by the US Army which found it effective in defeating unmanned systems. It is a clean-sheet design specifically for the C-sUAV mission. It is equipped with six rotors for rapid ascent and manoeuvring. Target guidance is achieved via the firms proprietary Sky-Dome command and control software and Trueview R20 onboard radar. The F700 is optimised for defence of critical infrastructure has an operating range of 5 km. It can be deployed against Group 1 and Group 2 UAVs. Intercept is achieved via NetGuns, a family of payloads mounted beneath the DroneHunter. NetGuns fire rapidly expanding nets to ensnare the target. Intercept of Class 1 drones is normally achieved by deploying a net which remains tethered to the F700, which then lowers the captured target to the ground where it can be secured and examined; the DroneHunter can tow drones weighing up to 6 kg. Larger, faster intruders are ensnared in a net which deploys a drogue chute to gently bring the drone down. Higher-flying weaponised drones can be intercepted as they descend on their terminal attack run. The AI-controlled DroneHunter operates autonomously, although a human operator can take over at any time.

The Modular Intercept Drone Avionics Set (MIDAS) developed by Aurora Flight Sciences with Department of Defense funding deploys bolos to foul the rotors of incoming sUAV. The fully autonomous MIDAS uses a radar feed to identify an oncoming threat, then switches to an AI-optical guidance system for the terminal intercept phase. The payload module beneath the MIDAS carries up to 16 'bolo' projectiles for entangling the target's propellers, enabling engagement of drone swarms or multiple single UAVs per mission.

Anduril's autonomous area-defence system, which was acquired by the US Special Operations Command (USSOCOM) under a January 2022 contract, takes a more aggressive approach. The multicomponent system can be easily set up in the field to protect critical infrastructure or expeditionary bases. The major components are the Sentry Tower and the Anvil UAV-based kinetic interceptor, both guided by the firm's Lattice command and control operating system. The sentry tower is equipped with radar and optical sensors as well as processors to detect and classify Group 1-3 aerial targets at ranges of 2-15 km, depending on aircraft size. The Anvil interceptor is a UAV specially-shaped to withstand kinetic impacts with other UAVs, and is held ready in the Anvil launch box. Intercept is achieved through direct impact with the target; Group 1 and Group 2 UAVs are destroyed while leaving the Anvil interceptor UAV intact for further missions. Due to using no pyrotechnic or explosive components, Anvil is suitable for use by civilian operators.

Raising Standards and Standardisation

Going forward, the JCO is expected to produce a DoD directive on C-sUAV as well as a unified assessment of C-sUAV capabilities. The Pentagon also plans to establish a Joint C-sUAV Academy at Fort Sill, Oklahoma, under the aegis of the Army's Fires Centre of Excellence. It will synchronise counter-drone tactics and training among the services. Programs will range from introductory level CsUAV instruction for all servicemembers, over higher-level training for unit leaders, to expert-level training for specialised counter-drone operators. The academy is expected to reach initial operating capability during early Fiscal Year 2024, and full operation capability in 2025.
Major Hellenic Defence Acquisition Programmes

Sidney E. Dean

Following a decade of lean budgets, the Greek government has embarked on an ambitious procurement programme to modernise and maintain the combat power of the armed forces.

The Greek financial crisis of 2009-2018 restricted government spending across the board, including defence. This forced a number of acquisition and maintenance programmes to be suspended for a decade. Following fiscal stabilisation, Athens devised a plan to catch up as well as possible. Greek Prime Minister Kyriakos Mitsotakis announced a major acquisition initiative on 9 September 2020.

In late 2022 Finance Minister Christos Staikouros cited a defence procurement budget increase from EUR 515 M in 2020, to EUR 2.5 Bn in 2021, and EUR 3.4 Bn in 2022. Overall, Staikouros forecast that actual deliveries to the armed forces would total EUR 11.5 Bn during the 2022-2028 timeframe.

The procurement surge benefits all three branches of the armed forces, namely the Hellenic Army (HA), Hellenic Air Force (HAF), and Hellenic Navy (HN). Major acquisitions programmes are managed through centralised agencies of the Ministry of National Defence. The General Directorate for Defence Investments and Armaments (GDDIA) is responsible for the planning and implementation of decisions regarding major defence procurements and programmes.

Hellenic Army

The Hellenic Army is systematically upgrading its armoured combat vehicles fleet, primarily with German and American equipment.

The first 44 of 1,200 planned M1117 Guardian Armoured Safety Vehicles were delivered to the HA in February 2022 under a US Foreign Military Sales (FMS) agreement. The M1117 is being phased out by the US Army since 2019 and are classified as Excess Defense Articles (EDA). The MRAP vehicles have primarily been deployed with US Army military police units in conflict



OPERATIONAL READINESS.

Mercedes-Benz Defence Trucks. Built to accomplish any mission.

Mercedes-Benz Defence Trucks offer you a tailor-made solution to any operational need – with Unimog, Zetros or Arocs vehicles. Our trucks support you reliably in all operational scenarios – including tough off-road conditions and highways.



Mercedes-Benz Trucks you can trust

zones. The Greek Army plans to use them for reconnaissance and surveillance operations. In mid-2022 the Greek defence minister also confirmed the country's desire to obtain AAV-7 amphibious assault vehicles being phased out by the US Marine Corps. In March 2023 the US State Department approved the transfer of 76 AAVs. The deal would be valued at USD 268 M.

In February 2023, Athens announced plans to purchase 205 KF41 Lynx infantry fighting vehicles (IFV) from Rheinmetall. Additionally, 103 of the HA's Leopard 2A4 main battle tanks (MBT) will be upgraded to the Leopard 2A7 standard by Krauss-Maffei-Wegmann (KMW); another 20 newly-built Leopard 2A7s will also be acquired. The German firms will collaborate with Macedonia-based EODH on the projects, which have a combined worth of EUR 3.5 Bn. Rheinmetall will also supply Greece with 200 Marder 1A3 IFVs which were retired from the German Army; this is in addition to 40 Marder IFVs already delivered in 2022.

The HA is also procuring Spike NLOS (Non-Line-Of-Sight) anti-tank guided missiles (AT-GMs) for the AH-64A and AH-64D attack helicopters; the long-range ATGMs could potentially also be placed on ground launch platforms on Greek islands in the Aegean to interdict hostile maritime and amphibious operations. The Army's purchase is valued at EUR 280 M. In addition, the HA is upgrading the outdated electro-optical systems of 19 of Greece's AH-64A attack helicopters to improve operational performance.

Hellenic Air Force

Major ongoing acquisition programmes encompass new and upgraded combat aircraft and high-performance unmanned aerial vehicles (UAVs).



The first Hellenic AF Rafale B flies over France prior to delivery in July 2021.

Under a contract initially signed in January 2021 and expanded in March 2022, the HAF is fielding a total of 24 Rafale fighter jets to replace older Mirage 2000s purchased in 1985. The package includes six two-seater Rafale B and 18 single-seater Rafale C variants. The procurement is valued at nearly USD 3 Bn. Half of the Rafales are newly-built and delivered directly by Dassault Aviation. As a cost-reduction measure, the remaining dozen are being taken over from the French Air Force; the latter units represent the F3-O4T variant, and were delivered to the French military between 2012 and 2018. The first six aircraft arrived in Greece in January 2022, with the full complement to be available by summer 2024. The French-made armament package for the Rafale will include the Meteor beyond-visual-range air-to-air missile, the SCALP cruise missile, the MICA





US Army surplus M1117 armoured vehicles arrive at Thessaloniki.

multi-mission air-to-air missile, and the AM39 Exocet anti-ship missile.

Ten of the HAFs remaining Mirage 2000s will be upgraded to the 2000-5 standard. This will provide the HAF with a total of 35 Mirage 2000-5, following earlier partial upgrades and imports. The HAF is also having 83 of its current F-16 fleet upgraded to the F-16V (Block 70/72) configuration. The F-16V programme is valued at USD 1.5 Bn. Both upgrade contracts are being fulfilled in Greece by Hellenic Aerospace Industry (HAI). The first two F-16Vs were returned to the HAF in September 2022, and the full conversion programme is slated to be completed in 2027. Athens has confirmed its continued interest in acquiring the F-35. However, any such procurement has been postponed until at least 2028 in order to finance other programmes.

The Greek Air Force currently operates leased Heron Medium-Altitude, Long-Endurance (MALE) UAVs, which are primarily tasked with maritime surveillance. Athens aspires to field domestically-produced, highperformance UAVs. Hellenic Aerospace Industries presented the model of the Archytas UAV at the September 2022 International Exhibition of Thessaloniki. Designed in collaboration with three Greek universities, the fixed-wing, vertical take-off and landing UAV is designed for reconnaissance and observation. According to HAI, it has an endurance of 4 hours and a maximum range of 300 km. The firm expects to build the first pre-production version of Archytas in 2023 and complete its maiden flight in 2024. A more advanced, combat-mission-capable UAV named Grypas is planned. HAI hopes to present the armed forces with a scaled aircraft by 2025.

SIMPLY NO RIVALS



Based on the market-leading AW139, the AW139M was designed to meet the stringent military and civilian certification requirements of government, homeland security and military users, for a wide range of missions, day and night. It provides enhanced operational effectiveness with mission detection and protection systems and a range of role equipment for multi-role and combat missions. Thanks to its compact footprint for confined area operations, its 60-min certified gearbox dry-run capability and crashworthiness to latest standards; it can meet the most challenging conditions anywhere.

Visit us at DEFEA, Stand C8 - Hall 4



<u>le</u>onardo.com





Concept image of a Belharra class frigate in Greek service.

Hellenic Navy

The Hellenic Navy is undergoing its largest modernisation phase in over 20 years. Major naval procurement encompasses new frigates, corvettes, refurbishment of existing MEKO frigates, new support helicopters, and weapon systems.

Following an intense competition by various foreign manufacturers, in September 2021, Athens opted to acquire three Belharra class multi-mission frigates, with an option for a fourth vessel. The class is also known as the FDI (Frégate de Défense et d'Intervention; ENG: Defence and Intervention Frigate). The Greek government signed the formal order contract, valued at EUR 2.26 Bn, with France's Naval Group in March 2022. The ships will be equipped with the Thales Sea Fire digital multi-function radar and the Sentinel digital electronic warfare system. The frigates will be armed with French weapon systems. These include the Aster 30 B1 area defence system, the MM40 Exocet Block 3C anti-ship

missile, the MU90 anti-submarine warfare (ASW) lightweight torpedo, and the CAN-TO torpedo countermeasures system. Construction of the first two vessels is underway. Naval Group plans to deliver these in 2025, followed by the third vessel in 2026. A fourth ship could be delivered in 2027 if the option is exercised.

A parallel procurement competition for a new class of corvettes is ongoing. Defence Minister Panagiotopoulos stated in late February 2023 that a decision was "imminent." He praised both competing industry teams' proposals as meeting the Greek Navy's needs. These proposals, which were formally submitted for review in December 2022, are Naval Group's GoWind and Fincantieri's FCX30 design. For the competition, Naval Group is partnering with Hellenic Shipyards, while Fincantieri is aligned with Greece's ONEX Shipyards & Technologies Group. The corvette contract is valued at EUR 1.5 Bn. Athens is again looking to order three vessels while retaining an option for a fourth. Completion of the first ship is



The domestically produced Agenor Special Operations Craft.

expected three years after contract award. Additionally, the four Hydra class (MEKO 200HN) frigates serving with the fleet since the 1990s will be upgraded, enhancing combat capability and extending service life. Following prolonged discussions, the Defence Ministry announced in April 2022 that EUR 500 M would be allocated to the overdue mid-life upgrade. Several foreign firms are partnering with local entities in bidding for the contract.

In addition to ships, the HN is introducing Harpoon anti-ship missiles (ASM). The Greek parliament approved the purchase of 50 missiles in July 2022, immediately after the sale was approved by the US State Department. The majority of the ASMs will be deployed on Air Force F-16s, with a small number reserved for the HN's five P-3 Orion maritime patrol aircraft which are currently being upgraded by Lockheed Martin. Rafael's Typhoon MLS-ER missile launch system and Spike NLOS long-range missiles valued at EUR 55 M are being procured for service on Machitis class patrol boats and on the Mk V special operations craft (SOC). The Spike-armed Typhoon system will permit fast, precise engagement of sea and shore targets at ranges up to 10 km. The HN's four Mk V SOC units are themselves new, being donated by the US Special Operations Command in 2021-2022. A fifth SOC joined the fleet in 2022. The Agenor, built by the Phi-Mechaniseas shipbuilding consortium, is Greece's first domestically-designed SOC. Armed with a Shark remote weapon station, the multi-mission boat achieves sprint speeds of 52 knots (96.3 km/h).

Finally, four MH-60R Seahawk helicopters were ordered in 2020 for delivery by 2025; these will serve as anti-submarine assets aboard the new frigates.

Looking Forward

While the majority of acquisitions are still foreign-sourced, Athens is placing great emphasis on strengthening its domestic defence industry and increasing autonomy. Greek partners are being included in all major import programmes. More importantly, as the UAV programmes demonstrate, the ambition is to undertake increasingly sophisticated research, development and construction at home. Already Naval Group has formed a Greek subsidiary (Naval Group Hellas) and is guaranteeing Greek industry a minimum of 30% of all work should the FN choose the GoWind as its new corvette. Future major acquisition programmes are likely to see more assertive domestic industry positions.



Supported by



lin

DSEI



Back in Business

Tim Guest

Greece has technological inventiveness and innovation going far back into its history. Recent decades, however, have seen a malaise and financial downturn impacting all of society, though economic recovery now seems to be in full swing, including for the nation's high-tech defence sector.

rom Archimedes' Screw, differential gears, cranes, winches, the torsion catapult and even a primitive form of cannon operated by compressed air, Greek inventiveness in the classical era, often in response to times of war and the need to secure military advantage. Fast forward to recent decades, however, from the latter part of the 20th Century to the first two decades of the 21st, and while Greek inventive spirit may have endured, the nation has experienced difficult economic, political and societal times, with its defence industry very much part of the wretched story. Yet, a remarkable economic recovery in the past few years now sees a nation emerging from its recent trials and tribulations, including in the area of defence, where the country's defence industry is developing a number of contributions to the market.

This article looks at the Greek defence industry from its origins during past times of conflict to its current resurgence, including a snapshot of some of the Hellenic companies offering high-tech systems, domestically and to the world.

Setting the Scene

NATO membership for Greece began in 1952. Due to the Cyprus crisis during the 1960s and 1970s, however, the country withdrew certain forces and command elements from the alliance and even contemplated withdrawing altogether at one stage during that period. That threatened withdrawal never transpired, thankfully, and today Greece is, once more, a full member. Yet it was this period of conflict with its Turkish neighbour that led Greece to establish a home-grown defence-industrial capability, enabling it to bolster its armed forces by itself. From tank and artillery ammunition, to offroad vehicles, aircraft engines and more, stateowned companies emerged to meet the requirement and included players like EAB, ENAE and others. Together, these young companies manufactured much of the weaponry needed by the country's



Pictured: Greek F-16Ds on a NATO exercise in 2018. Greece has a major part to play as a key member of NATO and the resurgence of its defence industry is good news all round.

armed forces at that time. However, this situation did not last.

Fast forward, to recent times, and between 2007 and 2012 Greece imported more defence materiel than any other member of the EU, with a languishing, ineffective state-owned defence sector in bankruptcy during the debt crisis from 2008/9-2018 when the nation's own fortunes were only salvaged by three consecutive bailouts by the EU. Without getting bogged down in the very complex political and financial machinations playing out during this gloomy phase in Greece's recent past, suffice it to say that a great turnaround is in now play, leading to high-tech developments emerging from today's rejuvenated Greek defence sector.

Rising Like a Phoenix

In 2020, the country's defence sector stabilised through the privatisation of its bankrupt state-owned players, much of which involved investments by foreign stakeholders. In addition, the Greek Ministry of Defence initiated a USD 6.7 Bn rearmament programme across all three services, and called for an overall re-emphasis on cooperation and collaboration with overseas parties, such as Egypt, Israel and the US, not simply for procurement from these, but also to support its own technology exports. A series of procurements and projects under the re-armament programme got underway, with procurements for the Hellenic Air Force (HAF) including, fighter jets, UAVs, an F-16 upgrade programme, as well as spares and maintenance support for a variety of equipment; procurement for the Hellenic Navy (HN), which includes four new frigates, various other new vessels, refurbishment of existing MEKO frigates, MH 60 R naval helicopters, as well as upgrade and modernisation support; and for the Hellenic Army (HA), a national vehicle programme is in play and light weapons are also being sought, together with unspecified antitank weapons.

In addition to privatisation and the procurement programme, the country has also formed partnerships with neighbours in response to geopolitical tensions, including with Egypt and Israel; it has also signed an update to the US-Greece Mutual Defence Cooperation Agreement (MDCA) for a 5-year extension. Indeed, with the US, Greece benefits from a government-to-government military sales framework, which allows it to secure certain items though foreign military sales, and other defence agreements. And while larger items will likely come through such routes, the US recognises the Greek Government's emphasis on developing its own local industry and increasing local production, while incorporating strong international partnerships into that mix, where appropriate. To that collaborative end, US firms are encouraged by the US Government's International Trade Administration to further such possibilities by connecting with several Greek industry defence associations, including: the Hellenic Aerospace Security and Defence Industries Group (HASDIG), the Hellenic Manufacturers of Defence Materiel Association (SEKPY) and EFA Ventures Group.

Greece has also signed other agreements in the 2020-2021 timeframe, including with France for the sales of arms and military support with the intention of strengthening strategic relationships with the EU and NATO, as well as bilaterally with the UK to boost trade and security and signing a letter of intent with the Netherlands for the procurement of Dutch warships. Further afield, Greece has signed a trilateral military cooperation programme with Cyprus and Egypt, and a USD 1.65 Bn deal with Israel's Elbit Systems for the establishment of a training centre for the HAF, spanning a 22-year contract period.

Made in Greece

With Greece's rearmament programme projected by some analysts to potentially exceed the rearmament programme's USD 6.7 Bn budget by 2025 by almost as much as another USD 6 Bn. The nation's domestic defence industries will undoubtedly share in new contracts with the Ministry of National Defence. Indeed, some have already been supplying the Greek military with 'made in Greece' weaponry in growing numbers since late 2020, such as drones and speedboats. Beyond these, collaborative projects are already underway with defence industry partners in allied states including Israel, France, the UAE, and the US, either as investors in now-healthy corporations such as Hellenic Vehicle Industry ($E \land BO$), or as partners in the co-production of key



Pictured: Greek F-16D intercepts a Montenegrin Learjet 45 on a simulated interception exercise in 2018. Greek industries have considerable high-tech electronics expertise for applications in land, sea and air domains.



SGL Engineering specialises in naval vessel metrology and project management, including weapon systems assembly, installation, and 3D alignment, measurements including gyroscopic azimuth measurements, noise and vibration analysis, and many other activities.

weapons, such as the four new frigates, mentioned above, at the ENAE and

Neorion Shipyards.

Some of the biggest defence contracts for home-grown defence technologies in years, were signed in 2020, when four of the nation's now privately-owned defence companies – Intracom Defence Electronics, EODH, Theon Sensors, and Skytalis – amassed deals with EU and Middle Eastern customers, (a new market for them), worth in excess of EUR 255 M (USD 300 M), which represented a 20% year-on-year increase in the value of contracts for those four. Beyond these companies, other, smaller defence contracts were signed exceeding USD 50 M for both domestic and overseas orders.

Also emerging from this post-2020 turnaround of fortunes and despite fierce competition from various European defence leviathans, the reborn Greek defence sector secured almost a third of upcoming programmes under the EU's Permanent Structured Cooperation (PESCO), which is the part of the EU's security and defence



Akmon, which manufactures, upgrades and rebuilds cable sets and harnesses for aerospace use has high-tech facilities to support its efforts, including clean rooms and higgh0grade production areas.

policy in which 25 of the 27 national armed forces pursue structural integration. In addition, there will be participation from Greek defence contractors in five of 16 projects under the European Defence Industrial Development Programme (EDIDP), along with over 180 participants from other EU countries. Those projects are for the LOTUS low visibility drone, the DECISMAR upgraded maritime surveillance system, the ESC2 improved command-and-control system, improved cyber defence under the PAN-DORA project, and the SMOTANET nextgeneration internal communications project. Greek companies will also participate in one of eight research projects - the PRIVILEGE 'encryption of sensitive military data' project - in the context of the Preparatory Action on Defence Research (PADR) work.

As if to underline the Greek defence industry's recovery further, NATO's Secretary General, Jens Stoltenberg, speaking in Brussels in March 2023 ahead of the release of the alliance's annual report, said that Greece was among seven out of 30 allies to meet NATO's military spending target of 2% of GDP in 2022. In fact, Greece had the highest rate of expenditure as a share of GDP at 3.54%, ahead of Estonia, Latvia, Lithuania, Poland, the UK, and the US.

A Show of Strength

When the rejuvenated Greek defence industry opened its doors in 2021 to the world at the nation's first DEFEA (Defence Exhibition Athens), not only was the importance of the event for Greece underscored by an impressive turnout by the Hellenic Armed Forces and Security Services, but also by the active participation of the Ministry of National Defence, working with the expo organisers on the organisation of the event. For the country's reborn high-tech sector, 97 companies, both state-owned and private industries, from defence, academia and related civil sectors, showcased themselves and their products among a first-year total of 312 exhibitors. As for the DEFEA 2023 event in May, a modest increase to 315 exhibitors from 22 countries is expected, though comprising a superlative turnout from Greek participants. Hellenic participants include many names forging a path in the country's reinvigorated defence ecosystem, which are, in no particular order, worthy of mention.

Starting out with state-owned, heavyweight Hellenic Defence Systems, EAS, which is engaged in the design, development, manufacture and sales of NATOstandard defence equipment, including: infantry weapons, weapon systems, missile systems, and munitions. It also conducts upgrade, modernisation and maintenance of weapon and missile systems, as well as testing and evaluation activities, including ballistic materials. The company is a dynamic partner with some 40 overseas ministries of defence. At the other end of the size scale, SME Elfon, designs and manufactures wiring harnesses and electromechanical assemblies to highest MILSPECs and subcontracts for tier 1 and 2 contractors in defence, aviation and space industries. Its customers include: Lockheed Martin, Textron, Northrop Grumman, Dassault, MBDA, Thales, OHB, Leonardo, Hellenic Shipyards, Elefsis Shipyards, and the Hellenic Navy. The projects it is involved in range from: F-16, T-6, and P3 A/C, to S-Frigate modernisation, Exocet, RIM-162 ESSM, RIM-116 RAM, Phalanx CIWS and others. Also in this field is electronics specialist, Akmon, which manufactures,



Provider of Special Forces armour solutions, Elmon, showcased latest developments in ballistic plates, helmets and other products at Enforce Tac 2022, when it also announced a second multi-million Euro contract to supply the Greek Army with body armour tactical carriers and armour plates.

TOTAL NAVAL DOMINANCE

Leonardo has more than 60 years' experience providing the most comprehensive, integrated portfolio of naval dominance products to customers worldwide, including multifunction AESA and tracking radars, multi-sensory weapon control systems, panoramic IRST, integrated communication systems and advanced combat management systems for total information superiority at sea.

Visit us at DEFEA, Hall 4, Stand C8 and at Seafuture, Stand C 19



leonardo.com



upgrades and rebuilds cable sets and harnesses for aerospace use, as well as electro-mechanical assemblies and hightech communications and electronic equipment for air, sea and land defence applications, meeting the highest Mil-Aero standards.

One of several companies at this year's event active in personal protective systems is Elmon, which offers a comprehensive product portfolio protective armour, tactical gear and CBRN protection for the harshest defence and homeland security requirements made at its stateof-the-art production facility. Another is Siamidis, which specialises in advanced ballistics and technical garments for military, law enforcement and fire & rescue professionals and has established, long-time international partnerships. It is a DuPont partner for DuPont Kevlar, DuPont Nomex, DuPont Tensylon technologies and a W L Gore licensed partner for GORE-TEX, GORE PYRAD, and GORE WINDSTOPPER textile technologies. Manufacturing is conducted inhouse at its vertically integrated, NATO/ NSPA-approved European facilities, with over 82% of production being exported. Also purveying anti-ballistic protection systems is Double Action Defence, which manufactures to NATO standards and is one of the main suppliers of such systems to the Greek Armed and Security Forces, as well as to overseas clients, including providing bulletproof vests and anti-ballistic plates to the UAE Presidential Guard (UAE-PG).

In the area of unmanned systems, Altus is a player that provides turnkey solutions for a wide range of applications, including: land and maritime border surveillance, intelligence gathering, airborne ISR, environmental monitoring, natural disaster management, GIS applications, protection of critical infrastructure, SAR missions, infrastructure inspection, RGB-D/thermal/multispectral mapping, aerial works data processing and aerial target drone applications. With customers in the aviation and defence/security sector, Altus has work in play with several organisations, including: NATO, the HA, HN, HAF, Hellenic Fire Service, Qatar Emir Air Force, Israeli Defence Forces, the European Commission and many more.

Also in this space, is Spirit Aeronautical Systems (SAS Technology), an unmanned systems manufacturer of various fixed wing and multi-rotor unmanned platforms. It also designs land and maritime unmanned systems, though the company's current main focus is mid-to-heavyload MR UAVs. SAS manufactures a series



In January 2023, Intracom Defence announced the EUR 14.2 M extension of its co-operation with Diehl Defence for the production of crucial electronic missile components of the IRIS-T family of missile systems. Same month, the company also received a new USD 10.2 M contract from Raytheon Missiles & Defense, for the production of electronic missile components of the Evolved Sea Sparrow Missile (ESSM) Block-2 system.

of ground stations with customised software applications and its products are fully customisable for bespoke projects. Its technical facilities include a design/ development laboratory, production line, product showroom and training facilities. Another name worthy of mention in this high-tech, unmanned sector is Ucandrone, which makes integrated UAVs for research purposes and other operations, collaborating with the Greek National Ministry of Defence amongst others. Its UAVs are made of composite materials and incorporate sophisticated sensors. The systems are capable of surveillance, recording and mapping for military and internal security needs. Systems include its fixed-wing Blackbird VT120, and MR system, Octopus.

In the electronics and communications space, Intracom Defence, (IDE), designs and develops advanced missile electronics, tactical IP communications, and C4I systems, as well as surveillance, hybrid electric power, and unmanned systems. The company has long-standing participation in European and NATO new technology development programmes and is a key player in the Hellenic Defence ecosystem. Another company, this time involved in a project mentioned earlier, is Etme Defence & Security, which, is leading the European Defence Industrial Development Programme (EDIDP) DECISMAR project in the SME category. DECISMAR is a decision support toolbox for acquisition planning in the maritime surveillance domain. Also on the electronics side is Hellenic instruments, which designs, develops and manufactures military, security and industrial electronic systems. Its capabilities include antenna design and RF planning, embedded systems, smart sensor devices, security and surveillance integrated systems, as well as ammunition sub-systems and fuzes, communication jamming and data-collection systems.

It is also worth mentioning two other players which will be showcasing at this year's DEFEA. With robotic and autonomous systems now taking position as battlespace norms, Soukos Robots is certainly one to watch. As an R&D centre, it designs and manufactures robotic systems for defence applications and has collaborated with both Greek and foreign governments, as well as with the US Army with its 'Castalia demilitarization system' for the disposal of conventional munitions. On the sensor side of things, Theon Sensors has established itself as a leading player in the night vision (NV) and thermal imaging (TI) market with over 50 customers worldwide. All of its products are designed in-house, and its capabilities cover optical, mechanical, electronics and system design. The company's main product range is the Linesman portable NV and TI system.

Despite years in the wilderness, the Greek defence industry appears to be alive and well and behind some impressive hightech systems and partnerships.

Ammunition Suppliers from Central and Eastern Europe

Martin Smisek

The following survey provides an overview of the most important ammunition producers from Central and Eastern Europe (excluding the republics of the former Soviet Union).

Albania

Since 1962, the Albanian arms industry has produced a variety of ammunition, explosives and infantry weapons, all of which faced rapid decline after the fall of communism in Albania during the early 1990s.

Kombinati Mekanik Poliçan specialised in the production of rifle, machine gun and mortar ammunition, including antipersonnel and anti-tank mines. Currently, the company reportedly produces only pistol rounds (9×18 mm and 9×19 mm). Uzina e Lëndëve Plasëse Mjekës continues with the production of explosives (TNT, RDX) and propellants (nitrocellulose).

Bosnia and Herzegovina

The country inherited a significant portion of the former Yugoslavia's military production capacities. In the past, some 51% of the total arms production within the former Yugoslavia was carried out on the territory of present-day Bosnia and Herzegovina (BiH).

The leading defence contractor is the state-owned concern UNIS-GROUP headquartered in Sarajevo. This concern is composed of eight companies providing a wide range of arms products and services, most of which are centred on explosives and ammunition manufacture. Production of small arms ammunition of calibres 5.56 mm to 12.7 mm according to NATO and Russian standards is the responsibility of Igman, an ammunition factory founded in 1950, and based in Konjic.

<u>Author</u>

Martin Smisek is a Czech freelance journalist specialising in Czech armament programmes and Czech and Slovak military history since WW II.



Some of the 23 mm and 30 mm rounds manufactured by the Bulgarian company Arsenal.

Another member of UNIS-GROUP is Pretis, established in 1948. Its manufacturing plant is located in Vogošća, a suburb of Sarajevo where it manufactures mortar ammunition (60 mm, 81 mm, 82 mm, and 120 mm), artillery ammunition (76 mm, 90 mm, 105 mm, 122 mm, 130 mm, 152 mm, and 155 mm) and also tank ammunition (76 mm, 90 mm, 100 mm, and 125 mm). The product portfolio of Pretis also includes 122 mm, 128 mm and 262 mm artillery rockets, aircraft bombs and rifle grenades.

Established in 1950, BINAS located in Bugojno in central BiH makes all types of fuses for artillery shells, primers, hand grenades, 40 mm cartridges for grenade launchers, and demolition charges.

UNIS-GROUP also includes UNIS GINEX in Goražde, south-east of Sarajevo, which is responsible for the production of initiating means for military and commercial use. The production programme comprises percussion primers for small arms ammunition, primers, duplex and blasting caps, delay elements, electric primers intended for fuses, electric squibs, igniters and different types of initiating explosives and chemicals.

Within UNIS-GROUP, the production of explosives is entrusted to PS Vitezit, founded in 1950 in the central town of Vitez. The company produces different kinds of military and industrial explosives, rocket propellants, powders for mortar and artillery ammunition, as well as detonating fuses.

Outside state-owned UNIS-GROUP, two private-owned companies in Goražde are engaged in ammunition production. While POBJEDA TECHNOLOGY manufactures pistol, blank and sports ammunition, POBJEDA-RUDET produces electric and non-electric detonators, plain detonators and detonating cords.

Bulgaria

Unlike some other former Warsaw Pact members, Bulgaria inherited substantial manufacturing capacities capable of producing an extensive range of ammunition for Soviet-era and current Russian weapons.



Croatian company Elmech Sintermak offers large calibre ammunition such as 155mm M101 and M107 high-explosive rounds.

The oldest Bulgarian arms manufacturer (established in 1878) is Arsenal, a private-owned joint-stock company headquartered at Kazanlak. It is one of the largest machine-building companies in the country that produces sub-machine guns, assault rifles, machine guns, grenade launchers, mortars, rocket-propelled grenade launchers, recoilless rifles, anti-aircraft guns and a wide range of ammunition.

The ammunition portfolio includes pistol and rifle rounds (5.56 mm, 7.62 mm and 9 mm), 23 mm and 30 mm rounds for anti-aircraft guns (ZU-23-2, ZSU-23-4 Shilka, AK-630), guns for infantry fighting vehicles (IFVs) (2A42, 2A72) and aircraft weaponry (GSh-23, GSh-6-23, GSh-30, GSh-301). Arsenal also produces a large spectrum of 40×46 mm rounds for grenade launchers, reactive propelled grenades for the RPG-7 series of weapons, 73 mm rounds for recoilless guns and a wide-range of mortar bombs (60 mm, 81 mm, 82 mm and 120 mm). The company also offers the ARS-8KOM 80 mm unguided rocket and its training versions. Moreover, Arsenal manufactures anti-tank mines, different types of hand grenades and fuses, percussion primers for small arms and artillery ammunition, powders and charges for rocket engines, mortar bombs, artillery ammunition and grenade launcher ammunition.

Another key producer is Vazovski Mashinostroitelni Zavodi located in Sopot. Today, it is the only state-owned arms plant in Bulgaria. The company manufactures mostly Soviet-era ammunition such as rounds for the RPG-7, 73 mm rounds for the SPG-9 recoilless gun and the BMP-1 IFV, and tank ammunition (100 mm, 125 mm). It also manufactures mortar rounds (60 mm, 81 mm, 82 mm, and 120 mm) and artillery (122 mm, 130 mm, 152 mm, and 155 mm) ammunition, 122 mm artillery rockets for the BM-21 Grad, anti-tank guided missiles (9M111M, 9M111-2, 9M113, 9M115), RPG-22, Bullspike anti-tank grenade launchers, S-5 and the S-8 series of unguided rockets and fuses.

The city of Ruse in northern Bulgaria is the home of ammunition manufacturer Dunarit. The main part of its product portfolio is composed of S-8KOM 80 mm unguided rockets and Soviet-era free-fall bombs for combat airplanes - high-explosive fragmentation (OFAB-100-120, OFAB-250-270, OFAB-500), high-explosive (FAB-500M-62), concrete piercing (BetAB-500), practice (P-50-70), and thermobaric (OFAB-100-120TB, OFAB-250-270TB, FAB-500M-62TB). The other section of the portfolio is made of large calibre (125 mm tank and 122 mm artillery rounds) and mortar ammunition (60 mm, 81 mm, 82 mm, and 120 mm), as well as rounds for RPG-7. Dunarit also produces hand grenades and detonating cords.

The product range of the Arcus company includes small arms, grenade launchers, mortars, and ammunition along with fuses. Ammunition produced includes 23 mm and 30 mm rounds for anti-aircraft guns and IFVs, 30 mm and 40 mm grenades for under-barrel and single-shot/ automatic grenade launchers, rounds for the RPG-7 and high-explosive mortar bombs (60 mm, 81 mm, 82 mm, and 120 mm).

Moreover, a subsidiary of the Bulgarian state-owned company TEREM-HOLDING, TEREM-Tsar Samuil, runs an ammunition

maintenance facility for mortar and artillery rounds at its plant in Kostenets.

Croatia

The Croatian defence industry developed during the country's War of Independence (1991–1995) mostly from the existing civilian enterprises and to a lesser extent from companies that dealt with defence production within the former Yugoslavia.

One of the leading Croatian companies in the manufacture of military, hunting and sports ammunition is M90, which was established in 1990. The production facility, which is located at Duga Resa, south-west of Zagreb, makes pistol and revolver ammunition, hunting and sports shotgun shells, rimfire rounds and nonlethal riot control ammunition for police and law enforcement agencies.

Another Croatian small arms ammunition producer is Bullet, operating in Zagreb since 1993. Its specialisation is the production of ammunition for sports and hunting weapons (rifles, pistols and revolvers), the production of pistol bullets, the sale of ammunition and reloading components and the testing of ammunition characteristics and bulletproof materials.

The ammunition is also produced by the ATIR military research and development agency in Zagreb in the form of different types of 40×46 mm rounds (high-explosive, riot control, target marker and practice) for grenade launchers.

The sole Croatian large-calibre ammunition producer is Elmech Sintermak, which started with its manufacturing of ammunition in the northern region of Hrvatsko Zagorje in 2017. The portfolio includes 60



60 mm HEI-LD mortar rounds delivered by Vojenský technický ústav for the Czech Army, which obtained 10,000 examples of this ammunition for ANTOS-LR mortars operated by the 43rd Airborne Regiment in 2020.

Photo: Explosi

mm, 81 mm, 82 mm and 120 mm highexplosive mortar rounds, as well as 105 mm, 122 mm and 155 mm high-explosive artillery ammunition. Elmech Sintermak also offers hand grenades, industrial explosives and sniper rifle ammunition.

Czech Republic

The oldest Czech ammunition producer Sellier & Bellot in Vlašim has been manufacturing products bearing its trademark uninterrupted since 1825. In 2009, the company was acquired by Brazilian Companhia Brasileira de Cartuchos. Sellier & Bellot manufactures pistol and revolver ammunition, sports and hunting ammunition, shotgun shells, rimfire rounds, as well as ammunition for armed and police forces (9×19 mm, 4.6×30 mm, 5.56×45 mm, 7.62×39 mm, 7.62×51 mm, and 7.62×54 mm).

The medium-calibre ammunition production is represented by ZVI with the plant in Vsetin that manufactures 20×102 mm rounds for aircraft guns and 30×173 mm, as well as 30×165 mm rounds for IFVs. The largest ammunition producer in the territory of the Czech Republic is STV GROUP with its headquarters in Prague

and five manufacturing facilities around

Bi-modular propellant charges for 155 mm howitzers are produced by Explosia, the manufacturer of the well-known SEMTEX plastic explosive. Bi-Modular Charging System consists of two types (BC-E and TC-F) of modules different in marking, colour, shape, and a visible black stripe.

the country. The company offers 14.5 mm machine gun ammunition, 30×165 mm rounds for IFVs, ammunition for the RPG-7, 73 mm PG-9V rounds, as well as tank ammunition (100 mm, 125 mm) and artillery ammunition (122 mm, 152 mm,

155 mm), 122 mm Grad rockets, as well as mortar bombs (81 mm, 82 mm, 120 mm) and anti-tank mines. In addition, STV GROUP is the largest Czech producer of plastic explosives, with an annual production of more than 100 tonnes.

Marketing Report: EVPÚ

Latest surveillance and military electro-optical systems at IDET 2023

EVPÚ Defence a.s. has been at the forefront of developing sophisticated and reliable electro-optical solutions for more than 20 years. The company is one of the traditional exhibitors at IDET, an important international security and defence event taking place in the Czech Republic, and this year will be no exception.

EVPÚ Defence's security system display will be centred around its latest SUMO-C900HD cooled thermal imaging camera capable of detecting a person up to 20 km away. Protected by a robust housing that enables its uninterrupted operation in all weather conditions, this thermal imager offers many standard and some optional features. The clear and sharp image of SUMO-C900HD is particularly suitable for border or coastal area surveillance, where it can be part of a cost-effective long range security solution.

Nevertheless, most of this year's large exhibition space, which will be shared between EVPÚ Defence and its Slovak partner EVPÚ a.s., is set to showcase defence systems. IDET visitors can look forward to seeing the remote controlled TURRA turret for 30mm automatic cannon, as well as the CMS-1 commander sight, CRANE-XLR gunner sight

and LAWAREC laser and radar irradiation detection system, which are destined for the Slovak Republic's BOV 8×8 armoured fighting vehicle (AFV) programme. Other military systems to be displayed include the MANTIS stabilised weapon station with a fully detached line of sight, GLADIUS weapon station with a partially detached line of sight, MANTIS MINI compact weapon station weighing under 90 kg and the GATRIA modular situation awareness system.

The EVPÚ Defence team is looking forward to welcoming visitors at stand no. 61, Hall P, Brno Exhibition Center, Czech Republic, from 24 – 26 May 2023.



Polish 122 mm M-21 HE FENIKS rocket with a high-explosive warhead can destroy targets up to a distance of 41 km. It is compatible with BM-21, RM-70 and WR-40 Langusta multiple rocket launcher systems.

Mortar ammunition (60 mm), 9 mm and 12.7 mm rounds, along with practice 40×46 mm grenades are also produced by the facility of Vojenský technický ústav in Slavičín.

ZEVETA Bojkovice produces, among others, URG-86 hand grenades, RPG-75M and RPG-75MP reactive anti-tank grenades, 68 mm RTG reactive thermobaric grenades together with DGO-1 and DGO-3 smoke cartridges. State-owned company Explosia, located at Semtín near Pardubice, is a crucial producer of explosives, detonating cords, spherical and nitrocellulose powders along with modular charges for 155 mm artillery rounds. The largest Czech defence contractor Czechoslovak Group (CSG) had its ammunition production centred on its subsidiary MSM GROUP located in Slovakia. Moreover, CSG acquired a 70% share in the Italian small-calibre ammunition manufacturer Fiocchi Munizioni in early December 2022.

hoto: Yugoimpor



In 2010, holding company Krušik and Yugoimport–SDPR founded the Forging Center for the production of ammunition parts by hot forging (projectile bodies for large calibre ammunition, rocket motor chambers for rockets and missiles).

Hungary

The primary Hungarian ammunition producer is MFS Ammunition with a factory in Sirok. The company was established in 1952 as Mátravidéki Fémművek. Its acquisition by Beretta Holding from RUAG Ammotech Group took place in August 2022. MFS Ammunition produces smallcalibre ammunition such as .380 Auto, .38 Special, .44 Magnum, .357 Magnum, .40 S&W, .45 ACP, 9×19 mm, 9×21 mm, 7,65Br, 9×18 mm, 7.62×39 mm, 7.62×54 mm and 5.56×45 mm SS109.

More recently, in January 2023, Rheinmetall commenced the construction of an ammunition factory for its subsidiary, Rheinmetall Hungary Munitions Zrt. The factory is being constructed at a new 150-hectare production site based in Várpalota, located in western Hungary. The site is intended to produce a variety of munitions, including 30×173 mm ammunition for Hungary's Lynx IFVs, as well as 120 mm tank ammunition and 155 mm artillery ammunition. Full production capacity is scheduled to be reached in 2025.

Montenegro

The modest defence industry mostly relies on factories from the Yugoslav era. The sector includes enterprises such as the former state-owned TARA arms factory in Mojkovac and POLIEX in Berane. TARA Aerospace is the manufacturer of pyrotechnical aviation cartridges, various types of ejection seat propulsion devices and automatic fire extinguishing systems for a wide range of aircraft. The ammunition portfolio includes ignition cartridges, fuses for 60 mm, 81 mm, 82 mm and 120 mm high-explosive and smoke mortar shells.

POLIEX was established in 1982 as a factory specialising in the production of explosives. Today, the company produces hand grenades, commercial and military explosives, initiation devices and boosters, as well as chemical substances.

North Macedonia

The sole active ammunition manufacturer in North Macedonia is ATS Ammunition (formerly Suvenir, established in 1981) situated in Samokov. The company has production lines for pistol, rifle and machine gun ammunition of calibres 9 mm, 5.56 mm, 7.62 mm and 12.7 mm. The annual production capacity is over 120 million rounds of small-calibre ammunition.

Poland

The crucial role in Polish ammunition production is played by PGZ (Polska Grupa Zbrojeniowa), a holding company established by the Polish Government to unite several dozens of state-owned defence industry companies. Within the group, the ammunition manufacture is the responsibility of enterprises MESKO, NITRO-CHEM, DEZAMET, BELMA and GAMRAT.

MESKO, established in 1922 in Skarżysko-Kamienna, produces small-calibre ammunition (9 mm, 5.56 mm, 7.62 mm, and 12.7 mm), medium-calibre ammunition (20 mm, 23 mm, 30 mm, 35 mm), mortar rounds (98 mm), artillery ammunition (122 mm and 152 mm), tank ammunition (120 mm and 152 mm). The company also produces rockets and missiles (Grom and Pionrun MANPADS, Spike-LR anti-tank guided missiles, the NLPR-70 unguided rocket for combat aircraft and Feniks 122 mm artillery rocket).

The chemical and armament industry company NITRO-CHEM based in Bydgoszcz produces explosives (TNT, RDX, HMX), demolition blocks, anti-tank mines and Mk 82 500lb aircraft bombs. NITRO-CHEM also offers ammunition elaboration services. DEZAMET at Nowa Dęba manufactures 40×46 mm grenades, 81 mm smoke grenades, mortar bombs (60 mm, 98 mm and 120 mm), 73 mm PG-15V rounds, 155 mm artillery ammunition, rifle grenades, hand grenades, fuses and LBĆw-10 practice aircraft bombs.

The origins of the company BELMA in Białe Błota date back to 1868. Today, BELMA manufactures MN-123 and MR-123 antitank mines, mining systems, including offroute anti-tank mines and MPD mines for mining of coastal waters.

The GAMRAT factory in Jasło produces rocket propellants, artillery nitroglycerine powders, various types of acoustic petards and smoke grenades.

Romania

As with Poland, the leading role in the Romanian arms industry, including ammunition production, is represented by a stateowned entity, namely ROMARM, which owns 15 factories and a research institute, a large part of which is engaged in the production of ammunition.

Powder production at Făgăraș started already in 1939. Today, Fabrica de Pulberi Făgăraș is the only manufacturer of explosives (TNT, RDX, PENT, and PHF-89) and solid propellants (for 122 mm Grad rockets and rocket-propelled grenades) in Romania. In 2005, Carfil in Brașov started the production of NATO-compatible weapons and ammunition. The company now produces the RPG-7 launcher with corresponding rounds, the SPG-9M recoilless rifle and its 73 mm ammunition, mortars (60, 81, and 82 mm) and mortar bombs (60 mm, 81 mm, 82 mm, and 120 mm).

Brașov in central Romania is also home to the METROM plant, the sole Romanian producer of copper sheet, copper tape and brass tape. METROM's military portfolio encompasses cartridge cases and bullet cups for ammunition in calibres 9 mm, 5.56 mm, 7.62 mm, 12.7 mm, 20 mm and 23 mm.

Pirochim Victoria, also in Braşov, produces propellant powders for ammunition. The facility can also perform ballistic tests and physical-chemical analysis of powders and nitrocellulose.

Uzina Mecanică Plopeni started producing ammunition in 1941. Today, it manufactures mostly medium and large-calibre ammunition for aircraft guns, IFVs, tank and artillery pieces (23 mm, 30 mm, 76 mm, 100 mm, 130 mm, and 152 mm), as well as 40 mm rounds for grenade launchers.



The Honorary Patronage of the President of the Republic of Poland Andrzej Duda





31st International Defence Industry Exhibition

SPI

5-8 09 2023 KIELCE, POLAND



South Korea Lead Nation



155 mm OFd M3-DV (HE ERFB BB) manufactured by ZVS holding from Slovakia has a maximum range of up to 40 km when fired from the L/45 gun and up to 43 km when fired from the L/52 gun.

The military product portfolio of Uzina Mecanică Tohan is composed, among others, of 122 mm Grad rockets, 122 mm artillery ammunition, fuses for artillery rounds, as well as smoke and illuminating mortar bombs (60 mm, 81 mm, 82mm, and 120 mm).

Another subsidiary of ROMARM is Uzina Mecanică Mija, which manufactures ammunition for RPG-7 weapons and a wide-range of hand grenades.

Operating as the infantry ammunition factory since 1939, Uzina Mecanică Sadu carries out the manufacture of rounds for small arms such as 7.62×39 mm, 7.62×51 mm, 7.62×54 mm, 5.45×39 mm, 5.56×45 mm, 7.65×17 mm, 9×18 mm and 9×19 mm.

Uzina de Produse Speciale Dragomirești was established in 1981. The products manufactured by this company include NATO standard medium-calibre ammunition (20 mm, 25 mm, 30 mm, and 35 mm), 40×46 mm grenades, Mk 82 aircraft bombs, demolition blocks and plastic explosives.

Serbia

Following the break-up of Yugoslavia, Serbia inherited a substantial arms industry sector capable of manufacturing a full spectrum of ammunition. Similar to some Central and Eastern European countries, a significant part of the Serbian defence industry is also owned by the state.

Ammunition factory Prvi Partizan located in Užice, some 200 km away from Belgrade, is composed of three production facilities that produce small-calibre ammunition for military, police and other security forces, as well as for hunting and sporting purposes. The military segment of the portfolio contains, among others, a wide range of 9 mm, 5.56 mm, 7.62 mm and 12.7 mm ammunition. Small-calibre ammunition is also produced by BELOM, which was established in December 2015 at Uzići. The company manufactures 9×19 mm, 7.62×39 mm and 12.7×108 mm rounds.

Holding company Krušik based in Valjevo produces M-75 and M-84 hand grenades, 40 mm rounds for under-barrel grenade launchers, mortar bombs (60 mm, 81 mm, 82 mm, and 120 mm), and the 155 mm M107 high-explosive artillery round. The company also produces Maljutka 9M14P1-2T and 9M14P1-2F anti-tank guided missiles, unguided air-to-ground rockets (57mm, 80 mm, 128 mm), unguided artillery rockets (107 mm, 122 mm, 128 mm), FAB-100 M80 and FAB-250 M79 high-explosive aircraft bombs, as well as anti-tank mines.

Established in 1948 in Čačak, ammunition company Sloboda offers rifle grenades, 40x46 mm grenades, medium-calibre ammunition (20 mm, 23 mm, 30 mm, 37 mm, 40 mm, and 57 mm), large-calibre ammunition for tanks (100 mm, 125 mm) and artillery pieces (76 mm, 105 mm, 122 mm, 130 mm, 152 mm, 155 mm), as well as rounds for anti-tank rocket launchers (M79 Osa, M80 Zolja, M90 Stršljen).

The leading Serbian manufacturer of explosives is Prva Iskra-Namenska Proizvodnja in Barič. The production programme encompasses TNT, PETN, RDX, HMX, HNS, TNR, as well as various composites based on these explosives. The company also carries out ammunition dismantling.

Another Serbian explosives maker is Trayal based in Kruševac. The company manufactures tyres, protective devices, industrial explosives, pyrotechnics, thermobaric hand grenades and 120 mm thermobaric mortar ammunition.

Chemical manufacturing enterprise Milan Blagojević-Namenska with its headquarters in Lučani, manufactures nitrocellulose, single-base powder, spherical powder, along with double-base powder. The product portfolio also includes double-base rocket propellants and propellant charges for rocket motors, powder charges, combustible elements of powder charges, Armour Piercing Fin Stabilised Discarding Sabot-Tracer (APFSDS-T) projectiles for tank ammunition, and celluloid containers for mortar shells. EDePro from Belgrade is engaged in the production of turbojet engines, rocket motors, gas generators for artillery ammunition (76 mm to 155 mm) along with the modernisation of artillery rockets (107 mm, 122 mm, and 128 mm). It is also engaged in the development of guided and ballistic missiles (ALAS multi-role missile system, SAGR laserguided missile, Pauk/Spider anti-tank missile, and Jerina-1 surface-to-surface missile).

Slovakia

The production of ammunition in Slovakia is represented by MSM GROUP. It owns a 50% share in ZVS holding (the rest belongs to the Slovak state through DMD GROUP) in Dubnica nad Váhom which produces medium-calibre ammunition (30 mm), mortar ammunition (60 mm, 81 mm, 98 mm, and 120 mm), artillery ammunition (122 mm, 152 mm, and 155 mm), tank ammunition (125 mm), 122 mm Grad rockets, impact fuses and ammunition components. The flagship of their production is the 155 mm artillery ammunition family that has been exported to more than 18 countries globally (such as Israel, Poland and Cyprus). MSM GROUP also operates the large-calibre ammunition maintenance plant in Nováky (MSM Nováky) and owns 14. OKTOBAR in Kruševac, Serbia (producing shell bodies for large-calibre ammunition), along with Spanish Fábrica de Municiones de Granada (105 mm tank ammunition, 106 mm rounds for recoilless guns, 105 mm and 155 mm artillery ammunition).

Slovenia

The sole representative of ammunition production in Slovenia is AREX Defense from Šentjernej, which manufactures plastic blank ammunition (9 mm, 5.56 mm, 7.62 mm, and 12.7 mm), dummy and drill cartridges (9 mm, 4.6 mm, 5.56 mm, 7.62 mm, 12.7 mm, .40, .45, and 12 gauge) and nonlethal rubber bullet ammunition (9 mm, 5.56 mm, 7.62 mm), as well as ammunition links and pistols.

Spain's Defence-Industrial Capabilities

Robert Czulda

pain's defence industry, especially its aerospace sub-sector, is a significant player in European defence. The current security situation in Europe and planned increases in defence spending could provide an additional boost to its further development.

Spain is one of those European countries for which a defence industry is an essential element of its industrial base. The Spanish Government considers it a strategic asset that enhances national sovereignty and Spain's position both in Europe and globally. Additionally, it is seen as a valuable contributor to the Spanish economy, which, despite its problems, is one of the leading economies in the European Union. Official data shows that it generates around 23,500 direct jobs, while some sources estimate that it creates up to 57,000 indirect and related jobs through additional spending. In total, 76.3% of Spanish defence industry companies are classified as SMEs. The Ministry of Defence has 509 companies listed on the Register of Companies (El Registro de Empresas) of the General Directorate for Armament and Material (DGAM, Direccion General de Armamento Y Material), while in 2020, there were 543 registered companies (380 of which declared sales in the defence sector).

The Madrid-based Real Instituto Elcano has observed that Spain was one of the most severely affected Eurozone countries by COVID-19. Obviously, this has also impacted its defence industry, causing disruptions to supply chains, reduced demand, and delayed procurement processes. However, despite the pandemic, the Spanish defence industry has recorded one of the highest rates of growth in recent years. According to an official statement by a DGAM Director, the strong position of the Spanish defence industry is the result of three factors. Firstly, it offers dual-use products and services. Secondly, it has a strong technological and innovative component, which favours the creation of highly qualified em-

Author

Dr Robert Czulda specialises in International Affairs and Polish Defence matters and is based in Poland at the prestigious University of Łodz.



The VCR Dragon 8×8 is based on the Piranha V platform, developed by MOWAG, the Swiss-based division of GDELS. The Spanish IFV variant is set to use Northrop Grumman's Mk 44 Bushmaster II 30 mm automatic cannon as its primary armament.

ployment and increased competitiveness. And thirdly, it has a positive impact on a high number of sectors in the auxiliary industry.

General characteristics

According to official data, 30 major entities comprise 90% of the entire defence market. Of these, Airbus Defence & Space (AD&S) and Airbus Military account for 66% of all international business conducted by the defence industry. When other industry leaders, such as Navantia, Indra Systems, GDELS-Santa Bárbara Sistemas, and ITP Aero, are included, the percentage increases to 86.9%.

Due to relatively low domestic demand, with Spain spending only 1% of its GDP on defence, the local industry relies heavily on foreign sales. In fact, 84% of all sales are international, totalling EUR 5.29 Bn in 2020, a decrease of 5.1% compared to 2019. Out of the 380 firms registered in the Register of Companies, 126 have reported international defence sales, which is five more than in 2019. This means that 33.2% of defence companies have found international customers for their products and services.

The Spanish defence industry is capable of designing, developing, and integrating large systems in the naval, land, and aerospace sub-sectors. Spain is also an important member of numerous international networks, including the EU's Permanent Structured Cooperation (PESCO), which includes Spanish participation in the Future Medium-Size Tactical Cargo (FMTC) aircraft project and the European Patrol Corvette (EPC) programme. Additionally, Spain, as one of the 22 members of the European Space Agency (ESA), plays a significant role in the EU's space projects such as COPER-NICUS (Earth observation) and GALILEO (Global Navigation Satellite System). Spain's industry has contributed to the development of the SENTINEL-1 and SENTINEL-2 satellites for COPERNICUS and has hosted ground stations for GALILEO. Furthermore, Spanish companies are involved in the HO-**RIZON EUROPE** funding programme for research and innovation.

Spain's strategy is based on providing ready-made solutions, as well as playing an important role in supply chains of international companies such as GDELS, Cessna, Bell, Gulfstream, Airbus Helicopters, and Bombardier. Over the years, Spain has gained a reputation as a country with broad competencies - for example, in a number of activities related to the aerospace industry - while at the same time attempting to become a leader in more specialised sectors, such as modern aviation materials. This includes both transport and specialised aircraft (including air refuelling), turbines, engines, aircraft structures,



A Spanish Air Force A400M (T.23-12) during a ferry flight.

composites, and machinery. Spanish EADS-CASA centres in Madrid, Toledo, and Seville have made strides in the field of carbon fibre-reinforced plastics, which is crucial in building next-generation lighter, more economical structures (it is worth noting that this material has been used in the production of A400M wings, as well as the A380 and A350 aircraft).

National champion

The aerospace sub-sector is the most important component in Spain's defence industry. It accounts for the largest number of international defence sales, totalling 64% of all defence exports, ahead of naval (13.5%), land (8.1%), and other sub-sectors. Moreover, 73.1% of its production is directed towards the military market with 43.8% of all employees working directly in the defence industry in this sub-sector. As much as 92% of the production of the Spanish aerospace sub-sector is targeted for export, which is due to the strong position of AD&S and Airbus Military; respectively, this represents 55.3% and 35.7% of all international defence sales in the aerospace sub-sector.

A distinguishing feature of the Spanish aerospace industry is its very high participation in multilateral projects and large investments in research and development (R&D). Spain is involved in several leading European projects, including the A400M, Eurofighter Typhoon, and Eurocopter Tiger. Additionally, Spain continues to participate in various international networks, including transport aircraft programmes such as the C-295 and CN-235, as well as the C-212 until 2013. Apart from the final assembly of the A400M, the facilities in Seville are also responsible for the assembly of the A350 XBW. The facilities in Getafe are involved in a conversion of the A330 MRTT (Multi Role Tanker Transport) aircraft. The Spanish are also to some extent involved in MBDA activities, a joint venture established in 2001 by merging the missile divisions of EADS (now Airbus), Finmeccanica (now Leonardo), and BAE Systems. The company is responsible for several multinational projects, including the Meteor missile, which has recently been integrated with Spanish Eurofighters. Getafe also produces tail cones for the A350 and A380, while Airbus facilities in Illescas produce composites and wing covers for the A350. A third place for production, integration, and testing of A350, A320, and A380 aircraft is Puerto Real.

ITP Aero – a joint venture established in 1989 between SENER and Rolls-Royce – has become one of the world's largest designers and producers of aircraft engines over the past few decades. The company, which built its knowledge from scratch, is now involved in several key projects, including engines for Eurofighter Typhoon aircraft (EJ200), A400M (TP400), and Eurocopter Tiger helicopters (MTR390-E). Today, ITP Aero operates in various locations globally, providing a wide range of aircraft enginerelated products and services to customers in the commercial and defence aviation industries. The presence of space centres on Spanish soil, including the EU Satellite Centre (EU SatCen) based in Torrejon de Ardoz, is also a benefit for the Spanish aerospace sub-sector.

Several technology parks have also been established, including Aéropolis in Seville, which has been operating since 2003 and is the only centre of its kind in Europe entirely focused on the aerospace sector. To increase their market position, industrial clusters such as Hélice (in Andalusia since 2004) and specialised R&D and testing centres have been established; an example of this is the Technologies Centre (Centro Tecnológico de Álava). This aerospace test laboratory is a good illustration not only of how innovative high-value potential can be built for the aerospace industry (not only military), but also that it is possible to create competences from scratch. The Technologies Centre is located in the Basque region, where its traditional steel and shipbuilding industry suffered as a result of the crisis in the 1970s and 1980s. With the help of local authorities, the aviation industry was created from scratch, and now employs between 6,000-8,000 people in over 40 companies.



The graphic shows the envisioned ecosystem of platforms and systems within which the FCAS is due to operate.

One flagship project that could provide Spanish industry with a significant technological boost is NGWS/FCAS (Next Generation Weapon System/Future Combat Air System), which aims to develop a new, multi-purpose jet aircraft as a successor to the Eurofighter Typhoon and Dassault Rafale following an agreement signed between France, Germany, and Spain in 2019. The coordinator of the Spanish industry and the leader in four of the eight priority areas is Indra Sistemas, which will collaborate with Airbus Germany and Dassault Aviation.

The fact that Spain enjoys an equal voice (its contribution to this initiative is 33%) and co-decides on the possible addition of new shareholders reflects its position and in this regard, ITP Aero is responsible for the engine in the project. In December 2022, GMV, SENER Aeroespacial, and Tecnobit-Grupo Oesía reached agreement to jointly lead Spain's participation in the Remote Carrier Technology Pillar (Pilar Tecnológico de Operadores Remotos). They are expected to design and evaluate new concepts of a set of unmanned vehicles, some with ISTAR observation capability.



Austrian Steyr-Daimler-Puch AG and Spanish General Dynamics Santa Bárbara Sistemas (both of which have since been folded into GDELS) jointly developed the Austrian Spanish Cooperation Development (ASCOD) family of vehicles. This resulted in the Pizzaro in Spanish service and the Ulan in Austrian service.

Other initiatives

The aerospace sub-sector is not the only thriving element within Spain's defence industry. Navantia is a leading Spanish company in shipbuilding, with a market share of 79.4%. The naval industry contributes 13.5% to the total sales of the defence industry, with 57.9% of all sales being for the military market. In 2019, Navantia had more than 3,800 employees and created over 8,000 direct jobs through auxiliary industries, as well as over 25,000 indirect and related jobs.

Navantia, which is owned by SEPI (Sociedad Estatal de Participaciones Industriales), is



MAY 8 - 11, 2023 | EDUCATION MAY 9 - 11, 2023 | EXHIBITS DENVER

BLUEPRINT FOR

The most critical conversations take place here. From concept to realization.

Through discussions on the latest breakthroughs in implementation to an exploration of innovation. Across policy, privacy and data management, safety and security, and emerging technologies. Beyond 5G to edge computing. Your path to our shared autonomous future starts at XPONENTIAL. The world's only uncrewed systems event unites the entire industry – from end users to regulators – to build concrete plans of action through transparent collaboration.

Plan your way forward. REGISTER NOW.

XPONENTIAL.org



A CG representation of an FCAS aircraft accompanied by loyal wingman UAVs.

currently involved in several important programmes. One of these is the S-80 dieselelectric AIP-equipped submarine. Navantia's shipyard in Cartagena has a contract to deliver four vessels of this class to the Spanish Navy (La Armada), signed in 2004. The first, the S-81, Isaac Peral, was launched in 2021 and began sea trials in mid-2022. The S-81 is expected to be handed over by mid-2023, while the other ships are scheduled for delivery by early 2026.

The company, which recently lost out on a Polish tender for new multirole frigates to Babcock, has another important programme underway. Navantia was awarded a contract by the Spanish Ministry of Defence to design and build five F-110 frigates for the Spanish Navy. The F-110 frigate is a new type of multi-mission warship that will replace the Navy's ageing Santa Maria class frigates. Navantia is also responsible for designing and integrating the ship's systems, including its combat system, communications, propulsion, and sensors. The company is also responsible for building those ships at its shipyards in Ferrol and San Fernando. An interesting aspect of this project is that the F-110 will have a "digital twin" that simulates the ship's performance under different operating conditions. This can be used to optimise the ship's design and performance, as well as to identify and address potential issues before they occur.

The Spanish defence industry is also active in the land domain, ranking third among sub-sectors. GDELS-Santa Bárbara Sistemas holds a leading position (44% of total defence sales), followed by Indra (14.3%), URO Vehículos Especiales (12%), and Iveco España (7.6%). This sub-sector generates 8.1% of all defence sales and employs 9.2% of the work staff directly employed in the defence sector. Only 22.2% of their products are for the military market.

An important project was launched in December 2021 when GDELS-SBS began production of the VCR Dragon, an 8×8 wheeled armoured vehicle. Spain has ordered 348 vehicles to be produced in Trubia (Asturias) at a





The Lanza Radar LTR-25 is a long-range tactical radar developed by Indra, with an instrumented maximum range of 463 km (250 NM).

cost of EUR 2.08 Bn. Ultimately, Spain could receive up to 1,000 Dragons in three batches, replacing two in-service wheeled vehicles - the Pegaso VEC-M1 and Pegaso BMR-M1. Several other companies are involved in the project, including Indra Sistemas, Sapa Placencia, and PAP Tecnos. Escribano Mechanical & Engineering will deliver locally designed and manufactured Guardian 30 turrets (which can be integrated with either a 30/40 mm Mk 44 Bushmaster II standard/ stretch automatic cannon or the Russian 30 mm cannon 2A42 30 and a coaxial 7.62 mm machine gun). The participation of the Spanish defence industry is expected to be at least 70%.

Future

The future condition of the Spanish defence industry may be determined by three significant projects, which are crucial from Madrid's point of view. The most prestigious and important, but also the most challenging, is the FCAS sixth-generation fighter aircraft. Furthermore, future F-110 multirole frigates, due to their technological advancement, could also provide Spain with a significant boost. The third flagship project – the Dragon 8×8 – is less promising, but nevertheless important.

At the same time, local press has that Madrid wants to strengthen the position of Indra, which is expected to become more influential in Europe. Additionally, the future of the Spanish defence industry may be influenced by the fact that Spain will hold the next presidency of the Council of the European Union from July to December 2023. Daniel Fiott, Head of the Defence and Statecraft Programme at the Centre for Security, Diplomacy and Strategy (CSDS) of the Brussels School of Governance (BSoG-VUB), believes that this gives Spain "an opportunity to help develop the Union's space and defence initiatives." Madrid will be responsible for the initial implementation of the EU's firstever strategy for space, security, and defence as space has clearly been identified as a strategic domain.

Another important factor is an expected increase in defence spending. Prime Minister Pedro Sanchez announced that Madrid would finally meet the NATO requirement to spend at least 2% of national GDP on defence by 2029. This means that Spain is expected to spend roughly EUR 24.1 Bn and it can be predicted that a significant portion of these funds, specifically for technical modernisation and R&D, will be directed towards the domestic defence industry

Why Mainstream 5G Won't Stand the Test of Time on the Battlefield

On the challenge of mission grade communications at the tactical edge, Macy Summers, President and CEO of Blu Wireless Inc., explains how IEEE mmWave 5G technology gives the front line a ' direct connect' advantage.

5G is being pitched as the way forward for defence communications and 3GPP (the primary global development association for 5G) is working with organisations such as the U.S. Department of Defense (DoD) to further its advancement. While using 3GPP 5G commercial networks, with appropriate security enhancements, may well be applicable to rear echelon and large military base scenarios, it is less suited to tactical and mission grade scenarios. In this article we'll explore the evolution of

tactical communications, typical use cases of 3GPP 5G in defence as well as its limitations.

A Solution Without a Problem?

When it comes to 3GPP 5G for defence, one might get an impression of 'a solution looking for a problem'. This is because 3GPP 5G is inherently centralised and has a significant overhead of functions and features not applicable to private (military) networks. It also doesn't readily conform with pass-through government IT cyber security policies.

That said, where you have a rear echelon or large base, it makes sense to utilise 5G commercial network technology and the features offered by its complex digital infrastructure and, indeed, this is how the industry is pitching it.

At a recent Armed Forces Communications & Electronics Association (AFCEA) event, several leading 3GPP equipment vendors gave presentations on 5G in defence scenarios. However, every example given, bar one, was 'in-garrison' rather than in a tactical or battlefield context.

The challenge with traditional carrier-based 3GPP 5G mobile networks is that they require a centralised core network that communications and service features must loop through – and this is usually housed in a rack-mounted computer system. As it isn't typical to put a core network in everyone's backpack, centralised 3GPP 5G is unlikely to cut it on the battlefield or in other tactical scenarios. Law enforcement is living this challenge in the USA with FirstNet. The lack of safety-of-life connectivity, in this nationwide example, leaves 3GPP LTE and 5G private networking as a supporting network, not the primary tactical one.

5G Comes in Different Shapes and Forms

IEEE 5G mmWave-based systems use peerto-peer networking rather than a centralised core (used in 'mainstream' 3GPP 5G). 5G mmWave networks are made up of multiple wireless radio nodes that communicate with each other in an overlapping mesh. Self-sufficient and self-managed, they find the fastest, most reliable direct connect paths using line-of-sight wireless communications to transfer data at the fastest rates. They allow for non-line-ofsight connections through 'daisy chain' communication, where every node can act as a relay point to 'shadowed' (out of range or geographically blocked) correspondents. One might draw a parallel with digital pushto-talk (PTT, TETRA or P25) radios which have been used at the tactical edge and by a number of first response forces (the police, fire brigade) since the mid-1990s. To this day, push-to-talk, direct-connect, radios remain one of the most robust and reliable communications systems in threat environments.

5G mmWave-based systems present a significant step forward in tactical communications. They are very easy to set up (unlike having to configure a core network) and utilise unlicensed spectrum at 57- 71 GHz V-Band, making them very difficult to detect (LPI/LPD).

A trial of 5G mmWave systems saw the technology interfaced with the networking systems of land vehicles. This use case was then tested in a variety of simulated tactical battlefield scenarios and was shown



Macy Summers

to provide 360° communications coverage via mesh networking to deliver undisrupted gigabit communication links between vehicles at typical manoeuvring distances.

Why mission grade communication requires different 5G technology

When considering the adoption of 5G in defence, it is important to differentiate between strategic and tactical/mission grade communications, with each echelon operating with different types of information and intelligence. Strategic information is what an adversary will spend a great deal of time and money on to intercept and decrypt, in order to work out battle plans and arrayed forces. Tactical information, however, is perishable so decrypted exploitation is less important. Things change quickly at the tactical edge.

So, while your HQ, supply chain, forward base, command post and tactical front all need to be connected, centralised 3GPP 5G networks won't stand the test of time in the battlefield. It makes good sense to leverage the 3GPP 5G commercial network for rear echelons, supply chain and large bases. However, 5G mmWave technology is superior when it comes to delivering a secure, stealthy and flexible tactical communications solution.

The Transformation of the Hungarian Defence Forces

Lieutenant General Dr. Romulusz Ruszin-Szendi

The global and European security environment is characterised by instability and unpredictability. Crises in distant regions may have both short- and long-term impact on Hungary's security, increasing the number and scope of threats and challenges to our country. Overall, the global security environment is deteriorating. The shifting balance of power is accompanied by a renewed intensification of great-power rivalries and an increased risk of confrontation.

In the 21st century, while the purpose of war remains unchanged, the theatres, forms and means of war are broadening with its characteristics changing and increasingly extending to the non-military dimensions of security. Although, the use of military force remains a priority, states are seeking to minimise military confrontation in time and space, and incidents that do not rise to the level of armed conflict and are difficult to monitor are increasingly coming to the fore. In such so-called hybrid warfare, state and non-state actors seek to advance their interests to the detriment of the opposing side through the coordinated use of military and non-military means for a specific strategic objective, and may take steps to exacerbate the challenges and crises threatening Hungary.

To the East, Russia has become more assertive with the illegal annexation of Crimea and the destabilisation of eastern Ukraine, as well as its military build-up close to NATO's borders. To the South, the security situation in the Middle East and Africa has deteriorated, causing loss of life, fuelling large-scale migration flows and inspiring terrorist attacks. We are also confronted with the spread of new technologies and weapons of mass destruction, cyber-attacks and threats to energy supplies as well as environmental challenges with security implications.

<u>Author</u>

Lieutenant General Dr. Romulusz Ruszin-Szendi has been the Commander of the Hungarian Defence Forces since June 2021, and is the youngest person to hold this position. In order that Hungarian Defence Forces will be able to provide appropriate answers to the above-mentioned challenges, the adaptability must become one of its core competencies beside the ongoing overarching modernisation and readiness.

Current Condition of the Hungarian Armed Forces

Addressing the challenges posed by the most-capable adversaries generally calls not for a larger force, but rather for a force that is equipped with appropriate modern weapons and has well trained human resources and support assets that can be postured for responsive and resilient operations in any theatre of potential conflict. Technology trends outside of the military domain are moving at an unprecedented pace, which require a more agile and innovative approach on behalf of our own defence forces. This innovative mindset, along with strategic investments in human resources and military technology, can empower the military to stay ahead of the curve, foresee emerging threats and respond effectively in real-time.

Today, the dynamics of defence innovation often work the other way around, and the Hungarian Defence Forces are determined



Lt Gen Romulusz Ruszin-Szendi is Hungary's Chief of Defence.

to understand the evolving military technology landscape. It is a critical part of our defence planning, considering that it is a factor that shapes the ways and means by which wars are waged. Hence, it is our utmost priority to conceptualise and precipitate changes in what is perceived to constitute military conflict, and condition the role of defence institutions in preventing, preparing for, engaging in and moving away from conflict.

The current state of the Hungarian Defence Forces is fundamentally shaped by the fact that less attention and fewer resources were allocated to the cause of national defence during the period following the Cold war and the political changes in Central and Eastern Europe. As major – primarily Soviet-made – weapons systems reached



A Hungarian PzH2000 during training. Hungary has ordered a total of 24 such howitzers so far.



A Lynx IFV is put through its paces off-road. The vehicle is due to become the backbone of Hungary's mechanised forces.

the end of their lifecycles, they could only be replaced in certain cases, whereas entire military branches and the related knowhow disappeared almost completely. In parallel, former defence industry capacities were also substantially reduced, and the defence mobilisation capacity of the national economy was essentially dismantled. Having taken indispensable information regarding from the Russo-Ukrainian War, we have a clear vision that those weapon systems have to be replaced with immediate effect. We often say that the development of the armed forces is not a promise, because we can already see the new military equipment coming in. Besides the upgrade of the 'big hardware', individual tactical gears have also been renewed. And, of course, Hungary's Defence and Military Development Programme - launched in 2017 – is going to continue in 2023 as well. The successful operation of modern armed forces requires the development of a committed and competent personnel with high quality training, education and continuous training, based on targeted knowledge elements, and with adequate physical fitness and mental resilience. In Hungary, too, the demographic challenges faced by developed societies - ageing, emigration, changes in the working capacity and physical endurance of the population - are factors that determine the military fitness of the population. The growing demand for human resources in the global and domestic labour market also poses a further challenge to the Hungarian Defence Forces.

Commander's Vision

Building security is a long-term endeavour that requires long-term investment. The defence of a country is built on complex and interdependent security elements comprising economic, political, social, environmental, cyber and information dimensions alongside the military aspect. Today's state and non-state threats and challenges may occur across the full spectrum of these security dimensions in many combinations, and therefore defence cannot be treated in isolation from other aspects of security. Addressing security challenges goes beyond the competence of individual sector ministries and requires cross-governmental cooperation, while military capabilities will continue to play a key role in the implementation of home defence tasks.

These changes put pressure on international security systems, organisations and procedures tailored to former conventional dimensions of warfare, which therefore need to be modernised in light of new security threats. International (political, legal, economic, security and defence policy-related, arms control, etc.) regimes, together with NATO, the EU and their respective Member States, including Hungary, must continually and flexibly adapt their ends, ways and means to an everchanging environment.

The Hungarian Defence Forces in the near future is going to be an organisation with state-of-the-art equipment, a high degree of mobility, and rapid reaction capability, one that is capable of constantly developing, adapting itself, and being renewed at the same time. In addition to being authentic, open, well-informed, agile and – last, but not least – resilient, it can carry out its tasks either on its own, or within Alliance frameworks.

My primary focus for the Hungarian Defence Forces is on continuous development. Our aim has always been to reinstate the capabilities of the armed forces to the previous levels and to further develop them. We are reaching this goal with the acquisition of the newest high-tech technologies, however, at the beginning of my tenure as Chief of the Defence Staff I outlined that our biggest priority should be maintaining a form of development through which these capabilities remain in our capacity, and which through we transform the forces. It is our utmost priority that this cycle of transformation and modernisation becomes a second nature when it comes to force planning, ensuring that we remain at the 'top of our game'.

Our security challenges

Migration

In the 21st century, challenges posed by non-state actors are becoming more and more persistent, and the Hungarian Defence Forces contributes to their mitigation primarily at their point of origin, by participating in crisis management operations. The spread of radical ideologies and terrorism within Europe and on its periphery poses a major threat. This may lead to the launching of conventional and non-conventional attacks even against Hungary, or the targeting of Hungarian citizens, in-



Hungarian Armed forces perform fast-roping from an H145M helicopter. Twenty such helicopters were ordered in 2018, with all delivered by December 2021.

terests, military operations and missions abroad. This includes attacks and acts of terrorism caused by disruptive technologies falling into unauthorised hands and thereby endangering national security.

Currently and in the foreseeable future, the most probable threat is a mass increase of migration overburdening government systems and law enforcement agencies, mainly from the Western Balkans route, but also from other directions affecting Hungary. This kind of "modern exodus" has serious consequences for the security and stability of Europe, including Hungary, while simultaneously posing national security, public order, humanitarian and public health risks. During a migration crisis, the Hungarian Defence Forces will act in support of the law enforcement forces. The Hungarian Defence Forces participates in the mitigation of the root causes of illegal mass migration (weak/failed states, ethnic and religious conflicts, extremist ideologies, climate change, the uncontrolled proliferation of weapons, the unilateral intervention of external actors, etc.) as part of the state's broader security and defence policy toolkit, within an international coalition.

The Western Balkans

Peace in the Western Balkans is one of Hungary's most important security policy interests, since it is at once a guarantee of European peace. In view of the security policy interests of the country, Hungarian troops have been participating in operations conducted in the Balkans since 1995. Hungary has been contributing staff officers and troops to the ongoing NATO-led KFOR operation since 1999. Hungary has been on the side of peace since the beginning, but the defence of the country requires strength and preparedness, and we must participate in peace support operations in the framework of the Alliance The Western Balkans have always been a region of outstanding importance to Hungary, and two-thirds of all our troops deployed on foreign missions are serving in the Balkans Joint Operational Area, in Kosovo and Bosnia-Herzegovina. Providing assistance in this region is among Hungary's strategic priorities.

Key Developments

In our volatile and unpredictable security environment, crises can develop unpredictably directly on Hungary's borders, in our intermediate region or at strategic distances. In a modern globalised world, even distant crises can rapidly spill over into the region and the territory of the country, undermining the security of citizens and the homeland, as the migration crisis of 2015 demonstrated.



A Land-Based (LB) MF-STAR radar from Israeli company Elta.

In addition to non-military means, the aggressive use of military force is playing an increasing role in the arsenal of state actors. This particularly justifies the reinforcement of national resilience and the strengthening of the capabilities and preparedness of the armed forces, with a view to successfully accomplishing armed defence and collective defence tasks as and when required, and typically international crisis management operations for common causes.

Due to the current state of the security environment the establishment of our new Force Modernisation and Transformation Command (FMTC) was pivotal. FMTC is an integral part in the development and transformation process of the Hungarian Defence Forces. It is one of our main priorities to have an institutionalised entity that helps define the future military context, identifying challenges and opportunities in order to innovate and maintain a warfighting edge, to ensure maximum interoperability, and to provide structure and priority to our forces through defence planning, education and individual training as well as capability development.

Transformation of the Hungarian Defence Forces

According to plans, the first long-range tactical transport military helicopter and the new radar systems are scheduled to

arrive. In addition, the numbers of the PzH self-propelled howitzers and the Lynx infantry fighting vehicles are going to increase further. Moreover, we are continuously 'scanning' the world to see what items of military equipment can fit into the development of the Hungarian Defence Forces.

Moreover, having been recently introduced, the Lynx armoured combat vehicles represent state-of-the-art technology; they will enter service with the Hungarian Defence Forces on the first occasion and are to be manufactured in Hungary as well. Furthermore, this year the air defence branch will receive radar systems of the kind that are used in the Israeli Iron Dome. The missiles related to them will safeguard the airspace of Hungary.

One important element in the Hungarian Defence Forces' development program is the creation of the combat-worthy, strong armed forces, which conform to NATO's concept for deterrence and are able to guarantee peace and the citizens' security. The importance of proportional contributions to the high-readiness response forces of NATO and the EU has significantly increased due to the radically changed security environment. High-readiness reaction forces actively contribute to improving the security of the Euro-Atlantic region, and possess the necessary tools to prevent and manage an armed conflict. That is why it remains in Hungary's interest to

continue contributing to such formations. As a result of capability developments, the Hungarian Defences Forces must become a well-equipped, highly mobile rapid-reaction force capable of immediate, swift and effective intervention within both national setup and allied frameworks. Furthermore, the Hungarian Defence Forces has to be able to provide significant contributions to high-intensity joint alliance operations, which serve as the basis for flexible, tailored participation in low-intensity (peace support, crisis management, etc.) operations as well. National and multinational military exercises demonstrating our military capabilities, together with multinational formations in different constellations, are effective tools of deterrence and defence, so we must preserve such participations.

National resilience

Ever since the fall of the Soviet Union and the reduction of our military, it is our utmost goal to rebuild the trust and relationship with civil society, to the degree that it becomes prepared and resilient in case of crises. The most important component of defending our homeland is a security-conscious society, prepared for its tasks to the necessary degree. This means that the establishment of widespread, structured networks and cooperation systems exercised already during peacetime is of vital importance, as are the addressing and involvement of citizens themselves. Like many other states, we have a long way to go in this regards, but have put down the basis for it to work properly in the future.

Defence Industry

Zrínyi Defence and Force Development Programme (hereinafter referred to as



The Nurol Makina Ejder Yalçın 4×4 protected vehicle is known as Gidrán in Hungarian service. Although Hungary received its first batch of vehicles from Turkey, subsequent batches are planned to be produced in Hungary.

the Zrínyi DFDP) will create a military force worthy of a millennial state, increasing the security of Hungarian citizens, and the military-industrial capacities necessary to maintain it. As a result of the force development, Hungary's military self-reliance will increase significantly, which is crucial not only for its self-defence and deterrence capabilities, but also to remain an effective contributor to regional, European and transatlantic security efforts.

Hungary's strategic objective is to develop the Hungarian Defence Forces by 2030 so as to become a credible and capable force in the region which, as a member of NATO, can ensure the country's security, deter any eventual aggression, support the joint defence by the Government against military and non-military threats and challenges, and fulfil its responsibilities as a member of the Alliance and the European Union. Zrínyi DFDP provides the framework for achieving this. In parallel with the implementation of the comprehensive programme, it is a national strategic priority objective for Hungary to become the key defence industrial centre of the region.

We have drawn the military lessons from the Russo-Ukrainian conflict, and they show up in the development of the armed forces as well. For example, the role of drones has risen to prominence, and the direction of developing the armed forces has gained more importance. We give priority to increasing the personnel numbers of their armed forc-



SPOTLIGHT ON: HUNGARY

²hoto: Hungarian MoD



A Hungarian Pilot boards his Gripen C for a Baltic air policing mission.

es, to the use of Western technology in replacing the earlier Eastern orientation and dependence, and the development of capabilities. Another important aspect is that we give preference to domestic defence industry to the greatest possible extent

Enhance international cooperation

In view of Hungary's close integration into the European and Euro-Atlantic security architecture, the development of the capabilities of the Hungarian Defence Forces should pay special attention to maintaining and enhancing the ability and readiness to cooperate with allied and EU forces. This is an important prerequisite for the defence of Hungary and Europe within the alliance framework, as well as for the effectiveness of participation in operations, missions and other tasks building up national defence

capabilities and management for the stability of the surrounding areas, and thus also for the success of deterrence and defence and resilience.

The maintaining of capabilities offered to NATO and the European Union, together with the long-term provision of contributions to international military operations, is a priority for the Hungarian Defence Forces.

The war in Ukraine had shown light on the severity of the problem that European nations are capable to sufficiently replenish stocks of ammunition in the long run. It is in the strategic interest of all European armed forces, and so of the Hungarian Defence Forces, too, not only to keep adequate ammunition stocks but also to ensure their secure and continuous replenishment. To counter this issue, Hungary is to join the seven-year "Collaborative Procurement of Ammunition"

Hungarian MoD



Two Hungarian Joint Terminal Attack Controllers (JTAC) during a training exercise.

project arrangement of the European Defence Agency (EDA), which jointly coordinates the procurement processes by aggregating European demand. Through this, Hungary and other nations will be able to provide better accessibility and lower prices in meeting the strategic ammunition needs of the Hungarian Defence Forces, which in return will at once contribute to creating markets for the Hungarian munitions factory to be built in the future.

The Way Forward

Our level of ambition does not decline, and we continue to need foreign missions due to the fact that this is how we can be valuable partners in the alliances. On the other hand, we are looking for opportunities to carry out new tasks in foreign missions so we can gain experience.

Threats and challenges arising from this changing security environment necessitate the maintaining of close transatlantic ties, as well as the improvement of the defence capabilities of European states, including those of Hungary. Transatlantic cooperation, in accordance with Article 3 of the Washington Treaty, is based on the coordinated development of allied forces and ensures the credibility of the collective defence enshrined in Article 5 of the Treaty through the continued interoperability, readiness and combat readiness of national forces.

The need to develop European defence capabilities is further underscored by the fact that Europe – apart from guaranteeing its own security – must also act as a security provider in neighbouring (crisis) regions in order to prevent or mitigate threats. The strengthening of CSDP could facilitate the management of crises erupting in the peripheries, as well as increase the efficiency of European defence industry synergies and we are standing firmly behind this initiative.

The Hungarian Defence Forces must become a sustainable military force that meets the requirements of the times, that is renewed in its approach, organisational culture and defence technology, that is well organised, that respects and preserves national traditions, that can be deployed effectively independently and within the framework of the Alliance and the European Union, and that strengthens its capabilities with a reserve system. It must have state-of-the-art equipped and trained troops, as well as flexible, adaptable, effectively deployable and sustainable defence capabilities to carry out its domestic and international tasks.



GRAM -GRID AIMING MODE

FOR COMMANDO MORTAR 60MM M6 C-640

MDAS -MORTAR DIGITAL AIMING SYSTEM

FOR MORTAR 81MM M8 & 120MM M12

DIGITALISATION OF MORTAR SYSTEMS

hds.hirtenberger.com

Hungary's Modernisation Plans

Mark Cazalet

Hungary has been investing heavily in military modernisation to enhance its national defensive capabilities and contribute to NATO collective defence. This article provides an overview of Hungary's major equipment procurement programmes, and how this will shape the country's force structure going into the future.

Since joining NATO in 1999, Hungary has been working to modernise and restructure its armed forces to meet the alliance's standards and contribute to collective defence. In 2017, Budapest launched the Zrínyi 2026 modernisation programme, which was aimed at replacing its Sovietera weaponry with modern systems, and increasing Hungary's defence expenditure to 2% of GDP by 2024, to be in line with NATO spending targets. Major new procurements include helicopters, tanks, artillery, infantry fighting vehicles, and air defence systems. The Hungarian government's investment in military modernisation reflects its commitment to enhancing the country's security and contributing to regional stability.

Major Programme Summary

Hungary's current major procurement programmes include the following:

 Leopard 2A7+ Tanks: In 2018, Hungary ordered 44 Leopard 2A7+ (Leopard 2A7HU) tanks from Krauss-Maffei Wegmann (KMW) to modernise its armoured forces. Deliveries are expected to commence later in 2023. In the meantime, Hungarian forces have received Leopard 2A4 (Leopard 2A4HU) tanks as a stop-gap and for training, with the first batch of four arriving in July 2020.

- 2. PzH 2000 Self-Propelled Howitzers (SPHs): In 2018, Hungary signed a contract with KMW for the purchase of 24 PzH 2000 SPHs to replace its Soviet-era artillery. The first ten howitzers were delivered by late-2022. Prior to their arrival, Hungary's tube artillery systems primarily consisted of Expal M-08 60 mm and Soviet 82-BM-37 82 mm infantry mortars, along with D-20 towed 152 mm howitzers. Evidently, the country has also recognised the need to improve its artillery capabilities at both the long and short-range segments, as in addition to the PzH 2000, the country is also in the process of obtaining Hirtenberger M12 towed 120 mm mortars.
- 3. KF-41 Lynx Infantry Fighting Vehicles (IFVs): In 2021, Hungary signed a contract with Rheinmetall for the purchase of 209 KF-41 Lynx IFVs in seven variants

Photo: Hungarian MoD



The acquisition of PzH 2000 self-propelled howitzers marks a serious capability increase for Hungary's armed forces, which have hitherto relied on towed tube artillery systems.

(IFV, command, reconnaissance, joint fire observer, mortar carrier, ambulance, and driver training) to replace its ageing Sovietera BMP-1 and BMP-2 vehicles. The first vehicle was handed over to the Hungarian armed forces on 15 October 2022.

- 4. H145M and H225M Helicopters: In 2018, Hungary ordered 20 H145M and 16 H225M military helicopters from Airbus Helicopters to replace its ageing fleet of Russian-made Mi-8 and Mi-17 helicopters. The first batch of two H125M helicopters was delivered in November 2019, and deliveries were completed by December 2021. Since then, Hungary's H125Ms have been undergoing upgrade work to integrate the HForce weapon management system, which will also be rolled out to Hungary's H225Ms, the first two of which are scheduled for delivery in July 2023.
- 5. Gripen fighter jets: In 2001, Hungary signed an agreement to lease 14 JAS 39 Gripen fighter jets (comprising 12 single-seater Gripen Cs and two twin-seater Gripen Ds) from Sweden for to replace its outdated Soviet-era MiG-29s. The lease included logistical support and training for Hungarian pilots and ground crew. The first aircraft arrived in 2006 and deliveries were completed in 2007. Under the original agreement, the lease was set to run to 2016, but in 2012, this was extended to 2026. In January 2022, Hungary contracted Saab to upgrade these aircraft to the Mission System 20 (MS20) Block 2 configuration. The upgrade will include improvements to the PS-05/A Mk 4 radar, Link 16 datalink, and introduces Mode 5 IFF, as well as allowing the aircraft to use a wider range of armaments.
- Gidrán 4×4 protected patrol vehicles: In 2019, Hungary ordered 10 Ejder Yalçın 4×4 (known as Gidrán in Hungarian service), and another 40 vehicles in 2020. He first batch of 10 were delivered in early 2021, to the 25th György Klapka Infantry Brigade. The Hungarian armed forces have a total requirement for ap-

proximately 300 such vehicles, and under the second phase of procurement, the remaining vehicles are planned to be built in Hungary.

7. NASAMS Air Defence Systems: In 2020, Hungary signed a contract with Kongsberg for the delivery of two National Advanced Surface-to-Air Missile System (NASAMS) batteries to bolster its medium-range air defence capabilities. The batteries will be integrated with Hungary's existing air defence network and are slated for delivery in 2023. Additionally, Hungary signed a separate USD 320 M deal for 60 AMRAAM-ER missiles as well as spares and training equipment through the US Foreign Military Sales (FMS) programme.

Hungary's Big Cats

Perhaps Hungary's two most noteworthy land programmes are the procurements of the Leopard 2A7+ MBT and the KF41 Lynx IFV, as both represent a serious improvement over what Hungary previously operated.

Hungary's 44 T-72M1s are being replaced on a like-for-like basis by the Leopard 2A7HU (Based on the Leopard 2A7+ standard), resulting in the tank fleet remaining the same size, albeit undergoing major improvements to firepower, survivability, and mobility. With the Leopard 2A7+, Hungary will also gain two to four possible upgrade paths from either KMW/KNDS or Rheinmetall/RBSL. Additionally, given that Germany has committed to the purchase of the new Leopard 2A8 variant, and KMW has previously also demonstrated a Leopard 2A7A1 variant, the tank family is likely to retain relevance for a good number of decades yet. Despite Germany and France's plans for deliveries of the first batch of Main Ground Combat System (MGCS) tanks to commence by 2035, deliveries are likely to span a further 10-15 years, meaning it is likely that that Germany will still have the need to operate Leopard 2 into at least the early-2050s.

Likewise, the KF-41 Lynx is set to provide a major step change to Hungary's mechanised forces, offering improvements in all key areas. Notably, the vehicles ordered by Hungary are due to feature Rheinmetall's StrikeShield hard-kill APS, providing protection against RPG, ATGM and tankfired HEAT projectile threats. As well as good protection, Hungary's Lynxes will also provide the country's only vehiclemounted anti-tank guided missile (ATGM) capability, being fitted with a pod of two Spike LR2 ATGMs in the turret.



As the first adopter of Rheinmetall's Lynx IFV, Hungary has decided to bet on the German design in a highly competitive field.

Under the contract, Rheinmetall will produce the first 46 vehicles in Germany, while the remaining 163 vehicles are to be built domestically at the joint venture based at ZALAZone industrial complex, in Zalaegerszeg. Low-rate initial production commenced in Hungary on 12 January 2023, while full-rate production is scheduled for July 2023. Under current plans, Hungary is expecting to have its first domestically-produced vehicles delivered in 2024, with deliveries complete by around 2030.

Reaching for the Skies

Air defence is a sector where Hungary needed particular improvement, as the country has been broadly reliant on obsolescent 2K12 Kub/Kvadrat family systems to meet its SHORAD/MRAD requirements. Kub/Kvadrat was a capable system by the standards of the late-1960s/ early-1970s - it was a mobile mediumrange system using solid-fuel missiles and semi-active radar homing (SARH) guidance. The missiles featured an interest-



The Kub system relied on the 1S91 radar vehicle for target trancking and illumination for its SARH guided missiles.



The NASAMS is set to provide Hungary with a significant boost to its MRAD capabilities, but at present the acquisition only consists of two batteries.

ing engine design, which used a rocket motor for the boost phase and ramjet engine as the sustainer, with both using the same combustion chamber.

However, the system has a number of downsides. Among these, due to their engine design, the Kub/Kvadrat family missiles tended to have a relatively large inner dead zone with a minimum missile range of around 4-5 km depending on the missile variant. This would have made it difficult to conduct many engagements at VSHORAD ranges, and this dead zone also represented a substantial portion of the maximum range, which was in the region of 22-24 km depending on the missile variant. A further problem was that the Kub/Kvadrat systems were only capable of performing one engagement at a time, due to relying on the 1S91 radar vehicle to both track and illuminate targets. This shortcoming of the design was only really corrected with the development of the 2K12M4 Kub in 1978 and later the 9K37 Buk in 1980, both of which added radars to the transporter, erector, launcher (TEL) vehicle, resulting in transporter, erector, launcher and radar (TELAR) vehicles. This reduced dependency on the 1S91 radar vehicle and allowed TELARs to conduct their own target tracking and illumination, thereby permitting multiple targets to be engaged simultaneously. By contrast, the Kub/Kvadrat family (with the exception of the 2K12M4 Kub-M4 variant) were limited to engaging one target at a time, albeit multiple missiles

could be guided to the same target. The acquisition of NASAMS will be a very meaningful upgrade for Hungary, greatly improving its ground-based air defence capabilities. Notably, Hungary is also procuring the newer AMRAAM-ER missile, presumably in conjunction with the more standard and shorter-range AIM-120 C7 AMRAAM. The AMRAAM-ER is based on the body of the Evolved Sea Sparrow Missile (ESSM), modified to use the seeker from an AMRAAM. The AMRAAM-ER is understood to be capable of engaging targets out to a maximum range of 40 km, while the basic AMRAAM, is understood to have a maximum range of 20 km when launched from the ground. Having said this, both missiles are fitted with active radar seekers, permitting the system to conduct multiple simultaneous engagements.

Gaps Remain for the Time Being

Despite a good start, Hungary still has some important areas left to address, with some of the more crucial gaps being in the very short-range and short-range air defence (VSHORAD/SHORAD) niches, as well as in rocket artillery.

Currently, in Hungarian service, the VS-HORAD/SHORAD range niches are currently served more or less exclusively by the MBDA Mistral-2 missile mounted on the Atlas vehicle-mounted twin-missile launcher, in Hungary's case mounted on the Unimog 1350L 4×4 Truck platform. The Mistral is a fairly capable short-range missile, notably possessing a proximity fuze - which is not always a given for MANPADS missiles, notably this feature was absent from Stinger variants prior to the FIM-92J/K models as well as Igla variants prior to Igla-S. As such, it would be more suited to engaging UAVs than some other MANPADS, but even so, the weapon system as a whole isn't suited to dealing with large quantities of small UAVs and loitering munitions, which is where the battlefield is trending currently. However, Hungary appears to already be indicating that it intends to further flesh out its GBAD capabilities, having joined NATO's 'Modular GBAD' initiative in 2020, which provides a multinational framework for the development and procurement of air defence systems in the VSHORAD/SHORAD/MRAD spectrum. Rocket artillery is another crucial sector where Hungary could benefit from investment into, as it currently lacks any such systems. The war in Ukraine has repeatedly highlighted the immense impact which can be made by artillery on the modern battlefield, particularly guided artillery. The war has further shown how important it is to have meaningful quantities of both tube and rocket artillery when the airspace is heavily contested by GBAD, as they become some of the only reliable means to conduct long-range strikes deeper behind the frontlines. Hungary has a wide range of options to choose from in this sector, with modern examples available from Brazil, India, Israel, Korea, Serbia, Turkey, and the USA. Here too, Hungary has been signalling its interest in obtaining such a system, with local press reporting in February 2022, that Lieutenant General Romulusz Ruszin-Szendi, the Commander of the Hungarian Defence Forces, and Gáspár Maróth, the Government Commissioner for Defence Development, had observed a firepower demonstration for a rocket artillery system in the United States. While the papers did not name the system specifically, it has been widely understood to refer to HIMARS.

As a whole Hungary's modernisation programme appears to be broadly moving in the right direction, and the leadership seems to already be in the process of resolving some of its armed forces' most pressing capability gaps. Alongside procurements, the country has been investing in its industrial base, and as it begins to integrate its new systems, it will be interesting to see how the country manages to sustain momentum on the domestic industrial side as well.

Hungarian Infantry Tactical Mobility

Kristóf Nagy

The ambitious armament programme of the Hungarian armed forces, originally called 'Zrinyi 2026', has also had a lasting influence on the equipment of the infantry. In addition to aspects of modernisation that affect all branches of the armed forces, such as small arms, communications or personal equipment, the issue of tactical mobility is of particular importance.

The Hungarian infantry has experienced a significant increase in combat value due to the preferential treatment in the conversion of their small arms systems to models from Czech manufacturer CZ, as well as new Carl Gustaf M4 portable anti-tank weapons. Personal equipment was also addressed within the

<u>Author</u>

Kristóf Nagy works in the defence industry and as a freelance trade journalist. This article reflects his personal opinion.

framework of the project originally called 'Digital Soldier', with elements such as the new plate carrier and helmet. With the procurement of the first batch of M12 120 mm mortars, manufactured by Hirtenberger, modern indirect fire capability also returned. However, the tactical mobility of infantry units, as well as their direct and indirect combat support has also been the focus of the armament programme for some time. This component is also becoming increasingly important due to the formation of large new units. For instance, the formation of the new 62nd Mechanised Infantry Brigade only began in the summer of 2022.

Infantry Fighting Vehicles for the Infantry Brigades

The future core of these mechanised forces will undoubtedly be the KF41 Lynx infantry fighting vehicle (IFV) from Rheinmetall. The agreement between the Hungarian government and the German defence company provides for the manufacture and delivery of 209 KF41 Lynx IFVs and new BP23 Büffel armoured recovery vehicles (ARVs), as well as other services such as simulators worth more than EUR 2 Bn. This makes the project the most cost-intensive to date in the context of upgrading Hungary's mechanised infantry.

SKY**RANGER30**

www.rheinmetall.com

REBIRTH OF AIR DEFENCE FOR THE ARMY

- Hybrid solution against current and future airborne threats
- High-performance 30 mm gun with airburst ammunition
- Customized guided missile expands operational spectrum
- Autonomous surveillance of airspace
- Easy networking in command structures



In the initial production phase, Hungary is to receive 46 Lynx IFVs and nine BP23 Büffel ARVs from German production. The remaining 163 IFVs will subsequently be produced in Zalaegerszeg in western Hungary by the Rheinmetall Hungary Zrt. joint venture between Rheinmetall and the Hungarian state. Aside from the IFV variant, mortar and air defence variants are also planned.

With the Lynx, Hungarian armed forces will regain a capability which has been absent since their BMP-1s were retired. At the time, these were replaced by BTR-80s for lack of a better alternative, which were not able to provide the same capacity to accept heavy armaments as a tracked IFV. This family of vehicles has also undergone some form of modernisation in the course of its life cycle and, in addition to the APC variant, medical and NBC reconnaissance variants are also in service with the armed forces. However, the replacement of the Russian-made wheeled armoured vehicle with the Lynx is only partially envisaged, as wheeled vehicles are also expected to play a considerable role in ensuring infantry mobility in the future.



The Gidrán mortar configuration is shown conducting a test firing. This version is armed with Rheinmetall's MWS120 Ragnarok manually-loaded 120 mm mortar, but other armament options have been offered, such as the semi-automatically loaded Aselsan Alkar 120 mm mortar.



The 45-tonne KF41 Lynx IFV will form the backbone of Hungary's future mechanised forces.

The Need for Protected Wheeled Vehicles

One of the solutions is the 'Ejder Yalçın' 4×4 vehicle, which has been in series production in Turkey since 2014. The protected wheeled vehicle can be fitted with protection conforming to STANAG 4569 Level 4 against ballistic threats. It is powered by a 375 hp turbo diesel engine and has an unladen weight of 14 tonnes.

The first 40 vehicles, known as 'Gidrán' in Hungarian service, have already been delivered by Turkey and equipped for a wide range of tasks. Numerous variants and possibilities for further development are planned for the versatile vehicle. According to the Hungarian Armed Forces, the vehicle, which is designed with an open system architecture, has the potential to perform a variety of specialised tasks. These extend beyond traditional infantry mobility, and into increasingly relevant segments such as the tactical mobility of drone operators or electronic warfare troops.

One of these core segments is certainly the revival of a powerful infantry indirect fire capability, which on the modern battlefield has limited survivability when not operated from a mobile platform. Even if the Hungarian heavy brigades envisage using the Lynx to meet their mobile mortar needs, the Gidrán has already demonstrated its suitability for this role in the summer of 2022 as part of a firepower demonstration. Rheinmetall's MWS120 Ragnarok mortar served as the indirect fire component during this display.

Similarly to the Lynx, the Gidrán will be largely manufactured in Hungary. A joint venture consisting of Rheinmetall and the Hungarian state-owned HT Division is slated to equip the vehicles with modern command and communications equipment as well as sensor technology. Around 260 vehicles are planned to be produced. According to Hungarian media reports, the integration of turret variants and weapon systems developed by Rheinmetall is also part of the project. The vehicles are due to be produced by town of Kaposvár, located South of Lake Balaton.

Outlook

Since the beginning of the current armament programme, the Hungarian infantry has undoubtedly experienced a huge leap forward in terms of capabilities and firepower. Aspects such as the commissioning of new uniforms with modern camouflage patterns and improved personal equipment not only increase the protection and thus the survival of the individual soldier. They also have a direct influence on the service satisfaction of the soldiers, which is a relevant factor for armed forces facing competition in other sectors of the labour market.

The real challenge of the future, however, will be the integration of individual components into a sophisticated command and control (C2) system that, through networking sensors and effectors, allows Hungary's forces to rapidly engage targets while maintaining good survivability. As part of meeting this challenge, a mobile air defence system mounted on a protected vehicle platform will be needed in future. Here, a decision has yet to be announced. Even though the Lynx is being pitched as a platform option by observers, there is also something to be said for a wheel-based solution, such as the Boxer from Artec. As such, Hungary still faces significant decisions ahead, and will also need to overcome technological and organisational hurdles associated with the introduction and harmonisation of individual systems.



Viewpoint from New Delhi



Ukraine War Delays Russian Weapons for Indian Armed Forces

Suman Sharma

A s Russia assumes the UNSC Presidency beginning April 2023, the Ukraine-Russia war, which has entered its second year, has begun taking its toll on partners and allies in some form or the other. Recently at the ongoing session, the Indian Parliament's Standing Committee on Defence was informed by the Indian Air Force (IAF) about shortage of spares for the IAF's frontline fighters, Su-30MKI and MiG-29 and the delay in the delivery of the remaining two regiments of the S-400 air defence system from Russia. The IAF operates more than 60 MiG-29 jets, comprising about three squadrons, and more than 250 Su-30MKI fighters, both of which are deployed strategically in the eastern and western sectors, overlooking China and Pakistan.

The Indian Parliament's Defence Committee recently observed that, "there is a major project where the deliveries have been stopped because of the war. So, we had a major delivery this year, which is not going to take place. They have given us in writing that they are not able to deliver it". The "major project" mentioned in the committee's report has been identified as the S-400 missile system contract, according to sources.

The Committee, observing the delay in acquisitions has urged the Indian Government's acquisition wing to take steps to deal with the problem, focussing on the need for next-generation state-of-the-art combat fighters for potential future conflicts.

IAF's Air Vice Marshal Suresh Singh (retd) says, "Russia is engaged in a war with Ukraine since February 2022. The Russian government's arms and aircraft factories are busy supplying spares and supplies to Russian armed forces. Indeed, spares support to IAF might be affected, but may not affect our operations in the near future, however in the long run, it may affect our operational preparations."

The delivery of the five S-400 surface-to-air, air defence missile systems valued at USD 5.4 Bn, contracted by India in October 2018, was to be completed by the end of 2023. Three out of these five regiments have reached India, the deliveries for which were expedited after the India-China border standoff began in 2020. The remaining two units were supposed to be delivered by end of 2023, which until recently appeared likely, despite the war in Ukraine. The three regiments of the S-400, which have been delivered, are deployed along India's western, northern and eastern borders.

The delivery of the two pending regiments has been delayed, owing to the war and also due to western sanctions on Russia. In July 2019, the Indian Government had informed its Parliament in a written reply that S-400 deliveries were "likely to be made by April 2023". According to media reports, Russia's Rosoboronexport CEO, Alexander Mikheyev had said at a defence exhibition in 2022, that all five S-400 regiments would be delivered to India by late-2023.

Russian Ambassador to India Denis Alipov has also mentioned delays in the remaining two regiments of the S-400, allegedly hinting towards payments. Vostro accounts have been established between India and Russia to facilitate rupee-rouble trade, but according to Ambassador Alipov, many Indian banks have shown reluctance to use this mechanism, fearing secondary sanctions from the US. Issues such as delayed payments, insurance and re-insurance continue to be the major hurdles delaying this deal. The difficulties in payments multiplied after Russia was shut out of the global SWIFT payment system, following its invasion of Ukraine. With several big-ticket deals on the anvil and a large volume of payment to be executed, both sides are discussing measures to resolve the matter.

Dr Sandeep Tripathi, Founder of Forum for Global Studies says, "The reliability of supplies has always been a key factor in shaping the policy regarding the diversification of defence imports. Russia's defence partnership with India is based-on the compatibility of mutual interest. If New Delhi diversifies radically, it will change the trajectory of the Indo-Russia defence partnership which will be detrimental to both the countries. China will get strategic space in Russia's strategic calculus."

Russia has been the long trusted defence supplier of India for more than six decades. But according to the latest Stockholm International Peace Research Institute (SIPRI)'s annual report, though Russia continued to be India's largest arms supplier, New Delhi's share of total arms imports from Russia decreased to 45% during the period 2018-2022, from 64% previously.

The report, titled 'Trends in International Arms Transfers, 2022'', states that Indian weapons purchased from Russia, US, France, and other countries has dipped by 11% in 2018-22 compared to 2013-2017, which could be attributed to the Indian Government's self-reliance initiative.

France occupies the second place with 29% of Indian arms imports, displacing the US at the third place with 11%. In 2018-2022 India also bought weapons from South Korea, South Africa and Israel. Despite an 11% decrease in its weapons imports in 2018-2022 compared to 2013-2017, India remained the world's largest weapons buyer from 2018-2022, followed by Saudi Arabia. The SIPRI report also mentions that Ukraine, which imported relatively few arms from 1991-2021, has become the world's third-largest arms importer due to the war.

SECURITY POLICY

The Phantom Supply Chains of European Armies

Juan M. Chomón Pérez and Craig Hymel

The Western arms industry is overstretched. With replenishment times for arms shipped to Ukraine alarmingly high, it is not enough for European armies to have quality suppliers. It is now also a question of being well-positioned in the delivery priorities of defence companies.

Over the past decades, European countries have allowed their weapon arsenals and ammunition stocks to run low. Instead of maintaining the knowledge base and lessons learned from major wars, governments and their militaries have cashed in on the peace dividend and adapted to the less demanding scenarios of expeditionary low-intensity warfare. In order to meet the materiel challenges Europe faces, only healthy supply chains can guarantee access to the materials, elements and components needed to manufacture at a rate not seen in decades.

To make matters worse, China has recently imposed sanctions on two American defence manufacturers over arms sales to Taiwan, Lockheed Martin Corporation and Raytheon Missiles & Defence, a subsidiary of Raytheon Technologies Corp. These sanctions came immediately after Beijing pledged to take countermeasures in response to Washington's downing of a suspected Chinese surveillance balloon that en-

<u>Authors</u>

Lieutenant Colonel (LtCol) Juan Manuel Chomón Pérez is a pilot in the Spanish Air Force with 12 years of extensive international experience in France, Netherlands, Germany, Italy, Djibouti, Mauritania and Afghanistan. He is a graduate of the Bundeswehr's Joint General/Admiral Staff Course and has a Master's degree in Military Leadership and International Security.

Major (MAJ) Craig Hymel is a US Army infantry officer who has served in various tactical positions throughout Germany, Poland, and the Baltics. He is a graduate of the Bundeswehr's Joint General/Admiral Staff Course and has a Master's degree in Military Leadership and International Security. tered US airspace at the end of January. Now these two entities will be added to China's sanctions list meaning they are banned from importing, exporting, and investing in China. The key word this time is 'importing', as that means a ban from importing all critical materials, mostly rare earth metals (also known as 'rare earths'), refined and processed in the Asiatic giant. Without rare earths, there are no modern weapon systems. As such, now is a good time to revisit history.



US Air Force pilot looking down at the suspected Chinese surveillance balloon as it flew over continental United States, on 3 February 2023. Recovery efforts began shortly after the balloon was downed.



WW2 (1942). Beginning of Operation Tungsten. Barracudas flying over a fjord shortly before attacking the Nazi battleship Tirpitz, stationed in Norway. The Tirpitz was intercepting Allied convoys carrying large quantities of raw materials such as Tungsten from ports in the UK and Iceland.



US Navy F-35 displaying tail colours with the Ukraine flag could not defend this country or any other without Beijing's silent consent. The US DoD had to provide a waiver for production of the aircraft with Chinese rare earth elements.

"Those who cannot remember the past are condemned to repeat it."

In past conflicts, securing the means to produce and keep weapon systems operational has proven decisive. Germany, a traditionally resource-poor country outside of coal and iron, learned this the hard way during WWI. Allies cut off maritime access to critical natural rubber and oil resources, compelling the IG Farben consortium to develop synthetic substitutes in the interwar years. Likewise, the WWII Allied powers successfully restricted German access to Tungsten (known as 'Wolfram' in German). The metal was in a sense equivalent to today's rare earths, due to its novel applications and importance in munitions and armour production. The Allied bloc pressured an ostensibly neutral Spain to stop providing Tungsten from the Galician region in Spain to Nazi Germany, in order to weaken its capabilities. The US instead became the main buyer of Spain's Tungsten, and the Allied maritime blockade prevented overseas access to the precious metal. Even prior to the war, Great Britain expropriated German-owned Tungsten mines in England. As a result, Germany was forced to resort to sifting through tailings from zinc mining, where the precious metal was heretofore considered a useless by-product; such was Germany's hunger and desperation for this critical raw material.

After WW2, the US Government began a comprehensive study regarding access to critical materials needed in wartime. Likewise, the US enacted the Federal Acquisition Regulation (FAR) to help ensure the US retained the industrial base and raw materials for all government programmes, including defence-specific applications. However, even as the US passed supplements specifically regarding rare earth metals in 1973, the growing neoliberal ideology meant that the world's greatest military power would soon forget hard-

learned lessons. Once the champion of globalisation, the US is now forced to create a Supply Chain Task Force to reassess the security of its supply chains. The task force's results highlight the precarious nature of US supply chains, with rare earth metals playing an especially critical role. Despite procurement rules stipulated in both the FAR and the Berry Amendment. the US Department of Defense (DoD) and its army of contractors routinely waive sourcing requirements, particularly regarding rare earths. In this regard, several defence companies have supplied weaponry containing Chinese rare earths to the US Government. Sub-contracting outsourcing was identified as the source of the violations, but the US Government was forced to issue an exemption to keep building weapon systems such as the F-35, also in the service of several European militaries. It therefore seems that we are forgetting a key lesson gained from the two world wars of the 20th century. Mastery of the periodic table makes it possible to produce the best weapon systems, while secure, vertically integrated logistics supply chains are key to victory in any protracted conflict.

Subcontracting and 'Just-In-Time' Culture

Pixabay

Photo: F

The US has identified these issues rather early, but in the EU, whose Common Security and Defence Policy is still in its adolescence, members have not yet come to grips with the problem they are and will continue to face. Economies of scale these past few decades have led to the emergence of large European companies such as EADS (now Airbus). Rheinmetall. Leonardo. Thales. Safran. and Indra, loosely bound together through agencies and agreements such as OCCAR. These armament companies have followed the same trends as their civilian corporate counterparts, of including heavy adoption of sub-contracting to obtain components and raw materials needed to manufacture weapon systems. Neoliberal globalisation has changed supply chains globally, and defence companies are no exception. These companies adopted a 'just-in-time' production culture, reducing or eliminating material and parts stockpiles to reduce overheads costs for the final product. Strategic independence, once fundamental for our military supply, has been degraded in favour of maximising business competitiveness in a globalised world. Put plainly, maximising profits has taken precedence over securing indigenous supply chains in support of national defence.

To the EU's credit, in recent years it has been working to develop a joint industrial policy. Recently, the European Defence Agency (EDA) examined these overarching concerns and published the Code of Conduct on Procurement, Offsets and Good Practices in the Supply Chain. Such policies are needed, as many EU countries cannot aspire to unilaterally establish independent indigenous military supply chains, in the same way as



The EU Commission final report on Critical Raw Materials 2023 recently published shows the immense dependence of the EU on imported critical raw materials.

SECURITY POLICY



EU Defence Supply Chain scheme produced by the EU Commission. This figure from the EU report shows dependencies on companies such as Glencore, Rio Tinto, and Anglo American. These are mining and trading companies based in Switzerland the UK, and/or UK-Australia. However, the EU itself lacks similarly large producers in this sector.

the US is attempting to do. Individually, their size, available natural resources, and industrial capacity prevent such autonomy, but the EU as a whole can achieve such an objective, thus enhancing the robustness and independence of its Common Security and Defence Policy.

Unfortunately, the Code of Conduct merely provides guidelines for the member states; there is no obligation to comply, and it thus fails to implement a true EU-wide industrial policy. To exacerbate matters, member states use Article 346 of the Treaty on the Functioning of the European Union (TFEU), to exempt themselves from complying with existing procurement rules. This leaves the security of their supply chains in the hands of contracting companies, with no corresponding national legislation in most cases obliging these companies to assume legal responsibilities for military procurement.

US and European Companies in China's Hands

The current supply chain situation within the EU, where no mandatory laws exist, either at interstate or national levels regarding critical materials needed for national defence, creates a significant vulnerability for its members' militaries. Even more worrisome, the European Commission itself forecasts a high risk of critical material shortages, and a very high risk of a rare earth shortages by 2025. But the situation goes from worrying to alarming when one notes that many of these materials are in the hands of China. It is no coincidence that today the elements cobalt, lithium, manganese, tungsten, antimony, bismuth, graphite, fluorspar and germanium are under a Chinese monopoly, in either the amount extracted or processed, with China providing more than 50% of the global total. Concerning the EU, China is its largest supplier with a 90% share and if we refer to heavy rare earths that are present in many of our most technologically-advanced weapon systems, this monopoly reaches almost 100% of the metals. China is well aware that Western strategic autonomy is in its hands.

The Chinese sanctions imposed on Lockheed Martin and Raytheon could represent just the tip of the iceberg. A hypothetical future projection of China's past threats or diplomatic uses of rare earths suggests that it will sanction any other defence companies that could directly or indirectly jeopardise its security. These would be, for example, any other companies selling arms to any country with which China is in conflict. Imagine the implications that this 'weapon' would have in the Ukraine conflict if China decided to clearly take Russia's side. Specific companies or countries as a whole could face limitations, interruptions or bans on their supply of rare earths and other rare metals. Finally, it is the Chinese Government which dictates the threshold of sensitivity that triggers a rare earth blockade.

On the US side, in a recent edition of China's Modern Defence Technology journal, Chinese researchers denounced the enormous military potential of SpaceX's Starlink and called for the development of capabilities to monitor, deactivate, or destroy this constellation of low-Earth orbit satellites. Among other concerns, scientists pointed out the ability of such satellite networks to detect their hypersonic missiles, and exponentially increase the data transmission of their aircraft such as the F-35 and their drones. They also argued that this network had already put their satellites in danger of collision in July and October 2021, a fact that was denounced by the Chinese Government before the UN.

The ban on the export and use of rare earths could be the perfect weapon to disable the Starlink satellite network or similar European networks, whose military utility has already been established as a result of the war in Ukraine. Given that sanctions constitute a low-cost, low-threat alternative to physically destroying satellites, as well as obviating the hazard from debris posed by destroyed hostile satellites to friendly satellites, they offer China the ability to curtail or even effectively negate Western satellite capabilities in the medium term. It would be an action within the so-called grey zone since it does not imply the use of force and as such would avoid an escalation towards a conventional military confrontation.

Another theoretical example, in this case European, would be the French company Dassault Aviation and the European company Airbus, which have sold both Rafale fighter and transport aircraft (A400M and C295) to India and Indonesia, respectively. In some cases, these agreements involve not only the sale but also a certain transfer of technology, since in the final stages of the procurement programmes the aircraft are produced in the buyer country. A rare earth ban against these countries would prevent them from producing sufficient quantities of avionics and mechanical parts needed to complete construction.

These theoretical examples are not at all far-fetched if we look at the retaliation provoked by simple balloon destruction and growing geopolitical tensions in the Indo-Pacific region. We should also recall that China has had a border dispute with India for years. It also actively claims, through its fishing militia, part of Indonesia's Exclusive Economic Zone in the Natuna Sea, and in late 2019 there was even an incident that resulted in military action. Furthermore, the tensions generated by Chinese aspirations to reconquer Taiwan have led to the February 2022 announcement of initial sanctions by Beijing against American companies Lockheed Martin and Raytheon for the sale of weapons to Taipei. Following the same argument, China could also issue sanctions against Dassault, and thus against France for selling armaments to other countries that threaten its security or national interests.

This example could be extended to other European weapon system manufacturers, such as frigate manufacturers, which have a growing presence in the Indo-Pacific, and which is set to grow even further. This is
envisaged in the 'EU Strategy for Cooperation in the Indo-Pacific' document published in April 2021. It states the EU's intention to "...cooperate with the navies of its partners, and develop their capabilities where appropriate, to establish global vigilance in the interests of maritime security and freedom of navigation, in accordance with international law ... ". Many modern frigates incorporate more than 1.5 tonnes of rare earths, but the case of the Rafale fighter aircraft is particularly significant, as it can carry nuclear weapons. The Rafale constitutes, along with strategic nuclear submarines, a key vector in power projection and a cornerstone of the French national defence strategy, based on nuclear deterrence that depends on various critical materials, including rare earths.

Strategic Insolvency in the Terrible Twenties

The impacts of sanctions are not limited to a potential future conflict in the Indo-Pacific. Another potential scenario is a shift in China's policy of support for Russia in its ongoing war against Ukraine. Western countries imposing sanctions on China could end up facing retaliatory measures such as a ban on exports of rare earths by the Chinese Government. As geopolitical tensions increase, the EU, Japan and Australia appear to be ratifying their alignment with US foreign and security policy. As a result, the hitherto limited exchanges of sanctions between these countries and China could expand and affect other areas, such as critical materials needed for the defence sector. The Western defence sector's dependence on Chinese rare earths throughout its supply chain represents a bitter enemy to its strategic autonomy both at the national level and within the framework



EU raw material needs in the defence and aerospace sectors.

of its Quadrilateral Security Dialogue and NATO alliance. It limits the West's technological sovereignty and may in the future be a limiting factor in its ability to respond to crises and sustain military operations.

This current period offers a window of opportunity for those enemies of Western countries who, aware of their weaknesses, could take advantage of them to challenge the West and achieve their objectives. Taiwan, the Senkaku Islands and the Exclusive Economic Zone (EEZ) in the South China Sea, and the Spratly Islands (claimed from the Philippines) are all at stake, but so too is the Arctic Circle, the ocean floor, or even outer space, in a critical period characterised by Western strategic insolvency.

Not without reason, this decade has already been dubbed by many defence analysts as 'the terrible twenties' due to manufacturing and supply chain problems. National-scale logistics have always constituted the life force of national defence, without which, international security vanishes as well. For better or worse, modern militaries are dependent on private companies for procurement and outfitting, and no Western defence company will voluntarily operate at a loss to secure either our independence from China, or the required war reserves for our militaries. This means Western governments bear the responsibility for overhauling industrial bases and supply systems in record time, starting with the most critical components and materials, especially rare earths.

Many EU hopes were pinned on the Critical Raw Materials Act published on 16 March 2023. However, the lack of strong measures in this new regulation fails to meet the needs of domestic production and self-supply of critical materials for EU defence industries. It seems that unless there is a diplomatic disagreement with China, the EU prefers not to clearly take interventionist and forceful measures against its economies. The problem is that if it has just taken China 10–15 years to take over the rare earth supply chain, the EU will need the same time to take it back. The EU's reaction time is out of step with the pace of de-globalisation and the current geopolitical landscape. Catching up will require a significant shift in gear by its member states.

HIGH PRECISION





CNC lathes, Turn-mill centers and complete solutions for manufacturing your components, such as:

- Precision components for the small arms and shooting sports industries
- Small arms projectiles, bullets and cartridges
- Optic components
- Parts for guided missiles www.index-traub.com





The South Caucasus in the Shadow of the War in Ukraine

Gayane Novikova

he trilateral ceasefire agreement signed on 9 November 2020 between Armenia, Azerbaijan, and Russia created a serious shift in the balance of powers in the South Caucasus. Consequently, Russia's influence on developments in this region has been brought into question by the close alliance between Turkey and Azerbaijan. For its part, Armenia has tried to recover following its devastating defeat on the battlefield. To the north, Georgia's priorities continue to be framed by internal developments. And looking south, Iran has been cautiously advocating for the "3+3" formula of regional cooperation. Furthermore, the magnitude of the Russian-Ukrainian war has contributed to further geostrategic changes and has increased the challenges throughout the South Caucasus. This article analyses several key aspects of the new geo-strategic environment in this region

Weaponised Energy

By signing the 'Contract of the Century' in 1994, Azerbaijan revealed its two major strategic goals: i) the restoration of its territorial integrity through the return, under its full control, of all territories lost after the first Nagorno-Karabakh (NK) war (1991-1994); and ii) Baku's gradual transformation into a provider of crude oil and natural gas to the world energy market. The first goal was achieved in the course of the 2020 Nagorno-Karabakh war. The second has, to some degree, been realised against the background of EU and US sanctions imposed on Russia after its illegal annexation of Crimea in 2014. These sanctions have been further expanded after the latter's invasion of Ukraine on 24 February 2022. Four intertwined developments shed light on the politicisation and weaponisation of the energy issue by Russia, the EU, and Azerbaijan.

<u>Author</u>

Dr. Gayane Novikova is the founder and former Director of the Center for Strategic Analysis, (Spectrum) in Yerevan, Armenia, and an Associate of the Davis Center for Russian and Eurasian Studies, Harvard University.



President of the Republic of Azerbaijan Ilham Aliyev has held an expanded meeting with President of the European Commission Ursula von der Leyen.

1) On 22 February 2022, Russia and Azerbaijan signed the "Declaration on Allied Interaction". In accordance with Article 7, the parties "refrain from any actions that, in the opinion of one of the Parties, damage the strategic partnership and allied relations of the two states." This document thereby prevented Azerbaijan from taking any openly pro-Ukrainian actions in the course of the ongoing war in Ukraine. In addition, it allowed Russia to partially escape sanctions imposed by the West. It also significantly reduced Russia's capacity to provide military support to Armenia within the framework of Russian-Armenian bilateral agreements.

2) On 18 July 2022, the EU and Azerbaijan signed the "Memorandum of Understanding on Strategic Partnership in the Field of Energy." As stated by Ursula von der Leyen, President of the European Commission, Azerbaijan is "a key partner in our efforts to move away from Russian fossil fuels." According to the EU–Azerbaijan MoU, Azerbaijan is expected to supply an extra 4 bcm of natural gas to the EU in 2022 (bringing the total to 12 bcm), and by 2027 to double the transfers. Meanwhile, BP, which operates Azerbaijan's largest gas field, Shah Deniz, in the southern Caspian Sea, announced that this field has limited capacity and cannot supply the entire volume of gas as agreed in the MoU.

3) On 15 November 2022, Russia's Gazprom announced that it had begun supplying gas to Azerbaijan within the framework of the new gas purchase agreement and would supply up to 1 Bn bcm through March 2023. Its partner, Azerbaijan's state oil company SOCAR, stated that the two companies "have been regularly cooperating in the field of gas supply and gas-chemical enterprises for the past 10 years. ... both companies are trying to optimise their infrastructure by organising the mutual exchange of gas flows. The mentioned agreement is also a part of the joint cooperation."

Consequently, Azerbaijan has begun to import Russian and Iranian gas to address its domestic energy needs and – with high probability – a certain volume of Russian gas has been transferred through Azerbaijan to Europe in order to fulfil Azerbaijan's EU obligations.

4) At the roundtable discussion "Pipe Dreams: Future-Proofing Energy Security" (Munich Security Conference, 17 February 2023), President Aliyev stated that the goal in the medium and long term was the expansion of the Southern Gas Corridor proposed by Azerbaijan. He emphasised that, by 2027, Azerbaijan planned to increase gas transportation through TAP (Trans Adriatic Pipeline) from the current 11 bcm to 20 bcm and via TANAP (Trans-Anatolian Gas Pipeline) from 16 bcm to 31 bcm.

Azerbaijan can become an important partner and energy provider for Eastern European states if it finds additional gas reserves and figures out its transportation routes. In December 2022, Azerbaijan, Turkey, and Turkmenistan signed two interagency memoranda of mutual understanding on the development of cooperation in the fields of energy and transportation, both of which aimed to provide Turkmen gas through the Caspian Sea to Turkey – and from there to Europe. However, this project will be both time- and resource-consuming, taking into consideration also the aftermath of the devastating Kahramanmaras earthquake in Turkey and Syria in February 2023.

Manoeuvres around Azerbaijan's energy resources do not affect either Georgia or Armenia as the former receives its oil and gas from Azerbaijan, the latter from Russia and Iran.

As a whole, Russia's curtailment of energy supplies to Europe after its invasion of Ukraine in February 2022, followed by EU and US sanctions on Russia's energy sector, have multidimensional and accumulative geopolitical effects. These sanctions have forced both the EU and the US to intensify joint efforts in the search for alternatives to Russian sources of energy, turning also toward autocratic regimes, in particular Azerbaijan. The desire of the EU and the US to secure energy flows by all possible means raises ethical questions regarding their commitment to human rights and democratic values. It also indirectly indulged, together with the Russian-Azerbaijani "Declaration on Allied Interaction," Baku's aggressive approach towards Armenia and to the Armenian population of Nagorno-Karabakh - both in violation of the November 2020, trilateral ceasefire agreement.

A Security Deficit in the South Caucasus

The panel discussion "Moving Mountains? Building Security in the South Caucasus" was on the agenda of the 2023 Munich Security Conference. Leaders of the three South Caucasus states were invited to evaluate the situations in their respective countries through the prism of the war in Ukraine. Holding this panel clearly reflected a concern by the Western powers regarding the security deficit in the region, as well as the understanding that a new regional war will have broad catastrophic consequences. Several conflicts of different intensity contribute to the growing security deficit.



Ilham Aliyev (President of Azerbaijan), Irakli Garibashvili (Prime-Minister of Georgia), Nikol Pashinyan (Prime-Minister of Armenia), Helga Maria Schmid (Secretary General, OSCE), and Christoph Heuesgen (Moderator, Chairman, Munich Security Conference) attending the panel "Moving Mountains? Building Security in the South Caucasus" on 18 February 2023.

A high intensity Armenian-Azerbaijani conflict can once again erupt in the shortto mid-term perspective. The unfinished delimitation and demarcation of the south-eastern segment of the Armenian-Azerbaijani border should be considered as a source of the most complicated and dangerous developments in the region. After the 2020 Nagorno-Karabakh war, Azerbaijan not only regained control over the territories surrounding Nagorno-Karabakh, but was also able to seize approximately one-third of the territory of the former Nagorno-Karabakh Autonomous Region. In May 2021, Azerbaijan's armed forces invaded Armenia's two southern provinces of Syunik and Gegharkunik, occupying about 41 km². Calling this operation "borders adjustment," Azerbaijan for the first time challenged the willingness and ability of both Russia and the CSTO to fulfil their security guarantees and obligations towards Armenia.

The next phase of Azerbaijan's direct aggression against Armenia occurred two months later after the signing of the MoU with the EU. On 13-14 September 2022, Azerbaijan's armed forces attacked and further penetrated into Armenia's sovereign territory. Azerbaijan again tested the strength of its partnership with Russia, the CSTO, and the EU. Its military aggression against Armenia went unpunished. The intense fighting only stopped after US diplomatic intervention, yet the Azerbaijani leadership continues to repeat its territorial claims.

An allocation of the EU's two-year Common Security and Defence Policy (CSDP) mission in Armenia, which has been deployed along the Armenian-Azerbaijani border since 20 February 2023 upon the request of the Armenian Government, was met with strong criticism from Russia and Azerbaijan. On the one hand, Armenia's noticeable move towards closer cooperation with the West, significantly stimulated by the Russian–Ukrainian war, has added fuel to current Armenian-Russian tensions - both political and diplomatic. On the other hand, this move will probably decrease the intensity of Azerbaijan's aggressive behaviour. In the best-case scenario, it may provide fresh impetus to the Armenian-Azerbaijani peace negotiations.

Georgia welcomed this EU mission in Armenia. As for Iran, although it was always opposed to the presence of any military non-regional force in the region, it did not openly criticise the Armenian Government. Another potential conflict to be watched closely is one that might occur between Azerbaijan and Iran. Tensions of a different nature between these nations have been simmering since Azerbaijan's independence. However, shifts in the geopolitical and political-military landscapes of the South Caucasus after the 2020 Nagorno-Karabakh war have since drastically changed their interaction.

Iran's security concerns have further increased after Russia's invasion of Ukraine. Azerbaijan's military and diplomatic pressure on Armenia has been aimed at forcing Yerevan to agree to open - in Baku's ter-



ICRC vehicle facilitating the transfer of a patient in need of urgent medical assistance across the Lachin corridor to Armenia, 19 December 2022.

minology - the "Zangezur corridor." This proposed new transportation link would give Azerbaijan uninterrupted access to the Nakhichevan autonomous republic (an exclave of Azerbaijan) via Armenian territory, and, according to the Azerbaijani side, should be operated under its full control. This route would thereby diminish Iran's transit role between these two parts of Azerbaijan, as well as between Turkey and Central Asia, simultaneously increasing Turkey's strategic weight. Furthermore, in the event of a new round of an Armenia-Azerbaijan military confrontation, this route would prevent Iran's access to Russia through Armenian territory and would limit its economic cooperation with the Eurasian Economic Union. Therefore, any attempt by Azerbaijan to change internationally recognised borders would be viewed by Iran as an immediate security threat.

Another external security concern for Iran is posed by significantly increased military cooperation between Azerbaijan and Israel – in addition to the direct threat from Israel. Besides, Baku's intensified anti-Iranian propaganda (which is sensitively echoed in the northern part of Iran populated mainly by ethnic Azeris), activated through official and social media channels, has been considered by Tehran as an internal threat to the regime.

In this configuration of powers, Iran's further steps have been focused on efforts to resist activity taken by the Turkey–Azerbaijan–Israel axis (Pakistan in the foreseeable future will become another link) through a reduction of its tensions with Azerbaijan. This is an improvement in its relationship with Armenia, and a bolstering of its partnership with Russia and India in all domains, including the military. The third conflict, which involves an ongoing confrontation between Azerbaijan and the ethnic Armenian population of Nagorno-Karabakh, can be characterised as a low-intensity conflict. According to Article 6 of the tripartite ceasefire agreement of 9 November 2020, "... in the next three years, a plan for the construction of a new traffic route along the Lachin corridor, providing communication between Stepanakert and Armenia, with the subsequent redeployment of the Russian peacekeeping contingent to protect this route will be determined. The Republic of Azerbaijan guarantees traffic safety along the Lachin corridor [the only route connecting Armenia and Nagorno-Karabakh. - G.N.] of citizens, vehicles and goods in both directions."

More recently, Azerbaijan's strong political, economic, military, and psychological pressure has culminated in a complete blockade of Nagorno Karabakh since 12 December 2022. The Azerbaijani side, by actually implementing an ethnic cleansing policy, has been trying to convince the parties concerned that the Lachin corridor remains open at all times. The Russian peacekeepers, who should guarantee the free movement of people and goods through this corridor, have no valid mandate to influence developments on the ground. An unprecedented activity of European and American partners, as well as the UN and the EU, demanding an immediate restoration of free movement in the corridor, remain only on paper. In reality, none of these international actors possesses the power to force Baku to change its modus operandi. For its part, after the 2020 Nagorno-Karabakh war, Armenia lost its status as a security guarantor for the NK Armenian population. Moreover, for the Armenian side, the only possible way to influence the situation on the ground would be a full-scale mobilisation of the international community in support of the NK cause.

What Next?

Beneficiaries of the war in Ukraine - primarily Azerbaijan and Turkey - will deepen their strategic cooperation and strengthen their joint military potential. There is a high probability, that owing to the multidimensional consequences of the Russian-Ukrainian war, Russia will face either a withdrawal from the South Caucasus or – at least – a significant reduction in its ability to meaningfully influence developments in this area. Simultaneously, the ongoing war in Ukraine will further intensify the alliance of convenience between Russia and Turkey. It has also pushed Russia and Iran toward closer cooperation. In the meantime, the competing interests of Turkey and Iran in the South Caucasus and Central Asia will collide with China's desire to become the leading extra-territorial power in both regions. The Iran-Saudi Arabia truce on re-establishing diplomatic relations, brokered by China on 11 March 2023, should be considered in this context as well.

Full-scale cooperation with Azerbaijan is crucial for both regional and extra-territorial actors. In turn, Azerbaijan, owing to its growing strategic importance, will gain additional economic and political leverage that can be utilised to strengthen its security and to challenge the security of its immediate neighbours, Armenia in particular. Under these circumstances, Armenia's drift towards closer cooperation with the West should be considered as an attempt to preserve its territorial integrity. However, whether Armenian diplomacy will be able to navigate between Russia and the West without provoking any of the parties concerned (first and foremost, Russia and Azerbaijan), remains unclear.

An acute security deficit has stimulated an increase in military cooperation and, correspondingly, in military competition in the South Caucasus. A gradually intensifying arms race has directly contributed to the region's further militarisation. Already very fragile from the political, economic, military, and diplomatic viewpoints, Armenia and Georgia are destined to remain junior partners in this geopolitical game.

Developments in the South Caucasus will remain in the shadow of Russia's war against Ukraine. To a certain degree, any outcome will influence the security system of the entire region. However, the established balance of power will hardly be altered any time soon.

Malaysia Confronts Challenging Defence Environment

David Saw

Malaysia's regional defence environment is characterised by a complex and dynamic security landscape, with a range of security threats, including border disputes, piracy, and terrorism. The country's strategic location in Southeast Asia has also made it an important partner in regional security cooperation efforts.

For the European defence industry Malaysia was once one of their favourite foreign defence markets, it offered good programmes to try and win. Equally as important was the fact that Malaysia was politically stable, therefore it was possible to build long-term relationships with key decision makers. This political stability also provided the basis for long-term defence acquisition planning, potentially allowing customers and suppliers to work together to generate satisfactory procurement outcomes.

Over time though, this 'idealised' defence procurement structure changed. The relatively benign system that had been so satisfactory in the past became much more competitive. The political stability that had been so highly prized in Malaysia started to unravel, with political factionalism becoming more and more visible. It should be noted that Malaysia's economy continued to develop, reflecting the better financial performance and higher sophistication of many of the national economies of Southeast Asia. Economic growth meant that political leaders could set ambitious development goals, geared towards further developing the national economy and improving the economic outcomes and social opportunities available to Malaysia's population.

It is clear that Malaysia's political and economic leaders have transformed the country over the past few decades, and efforts to diversify the economy from reliance on oil, raw materials and agriculture have also delivered benefits. However, once the national political environment became more combative, this tended to overshadow economic and social development. To this one must also add the economic impact of COVID and the ongoing costs of dealing with that crisis.

Strategic Environment

Key to understanding the broader Malaysian defence environment comes from an



A Royal Malaysian Air Force (RMAF) F/A-18D at RMAF Butterworth in northwest Malaysia, one of a force of eight F/A-18D acquired by the RMAF. The other main RMAF combat asset is a force of 18 Sukhoi Su-30MKM aircraft. Plans exist to acquire a new multirole combat aircraft.

analysis of the main strategic, economic and socio-political factors in Malaysia. Malaysia is located in a critical position in Southeast Asia, to the west of the Malay peninsula you have the Strait of Malacca, this is of major importance in that it has been described as the second-largest oil supply choke point in the world, after the Strait of Hormuz at the base of the Gulf. The Strait of Malacca is one of the major global trade arteries, if free passage of shipping could not be assured there would be significant global economic impact. Equally, Malaysia would accrue significant economic damage in these circumstances. Piracy remains an issue in the Strait of Malacca, albeit a manageable issue at this point.

Malaysia has a number of regional maritime border disputes with neighbouring states, but these are subject to negotiation and do not have a strategic impact. What does though are the competing maritime claims to the Spratly Islands area in the South China Sea. Here Malaysian territorial and adjacent Extended Economic Zone (EEZ) claims, as well as those of Brunei, the Philippines, Taiwan and Vietnam come into conflict with those of China. Moreover, China has made it clear that it regards the Spratly Islands as a key strategic area, and it continues to expand its presence in this area.

The Spratly Islands area is another major maritime artery, the ability to block or interdict this artery would be strategically beneficial in a regional context. There are also strong economic motives to control the area, there are rich fishing grounds and potentially large offshore oil resources that are extractable. The disputed nature of the Spratly Islands area has long been seen as having the potential to trigger a regional conflict.



KD Lekiu (FF30) enters Pearl Harbor after participating in a RIMPAC exercise. The two F2000 class frigates, KD Lekiu and KD Jebat, were commissioned in 1999 and currently represent the most sophisticated surface units in the Royal Malaysian Navy (RMN).

Another area of concern for Malaysian security planners is along the northern border with Thailand. The three southern Thai provinces of Pattani, Yala, and Narathiwat are the primary location of an ethnic Malay nationalist insurgency, which in its current incarnation has continued for some 18 years. To counter the insurgency, Thailand has deployed substantial numbers of military, paramilitary and police personnel in the three provinces. The Thai government has opened ongoing negotiations with various insurgent groups, but no end to the insurgency has resulted thus far.

From a Malaysian perspective, the primary mission is to avoid any overspill of violence from southern Thailand into northern Malaysia. Obviously there is sympathy for an ethnic Malay insurgency, although the preference would be for a negotiated end to the insurgency and a long-term political solution acceptable to all parties to the conflict.

Political Change

In terms of Malaysia's political stability, central to this was the United Malays National Organisation (UMNO), effectively 'the' political party of the majority Malay population and thus the dominant political force in the country. It would then form a coalition with ethnic Chinese and Indian parties as junior partners, to provide a representative government across the major ethnic groups in Malaysia. Initially, the coalition was called the Alliance, later it become the Barisan Nasional (BN). The UMNO + BN would provide the Malaysian government from 1957 through to May 2018, in that time there would be six different Prime Ministers. Since May 2018 there have been four different Prime Ministers, representing four different political coalitions.

The current Prime Minister of Malaysia is Anwar Ibrahim, who won the November 2022 election at the head of the Pakatan Harapan (PH) or Alliance of Hope coalition. By contrast, in that same election UMNO/ BN had their worst ever result. Ironically Anwar had once been a leading member of UMNO, but his fall from grace in that organisation would see him imprisoned twice after politically-inspired prosecutions. The fate of Anwar would be the point where politics in Malaysia went from stability to something far more combative.

In 2020 former Prime Minister Najib Razak (Prime Minister from 2009 to 2018) was sentenced to 12 years in jail for corruption, with appeals against this verdict being lost in August 2022. In March of 2023, former Prime Minister Muhyiddin Yassin (in office March 2020 to August 2021) was arrested on charges of bribery and money laundering related to COVID spending. Muhyiddin has been a political rival of Anwar's for years and there is known to be considerable animosity between the two, meaning that any corruption charges must be clearly provable otherwise this will be seen as a political prosecution.

The Economy

If the Anwar government is to survive in office it must deliver on completing the recovery from COVID and improving the economy. Although it is politically more progressive than previous governments, it needs to get the economy right or it will fail. Any hopes of significant defence procurement in Malaysia also depend on an

improvement in the economic situation, although the government does not appear well disposed towards defence and there are problems to confront regarding current defence programmes.

The first test as to how the Anwar government is viewed by the electorate will come in the state-level elections in July 2023. There are 13 states in Malaysia, and these local elections have no real impact on the government as such, but they will act as a virtual referendum on the performance of the government. Remember that the government is based on a coalition and should the state election results reflect major dissatisfaction with the government, some of their parliamentary support could evaporate and that might set the scene for the government to fall.

The national budget, released by the government in late February this year, really needs to deliver. Key elements were an increase in taxes on the wealthy and an increase in subsidies to help the lower paid. The government has admitted that it must reduce the national debt, officially this is running at USD 270.6 Bn currently, equivalent to 62% of Gross Domestic Product (GDP), up from 60.4% last year. However, if other government liabilities are included, the national debt stands at USD 338.2 Bn or 81% of GDP. Currently 16% of government revenue goes on paying debt interest. The aim is to get the official national debt down to 55% of GDP, essentially where it was prior to Covid.

Subsidies on petrol, diesel, Liquid Petroleum Gas (LPG), cooking oil, flour and electricity, saw the government spend USD 18 Bn in 2022. Reductions in commodity prices are expected to see the subsidy financial burden reduced to USD 14.4 Bn this year. Unfortunately, reductions in commodity prices also hurt the revenue situation of the Malaysian government. The main non-taxation source of revenue for the government are dividends from the state oil company Petronas, in 2022 they received of USD 11.2 Bn from this source. Reduced oil prices mean a reduced Petronas payment in 2023, expected to reach only USD 9 Bn.

The Anwar government needs strong GDP growth in the second quarter of this year, it needs the subsidy regime to satisfy the majority of the electorate and it needs to pay down the national debt, to reduce the interest payment burden on the national budget. If they can achieve economic stabilisation, without losing popularity, the government is likely to remain in office. A stable economy also means that more



public spending is possible, and this could potentially see more money for defence procurement.

Defence Programmes and Possibilities

For all of the negativity surrounding defence procurement in Malaysia, there was a positive development on 24 February 2023, when Korea Aerospace Industries (KAI) announced that it had won a USD 920 M contract covering the supply of 18

FA-50 aircraft, with deliveries to begin in 2026. This acquisition will go some way to meeting the Royal Malaysian Air Force (RMAF) Light Combat Aircraft (LCA) requirement, 36 aircraft were due to be acquired in total and will eventually replace the BAE Systems Hawk in RMAF service. Aircraft evaluated for the LCA requirement included the Tejas from India and the JF-17 from Pakistan. There are also reports that the RMAF will receive a new long-range air defence radar this year.

Deliveries of three new Maritime Patrol Aircraft (MPA) for the RMAF commenced in August 2022 with the arrival of the first CN-235. This capability was acquired via the US Navy Building Partner Capacity programme. Other outstanding RMAF requirements included a multirole combat aircraft, with Rafale, Eurofighter and Gripen amongst others being considered. This is clearly an expensive programme and potentially controversial in the current environment, hence no decision is expected in the short-term. The RMAF is also looking to acquire an AEW&C capability, new helicopters and an enhanced UAV capability.

Over the years the Malaysian government has looked to develop the Malaysian economy by moving into more sophisticated areas, it believed that defence procurement could aid that economic development, via the transfer of technology and offset programmes. It also believed that the local production of defence equipment could create employment and provide for the sustainment of said equipment throughout its service life. In consequence, defence procurement shifted from in principle finding the best and most affordable solution for the Malaysian military, to political and economic development factors becoming a key part of the procurement process. As such, procurement became vastly more difficult.

A good example of this is the fate of a number of programmes for the Royal Malaysian Navy (RMN). As previously discussed, the strategic situation of Malaysia demands that it has an effective maritime capability. To meet this requirement in the 1990s the RMN started the New Generation Patrol Vessel (NGPV) programme, this was won in 1997 by Blohm + Voss with the MEKO 100 design. At that time the RMN objective was to acquire 27 NGPV, but the first order for the NGPV covered only six units, to be known as the Kedah class, four of which were to be built in Malaysia by PSC-Naval Dockyard (PSC-ND).





KD Lekir enters Pearl Harbor in June 2022 for the RIMPAC 2022 exercise. One of two Kasturi class corvettes in Royal Malaysian Navy (RMN) service, with both units commissioned in 1984, both units have also undergone a Service Life Extension Programme (SLEP). Their replacement should be the Littoral Combat Ship.

There were management and financial problems at PSC-ND that delayed the NGPV programme, as a result Boustead Heavy Industries (BHIC) were invited by the government to take control of PSC-ND and resolve the situation, which they eventually did. As a result BHIC and their subsidiary Boustead Naval Shipyard (BNS), were in the leading position as regards the provision of shipbuilding and dockyard services to the RMN. However, with the commissioning of KD Selangor, the sixth and last unit in December 2010, the NGPV programme came to an end.

The RMN then developed a transformation plan, commonly known as 15-to-5, under the plan the 15 ship classes in RMN service would be reduced to five, the five being: submarines, Littoral Combat Ship (LCS), Littoral Mission Ship (LMS), Multi-Role Support Ship (MSS) and NGPV. The RMN already had two Scorpene class submarines, now the plan was to add two more. As regards the NGPV, the plan was to acquire 12 more units potentially built to an improved Kedah class (MEKO 100) design. The MRSS is an LPD-like capability, for disaster relief and





In late February, Korea Aerospace Industries (KAI) announced that the Royal Malaysian Air Force (RMAF) would become a customer for 18 KAI FA-50 Light Combat Aircraft. Malaysia now joins Indonesia, the Philippines and Thailand as a Southeast Asian customer for this Korean aircraft.

other missions, with up to three units to be acquired. For the LMS requirement, effectively an OPV/corvette hybrid, 18 units would be required. At the top end of the performance spectrum comes the LCS, effectively a frigate-type capability, with 12 units being required.

Progress has been made on implementing this transformation plan, in 2016 a contract was signed for four LMS, two of which would be built in China and two to be built in Malaysia at BNS. Then in 2019 it was decided that all four units would be built in China and the resulting Keris class were commissioned into the RMN between January 2020 and January 2022. This was the first time Malaysia awarded a major defence programme to China. However, a second batch of three LMS planned by the RMN will likely be built to a European design. As regards the MRSS programme, the RMN hopes to progress this in 2024 after receiving a funding allocation.

The most significant and currently the most problematic RMN programme is the LCS. Here the Naval Group Gowind 2500 design was chosen as the basis for the LCS and by 2014 the programme had evolved to the point where six LCS would be built by BNS in Malaysia. These units would be known as the Maharaja Lela class, the lead ship was to have been delivered to the RMN in April 2019, with the last unit to be delivered to the RMN in June 2023.

There have been major problems at BNS. KD Maharaja Lela was launched in August 2017, and expected delivery to the RMN is now due in the third-quarter of 2024, though there are suggestions that 2025 is more likely. The programme is now due to be complete with the delivery of the final unit in 2028. On top of these delays, the programme has been reduced in scope to cover only five instead of six LCS vessels. Despite the programme being in crisis, cancellation was never considered due to the implications for the workforce at BNS. The Public Accounts Committee (PAC) of the Malaysian Parliament issued a highly critical report on the LCS programme in August 2022.

What happens next with the LCS programme depends on the Anwar government, at best they can blame previous administrations and BNS with incompetence, at worst with malfeasance. In the meantime the RMN finds itself with an incomplete force structure plan and no firm guarantee when it will receive all five LCSs. Beyond that, it is clear that the Malaysian procurement system needs reform.

Taking Control of the Situation

Tim Guest

From earthquakes, floods and wildfires on the natural side of things, to man-made, mass-casualty events, as such incidents unfold, they present first responders and emergency personnel arriving on-site with typically chaotic scenes. Implementing immediate, coordinated and well-rehearsed control procedures is needed from the start, not least of which is the establishment of an incident command post.

major incident unfolds in a European setting and whether confined within one national border or spanning several, it requires an urgent, co-ordinated and effective response from a full gamut of blue-light emergency first responders and, potentially, coordination with other security services and armed forces, depending on the type of incident. Whether a terrorist attack, a plane crash, a rare European mass shooting, or an industrial accident involving fire and chemicals, no matter what the emergency, those services responding will, as far as is possible, follow standard operating procedures, guidelines and/or latest conventions laid down in their local forces' or wider nationwide/European operational doctrines. This article takes a look at some of the strategic mechanisms of European civil protection as it relates to major incidents, as well as the general tactical, on-the-ground considerations required for the establishment of an on-site incident command post (ICP).

European Civil Protection – a Glimpse

The European Commission relatively recently in 2019 upgraded what is known as the EU Civil Protection Mechanism and created rescEU, a process to protect citizens across the union from disasters and to manage emerging risks. Fully financed by the EU, rescEU has established a new European reserve of resources, (the 'rescEU reserve'), which includes a fleet of firefighting planes and helicopters, medical evacuation planes, and a stockpile of medical items and field hospitals and mobile shelters that can respond to health emergencies. The EU is also developing a reserve to respond to chemical, biological, radiological, and nuclear incidents. If an event overwhelms the ability of member states to help each other, especially when several countries simultaneously face the same type of crisis, then the EU will provide this extra layer of protection through the rescEU reserve, thereby ensuring a faster and more comprehensive response.



A major incident unfolds in a European setting and whether confined within one national border or spanning several, it requires an urgent, co-ordinated and effective response from a full gamut of blue-light emergency first responders, the first arrivals typically establishing an ICP for command and control purposes.

On the ground, individual member states' emergency services will be responsible for the roll-out of ICPs on site, as required and as necessary, whose staff, in turn, should be aware of the availability of resources provided by the rescEU, if an incident is of such magnitude that such resources are called on. Indeed, it is up to the member state to request assistance via the EU Civil Protection Mechanism if the scale of an emergency overwhelms the possibilities of a country to respond on its own. Once activated, the EU channels offers of assistance, made available to member states, through its Emergency Response Co-ordination centre. To strengthen the EU response to forest fires in 2022, the commission financed the stand-by availability of a rescEU firefighting fleet, which involved 12 firefighting planes and one helicopter placed at the disposal of all member states in the event of emergencies and resourced from Croatia, France, Greece, Italy, Spain, and Sweden.

In the case of such fire incidents, European response capabilities and command post deployment exercises are on the itinerary of several organisations; the Finnish Emergency Services Academy, Pelasiusopisto, for example, provides vocational education for firefighters, sub-officers, fire officers and emergency response centre operators in Finland, but also takes part in Europe-wide training. It offers a wide variety of speciallytailored skills for national and international professionals in the rescue and emergency field and is responsible for ensuring the training and recruitment of Finnish experts is in line and suited to international civil protection standards so they can be deployed overseas, if required. The academy actually took part in a table-top and ICP exercise based on multi-scenarios that cover natural, technological and man-made disasters co-ordinated during the 2018/2019 timeframe and conducted in Q1 2019 by a Consortium led by the French Directorate General for Civil Protection and Crisis Management. The exercise tested the national and European response capabilities in cases of major destruction with aspects of a major crisis requiring the deployment of civil protection modules, simultaneously, on several sites. Different scenarios were played out in virtual simulation using a variety of new technologies, with the command post exercises organised at the Civil protection and Fire Emergency Services National Training Centre (ENSOSP) in Aix en Provence and co-financed by the European Commission Civil Protection Financial Instrument (785563-UCPM-2017-EX-AG).

rescEU Overall

Overall, rescEU has seen a relatively soft harmonisation and introduction for command and control and civil protection during major European incidents, including the aim to increase cross border and international interoperability, as well as compliance with other existing systems, such as UN systems and US Incident Command System (ICS). While it was meant to be integrated into the jurisdictional basis of EU civil protection, its introduction has, according to some analysts, so far only resulted in relatively small changes in terms of resources and knowledge management. With natural disasters over recent years seemingly on the rise, such as wildfires in Sweden and Greece, and flash floods in Spain and France, with newer lessons learned, further suggestions to improve European Civil Protection beyond rescEU have been posited. Among these is the proposal to move from the already satisfactory modular system of the EU Civil Protection Mechanism (EU CPM) to an integrated,



Pictured: UK Bingley Boxing Day flood 2015. If an event overwhelms the ability of member states to help each other, especially when several countries simultaneously face the same type of crisis, then the EU will provide this extra layer of protection through the rescEU reserve.

more robust European Command System, one fully interoperable with other existing mechanisms, such as the aforementioned US ICS and UNOCHA (United Nations Office for the Coordination of Humanitarian Affairs).

The ICS, for instance, comprises a standard management hierarchy and procedures for managing temporary incidents of any size using procedures that should be preestablished and sanctioned by participating authorities, with all personnel stakeholders well-trained in all aspects before an incident occurs. The system includes procedures to select and form temporary management hierarchies to control funds, personnel, facilities, equipment, and communications and is a system designed to be used from the time an incident occurs until the requirement for management and operations no longer exist. Incident command structure is organised in a flexible and modular way so as to expand and contract as needed by the incident scope, resources and hazards with Incident Command established by the first arriving unit. As far as immediate facilities are concerned, ICS uses a standard set of facility nomenclature, several pre-designated incident facilities will be considered at any incident as response operations can be very complex requiring cohesive elements holding response personnel together as they work at different and often widely separate incident facilities and locations. Of these facilities it is the ICP that is, perhaps, the most important.



To strengthen the EU response to forest fires in 2022, the commission financed the stand-by availability of a rescEU firefighting fleet, which i nvolved 12 firefighting planes and one helicopter placed at the disposal of all member states. Pictured: Wildfire at Estreito da Calheta, Portugal.

Before we take a closer look at ICP facilities, a few aspects of the EU Civil Protection Mechanism are worth a mention to convey more of the complexity of the whole civil emergency response picture. At the heart of the EU Civil Protection Mechanism is the **Emergency Response Coordination Centre** (ERCC), which co-ordinates the delivery of assistance to disaster-stricken countries, such as relief items, expertise, civil protection teams, specialised equipment and rescEU resource. The ERCC operates 24/7 and can help any country inside or outside the EU affected by a major disaster on reguest from national authorities or the UN, delivering a well-coordinated response to human-induced disasters and natural hazards at European level, thereby avoiding duplication of relief efforts. It can also liaise

directly with the national civil protection authorities of the country in need to help lessen the burden on contributing states.

The Incident Command Post

For any incident, no matter how strategically co-ordinated it might become, it must have some form of tactical Incident Command Post on the ground, often established by the 'first' first responders arriving on scene. It might be located in a vehicle, trailer, tent, or within a building, but it must be in a location outside the immediate and potential hazard zone, though close enough to the incident to maintain command. The ICP is the location where the incident commander operates during response operations and there is only one ICP per incident or event, with its name typically determined by the name of the incident locale, for instance: 'Bataclan ICP', or 'Grenfell Tower ICP'. It is key to strengthening command and co-ordination on ground during disaster-related crises and incidents with first responders. The ICP is equipped with computers and other communication facilities to provide a link between on-site and national/international/ EU decision support and command and



Inside a Mobile ICP equipped with autonomous energy meeting room; an ICP's location must be suitable for its communications resources and incorporate conference and briefing rooms.

control mechanisms. This helps to coordinate multi-agency interventions to incidents such as regional flooding, landslide, oil spill, HAZMAT, off-airport aircraft crash, and others.

An ICP serves an important purpose for first responders and/or security services to manage an emergency efficiently and safely. When a large-scale emergency incident occurs, a command post is typically established, if feasible, often by the first service arriving on site. An ICP is intended to provide a mechanism and location from which emergency responders and management can converge to effectively coordinate and discuss responses to an incident and ongoing actions required. Such ICPs become the epicentre for directing and co-ordinating all emergency response activities. A service's operational doctrine will guide the service in selecting the right location for such an ICP, with sites for a specific incident chosen based on the location of developing circumstances, safety, and ability to establish





Graphic shown is the EUCPM Activations Map 2021. Suggestions have been made to move from the already satisfactory modular system of the EU CPM to an integrated, more robust European Command System interoperable with other existing mechanisms, such as the US ICS and UNOCHA.

reliable communications networking and connecting all personnel typically using TETRA.

Some of the guidelines to be followed by emergency team management in identifying acceptable locations for an ICP include ensuring adequate space for the size of staffing as well as fluid footfall of on-theground responders, for which 24-hour accessibility is crucial. Alongside this, personal hygiene facilities are necessary for both in-situ staff and responder visitors. The ICP should also be adequately sheltered from natural elements. Importantly, the location must be suitable for the ICP's communications resources, (mobile/PMR/ TETRA/radio/internet), and incorporate conference and briefing rooms. It must also be located in a safe location vis a vis the ongoing incident, ensuring all staff are



An ICP serves an important purpose for first responders and/or security services to manage an emergency efficiently and safely. Pictured: French company Toutenkamion ICP vehicle.

safe and secure. Once located, ICP staff must ensure other relevant parties are notified of its location, including through the provision of maps/driving directions/ communications details, together with staging areas and incident base locations. That said, being prepared to move to a different location should the need arise in an unfolding incident requires the ICP team to reconnoitre and be aware of suitable alternative locations.

Inside the ICP, communications may eventually include fixed phone lines, but wireless/cellular, TETRA two-way radios, and email will be essential from the start, with additional communications equipment such as portable radios with chargers and accessories, may soon become necessary to implement emergency communication procedures in protracted scenarios. Communications with government agencies, between distinct police forces, specific municipalities, and any identified emergency contractors necessarily involved in, say, search and rescue (SAR) operations, can be conducted on portable radios. ICP emergency managers need to ensure their communication equipment includes enough phone lines for all staff, computers and internet access, recharging stations for mobile phones, and TETRA radio communications equipment with established frequencies. Furthermore, callsigns, timed/regular radio checks, and an emergency communications schedule are essential to ensure all operatives are safe and accounted for.

The First Exercise

The first European civil protection exercise to explicitly test the 'Solidarity Clause' in the Lisbon Treaty was a European disaster-response simulation exercise in Carcassonne, France, around 10 years ago. This took the form of an Incident Command Post exercise to test the capability of command posts from different countries to cooperate during a major earthquake. While no operational teams were deployed, the command posts worked under realistic conditions of the kind personnel would encounter in the field. The exercise was organised by France and involved civil protection teams from Belgium, the Czech Republic, Germany, Hungary, Italy, Luxembourg, Poland and Spain. A European civil protection team reinforced by a liaison officer from the European Commission's Monitoring and Information Centre in Brussels co-ordinated the international teams, with the exercise 75% co-financed by the EC under its Civil Protection Financial Instrument.

INFORMATION SUPERIORITY -PRINT AND ONLINE

You know our print media.

Do you know our **websites**, too?

Reach out and use the Mittler Report websites for your marketing communication.



www.esut.de Europäische Sicherheit & Technik



www.marineforum.online MarineForum



www.soldat-und-technik.de Soldat & Technik



www.euro-sd.com European Security & Defence



www.hardthoehenkurier.de Hardthöhenkurier

More information:



www.mittler-report.de/ en/media-kit

Current page impressions will be provided at short notice upon request.

MITTLER REPORT VERLAG GMBH

Beethovenallee 21 · 53173 Bonn, Germany · Phone +49 (0)0228 / 3500870 info@mittler-report.de · **www.mittler-report.de**

MITTLER REPORT

EUROPE AND THE SEA A CONTINUING STORY

Anthony Dymock | Lutz Feldt | Patrick Hebrard Fernando del Pozo | Ferdinando Sanfelice di Monteforte

EUROPE AND THE SEA – A CONTINUING STORY



Scan me & order now!



Mittler mittler-books.de

May 2023

W MARITIME Defence Monitor

From the Sea and Beyond

Combined ESD/ MDM Special Issue

- Naval Artificial Intelligence
- Uncrewed Anti-Submarine Warfare
- Seabed Warfare
- European Naval Shipyard Review
- Italy's U212 Future Submarine Programme
- Coast Guard Operational Challenges and Responses



Contents

MARITIME INDUSTRY

- 93 European Naval Shipbuilding and Market Outlook Bob Nugent
- 100 Offshore Patrol Vessels and Shipbuilders in Europe Luca Peruzzi
- 106 The MILGEM Programme: Turkish Naval Procurement and Exports Bob Nugent
- 110 British Fleet Solid Support Ship Contract Award Interview with John Wood, Group Chief Executive Officer, Harland & Wolff

SHIP DESIGN & TECHNOLOGIES

- 113 Maintaining Deterrence and Defence: Italy's Improving Submarine Capability Strengthens NATO's Southern Flank Lee Willett
- 117 Decision-making at Machine Speed: Bringing Al into the Command Chain Richard Scott
- 122 Utilising Uncrewed Platforms for Persistent, Cost-Effective ASW in the North Atlantic Willem Hendrik Wehner, Jens Ballé and Klemens Ehret
- 126 Underwater remotely operated Vehicles in Europe: an expanding Market Luca Peruzzi

MARITIME POLICY, STRATEGY & FORCES

- 130 AUKUS Sets Sail in the Indo-Pacific Peter Layton
- 134 **The Pakistan Navy: Operating in a Resource-constrained Environment.** Interview with Admiral Muhammad Amjad Khan Niazi, Chief of Naval Staff, Pakistan Navy
- 137 Coast Guard Operations: Emerging Challenges and Responses Scott Savitz

MARITIME OPERATIONS & DOCTRINE

- 142 A Combined Approach: NATO Navies Develop Seabed Warfare Operations and Capabilities Lee Willett
- 148 Amphibious Assault Vehicles and Beach Defence Christopher F Foss
- COLUMNS
- 86 Masthead
- 87 Word from the Editor
- 88 Periscope

Masthead

Maritime Defence Monitor

MDM · Special Issue, May 2023 ISSN 1617-7983



Published by

MITTLER REPORT Mittler Report Verlag GmbH A company of the TAMM Media Group

Editors-in-Chief: Capt. (ret) Hans Uwe Mergener (hum), Conrad Waters (cw)

Publisher: Peter Tamm (pt)

Regional Correspondents

Black Sea-Central Asia: Korhan Özkilinc, France: David Saw, India: Suman Sharma, Israel: Tamir Eshel, Italy: Luca Peruzzi, NATO: Joris Verbeurgt, Nordic-Scandic: J. Bo Leimand, The Netherlands: Jaime Karremann, Spain: Esteban Villarejo, USA: Sidney Dean

Layout:

AnKo MedienDesign GmbH, Meckenheim, Germany

Production: Lehmann Offsetdruck und Verlag GmbH, Norderstedt, Germany

Office Address:

Mittler Report Verlag GmbH Beethovenallee 21, 53173 Bonn, Germany Phone.: +49 228 35 00 870, Fax: +49 228 35 00 871 info@mittler-report.de, www.mittler-report.de

Managing Director: Peter Tamm

Advertising, Marketing and Business Development

Achim Abele Phone: +49 228 25900 347 achim.abele@mittler-report.de

Stephen Barnard Phone: +49 228 35 00 886, Mobile: +44 7984 033154 stephen.barnard@mittler-report.de

Stephen Elliott Phone: +49 228 35 00 872, Mobile: +49 1590 173 0346 stephen.elliott@mittler-report.de

Exhibition Management and Advertising Administration: Renate Herrmanns Advertising Accounting: Florian Bahr

The views expressed are not necessarily those of the editors or publisher. All rights reserved. No part of this publication may be reproduced without prior written permission of the publisher in Bonn.

Cover Photo: The USS Seawolf (SSN 21) fast attack submarine transits the Pacific Ocean, 22 June 2021. Photo: US Navy/Petty Officer 3rd Class Olympia Martin

Word from the Editor

Photo: author



When we talk about the maritime sector these days, the discussion often revolves around global warming and its impact on the oceans. The contribution of shipping to reducing greenhouse gases is a popular topic. However, a new subject is starting to come into focus. Seabed warfare encompasses not only maritime warfare under water, but also the protection of maritime infrastructure. Competition for raw materials on the floor of the oceans is a closely related theme. Just recently, it has become known, that United Nations-affiliated International Seabed Authority will start accepting applications for deep sea mining.

The maritime domain encompasses more than rising seas, the extraction of raw materials and the flow of goods and data. Seas not only divide, but they also connect. Globalisation would not have been possible without international cooperation across oceans. Cooperation between Navies manifests understanding between nations. As such, it can become an expression of like-mindedness and even partnership.

The cruise of the RFS Admiral Gorshkov, a Russian Navy frigate, which has received little public attention, is a good example of this truth. Remarkable results have occurred on her voyage. She met Chinese, Iranian and South African naval units in the course of two separate trilateral manoeuvres. In addition, port calls in Djibouti and Jeddah make us take notice.

Together with her accompanying tanker RFS Kama, the hypersonic Zircon missile-equipped frigate took part in the exercise 'Mosi II' in South African waters. This was followed by 'Maritime Safety Belt 23', another naval get-together at the Iranian coast. Besides the respective host navies, (different) Chinese units were involved in both exercises.

Don't these exercises highlight strategic change? It takes place insidiously and often unnoticed. In the case of Africa, regional observers have noted an increase in the Russian and Chinese naval presence in the Indian Ocean. Russian naval forces have conducted exercises with Chinese and Iranian units in the northern Indian Ocean. Now, they have operated together with China off South Africa. The expected Russian military base in Bur Sudan on the Red Sea will increase Moscow's strategic reach and presence in Africa, beyond into the Middle East. The same applies to the Chinese presence in Djibouti.

Moscow and Beijing are using the deployment of naval units as a means of strategic communication. For the Kremlin, the excursion of RFS Admiral Gorshkov, declared as a longrange test, is not only a show of arms and a demonstration of strength. It is ostensible proof that Russia is capable of maintaining its international military relations despite the strain on its armed forces and its economy posed by the war in Ukraine. Meanwhile, Beijing follows its own agenda, sets its own rules, and demonstrates that it is not very choosy about its partners.

'Mosi II' – like 'Maritime Security Belt 23' – can be understood as a signal that the muchdesired isolation of Moscow following the illegal invasion of Ukraine is not bearing the expected fruit in the Global South. This tension was openly revealed at the latest G20 foreign ministers' meeting in India. Moreover, China is not universally perceived as a systemic and economic rival.

Even if Russia violates international law, the 'collective West' in is confronted with a stark truth: the Global South sees the West's actions more critically. The rules-based system is questioned because, from a Third World perspective, it is not consistently applied. The examples of Afghanistan, Iraq and Syria, not to mention European migration policy, are all examples of a perceived lack of coherence. The future success of the West's diplomacy will therefore be measured by a more dependable application of the rules-based value system. Additionally, particularly in Africa, there is an expectation that there should be a shift from a donor mind-set to a true partnership where shared interests are identified and cued into a strategic agenda.

In short, the voyage of the RFS Admiral Gorshkov can be viewed beyond its operational or even maritime insights, teaching us a more far-reaching lesson. We look forward to continuing the exploration of this theme in future editions.

Yours Aye Uwe

EUROPE

FRANCE & THE UNITED KINGDOM: SUBMARINE PROGRAMME PROGRESS

Recent months have seen further progress with the nuclear-powered attack submarine (SSN) programmes of Europe's two leading maritime powers. On 19 February 2023, HMS *Anson*, the fifth *Astute* class SSN departed her building yard at Barrow-in-Furness to sail for her homeport at the Royal Navy's submarine base at Faslane on the River Clyde to commence an extensive period of sea trials. The submarine has a submerged displacement of 7,800 tonnes and is 97 metres in length. She will be armed with a total of up to 38 Spearfish heavyweight torpedoes and Tomahawk Block V land attack cruise missiles. Launched at Barrow on 20 April 2021, HMS *Anson* had previously been commissioned on 21 August 2022 (see MDM October 2022). The two remaining submarines in the class are expected to be in service by 2026.

Subsequently, at the end of March 2023, France's Naval Group commenced initial sea trials of FS Duguay-Trouin, the second boat in the French Navy's Suffren or 'Barracuda' class (France's delivery programme follows a different sequence than that adopted in the United Kingdom and the submarine will only be formally commissioned after trials have been completed). Displacing 5,300 tonnes submerged, the design is smaller than its British counterpart – although larger than the previous Rubis class - and, accordingly, has a somewhat smaller weapons' load-out of up to 24 F21 heavy torpedoes, Exocet antisurface and/or MdCN cruise missiles. FS Duguay-Trouin is expected to be delivered before the end of 2023 and current plans envisage all boats in the six-strong class being operational by the end of 2030.

MDM Editorial Commentary: The im-



HMS Anson pictured departing her builders' yard on 19 February 2023.

minent operational debut of these two new submarines is timely given the return to Cold War conditions with Russia and the priority that the Russian Navy has given to modernising its own underwater forces. Nevertheless, both the British and French submarine arms remain under pressure given the impact of previous financial and technical constraints in delaying the previous generation of Cold War era boats. For example, the simultaneous decommissioning of the British *Trafalgar* class submarines HMS *Trenchant* and HMS *Talent* on 22 May 2022 temporarily reduced the Royal Navy's SSN flotilla to just five boats. This is two less than the targeted force level of seven submarines. This deficit will not be entirely remedied until the final *Astute* enters service.

In the longer term, the changed political environment has resulted in an inevitable debate as to whether underwater forces will need to be expanded to meet a higher threat level than was previously envisaged. Speculation at the time of the AUKUS-related announcement of Australia's entry into what was formerly the SSN(R) – replacement nuclear-powered attack submarine – programme in March 2023 suggested the Royal Navy is looking to a significant expansion of its submarine arm in the longer term. In addition to the matter of whether this ambition is financially achievable, the appropriate balance of manned and unmanned assets in the future underwater force structure will be another important question given the ever-increasing potential of unmanned and autonomous underwater vehicles. A number of articles in this edition build further on these themes.

FRANCE: FIRST POM ARRIVES IN NEW CALEDONIA

The renewal of France's overseas patrol forces took a major step forward at the start of April 2023 with the arrival of FS *Auguste Bénébig*, the first of six new 'patrouilleurs outre-mer' (POMs) at her assigned homeport of Nouméa in New Caledonia. Being built by French company Socarenam under a contract signed in December 2019, the POMs have been specifically designed for service in France's overseas territories, with the intention being to assign a pair of the class to each of New Caledonia, La Réunion and French Polynesia. The programme forms part of a wider French renewal of its maritime constabulary assets that will also ultimately extend to the acquisition of ten oceanic patrol vessels and six corvettes; the latter as part of the wider European Patrol Corvette initiative.

The POMs displace 1,300 tonnes at full load and are 80 metres in length. An interesting design feature is the provision of a flight deck and hangar for drone operation as compared with the more traditional helicopter. The ships are otherwise lightly armed with a Nexter 'Narwhal' 20mm remotely operated weapons station, reflecting their primary presence and surveillance role.



The lead POM FS Auguste Bénébig at Brest prior to making the lengthy voyage to her assigned homeport of Nouméa in New Caledonia.

GERMANY: TYPE 127 FRIGATE

The German Navy's Zielbild Marine ab 2035 (see below) envisages the procurement of six Type 127 frigates. Optimised for anti-air warfare, they will form the core of combat groups operating on NATO's northern flank and on global deployment, serving alongside the ASW-focused Type 126 frigates. Although previously kept on the back burner, the advent of 'Zeitenwende' has given the project momentum. One option seems to be focused on a 'military off-the shelf' solution to achieve rapid realisation. For example, the US Navy's Constellation (FFG-62) class design, itself a derivative of the Franco-Italian FREMM, would be a potential contender based on its use of Aegis technology.



GERMANY: FUTURE FORCE STRUCTURE

At the end of March 2023, the Bundeswehr (German Armed Forces) revealed a vision of the future German Navy for the period for 2035 and beyond (*Zielbild Marine ab 2035*). The German Navy's envisaged 2025+ fleet structure provides for a force of 15 frigates, six to nine corvettes, six to nine submarines, 12 mine countermeasures vessels and supporting auxiliaries. In addition, the fleet will include an undetermined number of mine warfare unmanned surface vessels (USVs), six large unmanned underwater vehicles and up to 18 unmanned future surface combat systems. The vision makes it evident that expanded use of unmanned systems, alongside greater reliance on artificial intelligence, is critical to the navy's future plans.

The same trend is clear with respect to naval aviation. There will be eight manned P-8A Poseidon or future 'Maritime Airborne Warfare System (MAWS) maritime patrol aircraft supplemented by an undetermined number of NH-90 Sea Tiger helicopters. Additionally, a total of 28 unmanned flying systems will be stationed at Nordholz, the naval air arm station. These will encompass six unmanned aerial systems to supplement the MPAs and as many as 22 smaller ship-based unmanned aerial vehicles to support the Sea Tigers.

Vessel Type	Mission	Previous Plan 2031	New Vision 2035+
T127 Frigate	Surface warfare/air defence	5	6
T126 Frigate	Anti-submarine warfare	6	6
T125 Frigate	Stabilisation operations	4	3
K130 Corvette	Surface warfare	10	6-9
Future Combat Surface System	Surface warfare (Unmanned)	-	Up to 18
MCMV	Mine warfare	11	Up to 12
MCMV Toolbox Systems	Mine warfare (Unmanned)	-	To be determined
T212CD Submarine	Surface/sub-surface warfare	8	6-9
Unmanned Submarine	Intelligence gathering	-	Up to 6
T424 Auxiliiary	Intelligence gathering	3	3
T702 Auxiliary	Fleet replenishment vessel	3	3
T707 Auxiliary	Fleet tanker	2	3
T404 Auxiliary Successor	Supply/support vessel	6	6

MDM Editorial Commentary: The 2035+ naval vision holds out the prospect of a real turning point (Zeitenwende) for the German Navy. This is not only due to the increased number of large surface and sub-surface units, the larger, unmanned systems included, but also because the threat has again become the yardstick against which to determine force structure. This opens up the prospect of the navy becoming more capable of handling the demands of multi-domain operations.

A noteworthy feature of the proposed structure is a consistent application of the 1:3 ratio; both for manned and unmanned platforms. In effect, for every one deployable unit, there is a total requirement of three to support such factors as training and maintenance. Technological progress manifests itself in the use of autonomous vehicles in conjunction with modular manned vessels; drones will be used as sensors and weapon-carriers across all domains in conjunction with their 'manned twins'. Arguably, the trend towards bigger and more expensive manned units is being balanced by use of the potentially cheaper unmanned swarm to create the necessary mass.

Periscope

Since the beginning of March 2023, a draft design produced by thyssenkrupp Marine Systems (tkMS) has also been a potential programme contender. This is based on a MEKO A400 AMD (air and missile defence) concept. In response to MDM's enguiries, we have been informed that the design is approximately 160 metres long and has a displacement in the region of 10.000 tonnes. It is designed for a crew of 150 personnel and will be able to reach a speed of 32 knots. The illustration provided exclusively to MDM reveals a twoisland design similar to that introduced with the Type 125. Armament includes a 127mm mounting, two separately-located VLS complexes (one forward and one aft) with a total of 48 cells and Rolling Airframe Missile (RAM) launchers. In addition to surface-to-air missiles, various concepts for engaging sea and land targets over various distances are being examined, including the use of high-energy weapons. It would seem that unmanned vehicles and containerised systems will also be incorporated in a modular configuration, including a containerised towed array to supplement the ship's hull-mounted sonar.

MALTA: DELIVERY OF OFFSHORE PATROL VESSEL P71

On 22 March 2023, the new offshore patrol vessel P71 was officially delivered to the Armed Forces of Malta by Italy's Cantiere Navale Vittoria. The new vessel, reportedly costing in the region of EUR 50 M, was ordered in January 2019 and arrived in Maltese waters towards the end of 2022. Acquisition of the vessel was supported by the European Union's Internal Security Fund, contributing 75% to the acquisition cost. This assistance is partly a reflection of Malta's 'frontline' position in the ongoing Mediterranean migrant crisis and a consequent need to bolster its maritime surveillance and search and rescue capacity.

P71 has been built to Italy's Cantiere Navale Vittoria's OPV748 design. Displacing some 2.250 tonnes at full load, she is 74.8 metres in overall length, 13.0 metres in overall beam and has a maximum draft of 4.8 metres. Key design features include a 360° panoramic bridge and a hybrid diesel/diesel-electric propulsion system that can achieve a maximum speed in excess of 21 knots. The ship is equipped with two rigid-hulled inflatable boats (RHIBs) and can land and refuel a medium weight helicopter. A 25mm-armed remotely-controlled weapons station is supplemented by lighter calibre machine guns. The larg-



The Armed Forces of Malta have taken official delivery of the new offshore patrol vessel P71.

est vessel to serve with the Maltese Armed Forces, *P71* will replace the elderly *P61*; a former Irish Naval Service vessel that was acquired as a temporary stopgap until a more modern capability could be acquired.

NORWAY: NAVAL STRIKE MISSILE SECURES (NSM) FURTHER ORDERS

Recent months have seen Norway's Kongsberg secure several new contracts for its Naval Strike Missile (NSM). In November 2022, the UK Ministry of Defence ended years of prevarication over its future surface-to-surface missile capability with an announcement that a total of 11 Royal Navy Type 45 destroyers and Type 23 frigates would be fitted with the Norwegian missile, replacing vintage 'Harpoon' systems that are due to be retired in 2023. The NSM will effectively bridge the gap between Harpoon's withdrawal and the advent of a new generation of Anglo-French missiles around the end of the decade that are being developed under the Future Cruise/Anti-Ship Weapon programme. Meanwhile, the Type 23 frigate HMS Somerset became the first Royal Navy vessel to begin adaptation to operate the NSM as part of a package of works being carried out at the Devonport naval dockyard.

Two additional contract announcements guickly followed. On 12 December 2022, Kongsberg reported that the Netherlands Ministry of Defence had entered an agreement to acquire the NSM for their four De Zeven Provinciën class frigates. As was the case for the British order, the value of the award was not declared. Subsequently, however, Kongsberg announced early in January 2023 that it had secured a "substantial order" worth in excess of NOK 5 Bn (USD 0.5 Bn) from the Commonwealth of Australia for the NSM, confirming a selection decision announced during 2022. The NSM will equip the Royal Australian Navy's Hobart and Anzac class combatants, entering service from 2024.

With both Spain and Latvia also both recently announcing their intention to acquire the NSM, the Norwegian missile has arguably become the anti-ship missile of choice for 'Western' navies and coastal defence arms.



Kongsberg's Naval Strike Missile has gained further export success. Here the weapon is seen being fired from USS Gabrielle Giffords (LCS-10)

THE AMERICAS

UNITED STATES OF AMERICA: INGALLS SHIPBUILDING COMPLETES FINAL FLIGHT IIA ARLEIGH BURKE CLASS DESTROYER

On 3 April 2023, the new US Navy destroyer PCU (pre-commissioning unit) *Lenah Sutcliffe Higbee* (DDG-123) departed Huntington Ingalls Industries' Ingalls Shipbuilding facility at Pascagoula Mississippi prior to a commissioning ceremony scheduled for 13 May. The warship is the 34th *Arleigh Burke* (DDG-51) class destroyer built by Ingalls and, notably, the final Flight IIA variant of the class to be completed at the yard. Although General Dynamics Bath Iron Works – which shares construction of the *Burke* class with Ingalls – is still finishing a handful of its own Flight IIA variants, construction is now increasingly focused on the new Flight III design. These incorporate Raytheon's new, modular AN/SPY-6(v)1 radar, formerly known as the Air and Missile Defence Radar (AMDR), alongside associated power generation upgrades. PCU *Jack H. Lucas* (DDG-125), the lead ship of the new variant, completed initial sea trials from Ingalls at the end of 2022.

MDM Editorial Commentary: The future USS *Lenah Sutcliffe Higbee* will be the 71st *Burke* class destroyer to be commissioned into the US Navy, her entry into service taking place nearly 33 years after the arrival of the lead ship of the class. With a total of 93 ships



HHI's Ingalls Shipbuilding division has delivered USS Lenah Sutcliffe Higbee (DDG-123), the final Flight IIA Arleigh Burke class destroyer to be constructed at the yard.

currently authorised and future planning envisaging continued orders until around the end of the decade, the total class looks set to exceed 100 vessels. This confirms the *Burke* class's place as one of the longest-running construction programmes in US Navy history, as well as the navy's numerically largest class of major surface combatant since the end of the Second World War.

Whilst this record speaks well of the original DDG-51 design, it also highlights the failure of the US Navy to develop an effective replacement to the veteran class in the post-Cold War era. The *Zumwalt* (DDG-1000) class destroyer that was intended to follow the *Burke* class into series production has proved to be an expensive dead-end. This leaves future hopes for the navy's large surface combatants pinned on the successful development of the proposed DDG(X) replacement design, which is unlikely to enter production until the turn of the decade at the earliest. In the meantime, the likely commencement of the FREMM-based *Constellation* (FFG-62) class frigate deliveries around the middle of the decade may well provide further evidence of the benefits of a more iterative approach to warship design.

ASIA-PACIFIC

JAPAN & SOUTH KOREA: PROGRESS WITH NEW FRIGATE CONSTRUCTION

In contrast to the experience of the US Navy, the fleets of Japan and the Republic of Korea are managing to make considerable progress with bringing new surface combatant designs into service. On 7 March 2023, the Japan Maritime Self Defence Force (JMSDF) commissioned JDS *Mikuma* (FFM-4), fourth of a planned 12 ships of the *Mogami* (FFM-1) class of modular, multi-role frigates. Displacing around 5,500 tonnes at full load, they are smaller than recent JMSDF escort designs. Importantly for a fleet struggling with manpower issues, they can be operated with a crew of as few as 90 personnel, utilising innovations such as a panoramic 360 degree screen incorporating augmented reality know-how in their combat management centres. They form an important part in JMSDF plans to increase overall numbers of surface combatants to match Chinese naval expansion.



JDS Mikuma (FFM-4) pictured at the time of her delivery on 7 March 2023.

Neighbouring South Korea is also bringing considerable numbers of smaller surface combatants into service through progressive completion of its FFX series of frigates. The design has been built in three iterations. Six ships of the Batch 1, *Incheon* (FFG-818) class, were commissioned between 2013 and 2016 and have been followed by the eight units of the Batch 2, *Daegu* (FFG-818) class design. Five of these are now operational following commissioning of ROKS *Daejeon* (FFG-823) on 27 February 2023 and all of the remaining trio have been launched. Accordingly, attention is now turning to the six planned Batch 3 vessels. The prototype, ROKS *Chungnam* (FFF-828) was launched at Hyundai Heavy Industries' Ulsan shipyard on 10 April 2023. Displacing around 4,300 tonnes at full load, the new vessel continues a process of iterative improvement seen between the previous batches. Most notably, the new ship incorporates a new integrated mast structure with a four-sided, active phased array radar. She is expected to enter service before the end of 2023.

MDM Editorial Commentary: The continued delivery of sophisticated surface combatants to the leading Asia-Pacific fleets is an indication of the ongoing shift in the balance of naval power, as well as naval construction skills, to countries in the region. The advent of the *Mogami* class provides the JMSDF with a real opportunity to use technological progress to combat the erosion of its comparative qualitative and quantitative position compared with China's People's Liberation Army Navy (PLAN), reinforcing broader American initiatives to counter Chinese naval expansion. Meanwhile, South Korea's realisation of the FFX programme should provide it with an operational fleet of 20 powerful frigates, optimised for littoral warfare but capable of extended deployment, by the end of the decade.

AUSTRALIA: ACQUISITION OF DEDI-CATED UNDERSEA SUPPORT VESSEL

In early April 2023, Australia became the latest of a growing number of nations obtaining dedicated assets to support undersea surveillance operations. Australia has acquired this capacity through a commercial off the shelf approach involving the purchase of MV Normand Jarl, a Norwegian flagged offshore support ship that was first completed in 2013. To be renamed ADV Guidance, the 7,400 tonne vessel will be primarily used to support undersea surveillance systems trials, including the ability to deploy undersea crewed and uncrewed vehicles, including robotic and autonomous systems. Acquired at a cost of AUD 110 M (USD 67 M), the new ship will enter Australian service before the end of 2023 after completion of inspection and certification in Singapore. This edition's article by Lee Willett on Seabed Warfare provides further background on growing international interest in this domain.

AFRICA & THE MIDDLE EAST

QATAR: CONSTRUCTION OF THE AMPHIBIOUS TRANSPORT DOCK QENS AL FULK MOVES AHEAD

The last piece in the jigsaw of Qatar's ambitious naval expansion programme is falling into place as construction of its new amphibious transport dock moves ahead. A formal launch ceremony for the vessel, which has been named QENS Al Fulk, took place at Fincantieri's Palermo shipyard on 24 January 2023. The ship was subsequently transferred to the company's Muggiano facility near La Spezia early in April to complete final outfitting. Displacing around 9,000 tonnes at full load, QENS Al Fulk is based on Algeria's Kalaat Béni Abbès, which was delivered by the Italian company in 2014. In addition to being equipped with a helicopter flight deck and dock well to support amphibious operations, the design is unusual in being fitted with an area air defence system built around the MBDA 'Aster 30' surface-to-air-missile and Leonardo' Kronos' active phased array radar.





Fincantieri is making good progress with building Qatar's amphibious transport dock QENS AI Fulk.

QENS AI Fulk is part of a seven ship order initially agreed between Qatar and Fincantieri in 2016, which also comprises four frigate-like air defence 'corvettes' and two fast attack craft type 'offshore patrol vessels'. Five of these units have been delivered to date, with handover of the final corvette, QENS *Sumaysimah*, believed to be imminent.

OPERATIONAL ANALYSIS

RFS ADMIRAL GORSHKOV DEPLOYMENT

On the afternoon of 13 April 2023, the Russian frigate RFS *Admiral Gorshkov* left the Suez Canal and headed northwards accompanied by her support vessel, the tanker RFS *Kama*. Both units were detached from the Russian Northern fleet on 4 January 2023 for a long-distance voyage. This has given rise to a few surprises. From 17 to 26 February, the two Russian units took part in the trilateral exercise 'Mosi 2'. At South African invitation, the host navy and three units of the Chinese Navy (PLAN) practised with the Russian globetrotters off the east coast of South Africa. Also noteworthy was their participation in 'Maritime Security Belt', a naval exercise encompassing the Russian Federation, China and Iran that was held in mid-March off the Iranian port Chahbahar. After a stop in Djibouti, the small Russian task force then headed for the Saudi city of Jeddah. It was the first port visit of Russian units to Saudi Arabia in ten years.

Tartus, potentially the next port of call, provides supply and maintenance facilities for the Russian Fleet and has considerable strategic value for Moscow. It is a base for Russian vessels operating in the Mediterranean and includes a pier, fuel tanks, a floating dock and barrack facilities. Prior to Russia's invasion of Ukraine, as many as 16 Russian units were cruising off the Syrian coast. Currently seven Russian warships remain deployed to the Mediterranean, including the submarine RFS *Krasnodar*, a member of the improved Project 636.3 'Kilo' class.

The presence of RFS Admiral Gorshkov influences the strategic balance in the Mediterranean. Of itself, the 135 m long, 5,400 tonne displacement frigate is no peculiarity, were it not for its unique armament. In addition to the 'Kalibr' cruise missile – a common outfit aboard Russian vessels – Gorshkov also has the newer 'Zirkon' missile onboard. Zirkon (Russian designation: 3M22 Tsirkon (Циркон), NATO designation: SS-N-33) is reported to reach nine times the speed of sound (Mach 9). The payload is 300 kg and the warhead can be conventional or nuclear. According to official Moscow announcements, the missile hit a sea target at a distance of 1,000 km during tests.

Russia has reached an important milestone with the development and readiness of the Zirkon. Hypersonic programmes in the West lag Russian and Chinese developments. Despite some setbacks, even admitted by the Russian authorities, Zirkon's operational readiness seems to have been achieved. This contrasts with the West's weakness in developing adequate countermeasures and countering hypersonic missiles.

Game Changer

Russian Ministry of Defence mil.ru

photo:

Even with some scepticism about the operational capability of the overall system, the presence of RFS *Admiral Gorshkov* in the Mediterranean poses at least an indirect strategic challenge to the pro-Ukrainian Western community. In the event of a launch from international waters, European decision-making centres could be reached within a short time. Zircon travels about three kilometres per second at Mach 9. This means that 1,000 km can be covered in five and a half minutes. Moscow remains unpredictable. The course of the war also shows that the Kremlin does not shy away from nefariousness. This means that an active intervention of RFS *Admiral Gorshkov* cannot be dismissed out of hand.

The fact is that if *Gorshkov* were to be positioned in the eastern Mediterranean, Kiev could still be reached with Kalibr, and the regions on the Ukrainian Black Sea coast with the Zirkon. The missiles would have to fly over one or more NATO countries, most certainly Turkey. Is this an influence on the decision-makers in the Kremlin? Maybe it is, perhaps driven by the consideration that one of the latest Russian weapons (or parts thereof) could fall into the hands of Western intelligence services. The Russian frigate – and her advanced weapon systems – reshuffles the cards in the Mediterranean. This is at the same time as the US carrier group centred on the USS *George H.W. Bush* passed Gibraltar homeward on 12 April. The aircraft carrier spent a total of 230 days in the Mediterranean. With its withdrawal, there will be no American aircraft carrier in the region for the first time since December 2021.

An image of RFS Admiral Gorshkov dating from 2018. The frigate is currently operating in the Mediterranean as No. 454.

European Naval Shipbuilding and Market Outlook

Bob Nugent

The dramatic changes in Europe's security environment due to the war in Ukraine continue to reshape all aspects of military planning and expenditure in the region. While much attention has been focused on the impact of the Ukraine conflict in the ground and air domains, it has also affected naval programmes and infrastructure in Europe. This article explores regional naval shipyard and construction trends and developments across three regions in Europe. It concludes with a brief consideration of longer term trends and implications for naval industry in Europe as the continent's security situation continues to change. We draw our data from AMI International's proprietary content used in their naval market forecasting products.

Our regional review of current and forecast ship construction programmes starts in the Baltic region (Poland, Finland, Sweden and Denmark). It specifically identifies local shipyards engaged in or capable of naval construction in those countries. Next, we review similar information for Western Europe (Germany, France and the United Kingdom), followed by Mediterranean Europe (Spain, Italy Greece and Turkey). We also include some general observations on prospects for European naval shipbuilding in the coming decade.

Overview

AMI's 20 year forecasts (Table 1A and Table 1B) below presents a 'pre-war' snapshot of European naval shipbuilding. Taken together, these two European regions contribute about 30% of global forecasted new ship acquisitions worldwide over the next two decades, as measured by acquisition value. These regional forecasts have remained steady over the past decade, despite the deterioration of the security envi-

Author

Bob Nugent is a member of the Strategy, Management and Operations faculty at the Busch School of Business at The Catholic University of America, and is a doctoral candidate in management at Virginia Tech. A retired US Navy officer, he consults on strategy, competition and management issues with aerospace and defence companies.



The lead Royal Navy Type 26 frigate HMS Glasgow transits the Clyde prior to being floated out. The UK has the highest projected naval expenditure amongst European countries over the next two decades but much of this is allocated to new submarine construction.

ronment in Europe, accelerated by Russia's 2014 annexation of the Crimea and, now, other parts of Ukraine.

Table 2 below shows the five countries in Europe with the highest total forecasted

new construction naval spending, representing just over 50% of the entire forecast for NATO (excluding the United States) Non-European NATO member Canada, driven by its new frigate programme, ac-

Table 1A: NATO (less United States)						
Total No.In ProgressPlannedTotal ValueTotal Buildof Projects(2022-41)						
153	66	72	USD 287,562.12 M	798		

Table 1B: Non-NATO Europe (led by Sweden and Finland)						
Total No. of ProjectsIn ProgressPlannedTotal ValueTotal Build (2022-41)						
22	11	7	USD 10,429.00 M	104		

counts for another 25% of total NATO forecasted expenditures, all measured in USD M.

The war in Ukraine has permanently altered the continent's security landscape

Table 2:Five European Countries withHighest Total Forecast NavalExpenditure 2022-2042

Country	Expenditure			
United Kingdom	USD 61,396 M			
France	USD 29,080 M			
Germany	USD 24,296 M			
Italy	USD 23,676 M			
Turkey	USD 19,764 M			
Total	USD 158,212 M			

- notably with the prospective accession of Sweden and Finland into NATO - and prompted many country-level re-evaluations of planned defence spending. However, prospects for marked increases in European naval shipbuilding currently remain aspirational. Any substantive increase in new ship acquisitions from Europe's naval builders would have long lead times and programme durations. Accordingly, any uplift in new ship acquisitions driven by the Russo-Ukraine war are not expected to result in changes to existing forecasts for at least another one to two years. Moreover, any such increases will be complicated by the inflationary and recessionary forces at work on the region's economies, further clouding the prospects for higher naval acquisition budgets.



The Polish Navy's 'Miecznik' class frigates will be built by a consortium that includes PGZ Naval Shipyard & Remontowa Shipbuilding to Babcock International's 'Arrowhead 140' design.

Hence our review of the impact of the Ukraine conflict on naval shipbuilding to date shows more in the way of continuity with historical patterns than change. Underinvestment in naval capability continues: a factor consistent with overall declines in naval ship purchases - and increasing costs of ships and systems - that have marked the post-Cold War period. European shipbuilding programmes continue to suffer delays and postponements, due in part to continued constraints on European defence spending, as well as the competing pressures to prioritise the air, missile and ground capabilities that have been more visible in the Ukraine conflict. On the plus side of the naval shipbuilding ledger, selective progress on programmes such as the Netherland's future submarine acquisition and increased naval spending by Eastern

noto: Saab A



The Blekinge (A26) class submarine project is one of seven new Swedish construction ship and submarine programmes listed by AMI.

European countries (corvettes for Ukraine and Romania, frigates for Poland) offer some encouragement for future business growth among Europe's naval shipyards. We note other recent signals of future shifts away from current patterns of (low) naval budgeting and building in Europe. These include:

- Denmark committing to revised defence policy and shipbuilding infrastructure plans, with new investments (a total of over USD 5 Bn has been mentioned) for shipbuilding and new ships.German company TKMS acquiring new facilities to improve capacity.
- Finland reportedly raising its 2023 defence budget by 20%, potentially supporting the realisation of agreed naval programmes.
- **Italy** continuing a major fleet renewal that will benefit Fincantieri's Italian yards.
- Turkey building MILGEM corvettes for export to Pakistan and the United Kingdom, as well as promoting other naval vessels and equipment for overseas sale. Domestically, the new amphibious assault ship TCG Anadolu was commissioned into Turkish service in April 2023.
- The United Kingdom gaining renewed naval export momentum, as evidenced by Babcock's sale of the Arrowhead 140 design to Indonesia and its selection for the Polish frigate programme. This follows on from BAE Systems' success with the Global Combat Ship in Australia and Canada.
- Continued European collaboration on new naval programmes, including the engagement of Fincantieri, Naval Group and Navantia in the European Patrol Corvette (EPC) and the cooperation between Germany and Norway in procuring new submarines.

Marine Systems

Tomorrow's standards today. For your navy.

Experience counts.

thyssenkrupp Marine Systems is one of the world's leading naval system providers.

Our submarines, naval surface vessels and maritime defence equipment is known for superior technological excellence, reliability and longevity. Based on over 100 years for submarine experience and cutting edge technologies, we have already provided more that 160 highly capable and stealthy submarines to over 20 navies worldwide.

Our engagement is not constrained to technological and developmental issues, but includes safety, rescue and standardization activities in support of our customer navies, procurement offices and industrial partners.

See the benchmark for non-nuclear submarines at www.thyssenkrupp-marinesystems.com

engineering.tomorrow.together.



The Baltic Region

Baltic countries generally have small but capable naval ship construction infrastructure. Most have a single primary builder, and other secondary yards for niche construction, as well as repair and modernisation work. Governments in these countries generally award contracts that ensure local yards are primary builders or otherwise have significant workshare in new naval construction. One exception is Denmark, where there is currently no local facility capable of specialised naval ship construction following the 2009 closure of Odense Steel Shipyard. The smaller Baltic countries of Estonia, Latvia, and Lithuania also have significant capacity to build and repair larger commercial ships, but are not currently engaged in naval construction. One major exception is Baltic Workboats Estonia, which is a builder and exporter of patrol boats.

Poland: AMI forecasts five new construction ship and submarine programmes. The two shipyards that engage in naval ship construction are involved in the current MCMV building programme building and the recently awarded frigate programme, as summarised in Table 3.

Finland: AMI forecasts three new construction ship programmes set out in Table 4. The country's Rauma shipyard is its primary facility for construction of more complex naval ships. Finland does not currently operate submarines. Three other shipyards – Marine Alutech Oy Abare, Meyer Turku Oy, and Helsinki Shipyard – are capable of building smaller vessels, as well as commercial platforms.

Sweden: AMI forecasts seven new construction ship and submarine programmes set out in Table 5. The county's primary naval shipyard is Saab Kockums, while a second yard, Swede Ship Marine AB, can perform work on smaller patrol craft and amphibious vessels.

Denmark: AMI forecasts three new construction ship and craft programmes. The country's planned 800 tonne environmental protection vessel and future 3,000 tonne OPV are expected to be designed and built in Denmark at one of the country's existing commercial shipyards, perhaps with investments to enable the selected yard to meet naval-related construction standards. Smaller patrol boats are also expected to be allocated to a local yard, such as Søby Vaerft.



The French nuclear-powered attack submarine FS Suffren under construction at Naval Group. Cherbourg. AMI expects France to spend USD 10.9 Bn on submarines over the next two decades.

Table 3: Poland		
Project	Status	Local Yards Involved
'Kormoran II' Class MCMV	Building	Remontowa Shipbuilding & PGZ Naval Shipyard
Maritime Border Guard 70 M OPV	Building	None (built by Socarenam, France)
'Miecznik' Class Frigate	Awarded	PGZ Naval Shipyard & Remontowa Shipbuilding [1]
Hydrographic Survey Ship (AGS)	Planned	PGZ Naval Shipyard & Remontowa Shipbuilding [2]
Future Submarine ('Orka' Project)	Planned	To be determined

1. With design assistance from Babcock International

2. With design assistance from a foreign supplier

Table 4: Finland						
Project	Status	Local Yards Involved				
Turva Class OPV (Batch 2)	Awarded	Meyer Turku Oy				
<i>Pohjanmaa</i> Class Cor- vette	Awarded	Rauma Marine Constructions				
Inshore Minesweeper (MSI)	Planned	TBD (will be a local shipyard)				
Table 5: Sweden						
Project	Status	Local Yards Involved				
Artemis SIGINT Vessel	Building	Saab Kockums (final outfitting)				
<i>Blekinge</i> (A26) Class Sub- marine	Building	Saab Kockums				
Coast Guard KBV 230 PV	Awarded	None, contracted to Damen [1]				
Future Surface Combat- ant (Visby II)	Planned	Saab Kockums				
Future MCMV	Planned	Saab Kockums				
Future Logistics Ship	Planned	TBD (likely Saab Kockums)				
Next Generation Subma- rine (UB30)	Planned	Saab Kockums				

1. Maintenance will be carried out by Damen Oskarshamnsvarvet

Western Europe

The UK, France and Germany are Europe's leading naval shipbuilding countries, with industry supporting a steady domestic demand driven by the region's largest and most capable navies, as well as serving export markets around the world. Each country fields a layered naval shipbuilding infrastructure, led by large, multi-purpose builders of a variety of surface ship types, robust mid-tier vards, and specialised builders of vessels such as submarines, mine warfare ships, and smaller fast combatants. The UK and France also maintain robust nuclear submarine construction facilities. Each of the three countries benefit from strong naval combat systems, sensors and weapon companies, which supports ship-system integration across a number of major ship programmes.

AMI's 20-year forecasts of future naval ship acquisitions for each of these countries are shown in Table 6 below. This data highlights that all three nations are acguiring new ships to maintain a balanced portfolio of capability across mission types, although Germany is significantly more weighted to replacing surface combatant and auxiliary types compared to the UK and France. The UK's replacement strategic submarine (SSBN) programme skews that country's spending on submarines and is moving dramatically upward; without that expenditure, British future naval acquisition by ship type, distribution and cost would be closer to its French peer.

The shipbuilding infrastructures that will delivery these new ships are scaled for domestic markets that have slowly but steadily declined over the past three decades, making growth in export opportunities and diversification into other markets increasingly vital to sustaining their businesses to local shipyards. Scaled to this market structure and demand, the region's builder yards, operating as publicly traded business entities, would require some lead time to scale up (in physical plant and human resources) in response to increasing demand for naval ships. In other words, there is limited spare capacity to significantly increase naval building, even if financial resources were already available.

Additionally, the experience level of naval shipbuilders in all three countries is reducing, as the generation that built and sustained the larger number of Cold War-era naval platforms has retired, or will do so over the coming decade. Their replacements are fewer in number, due to reduced domestic demand and fluctuating export orders (many of which are increasingly built in the country ordering the new ships rather than in European yards). This structural, human resource constraint could also make it difficult for Northern European shipyards to increase production beyond current levels.

Navies in the Northern Europe region are recognising some of the potential risks of their current 'peacetime' naval industry configuration. In November, Germany was among six countries entering a 'Northern Naval Shipbuilding Cooperation (NNSC) Initiative'. Other countries participating in the initiative were Denmark, Germany, Finland, the Netherlands, Norway, and Sweden. The initiative creates a venue that brings together naval and industry leadership to address naval shipbuilding limitations by innovation in areas like modularity, interoperability, and a less rigid and countryspecific system of certification and standards. Advancing the state of naval ship propulsion is also within the scope of the initiative. Although France and the UK were not included in these discussions, similar measures to better connect naval and industry perspectives are ongoing in those countries as well.

Mediterranean/Southern Europe

The major countries covered by this region continue to support a combination of government-owned and/or privately held shipbuilding infrastructure. Spain's industrial strategy has focused on making the shipbuilding industry more selfreliant. Spanish naval platforms are locally built by Navantia at their four major shipbuilding and repair facilities located at Ferrol, Cadiz, San Fernando, and Cartagena. Italy also relies on a single company – Fincantieri – for most new naval ship construction. Turkey's shipbuilding infrastructure is less concentrated, with several commercial yards as well as the navy's shipyards - at Gölcük and Istanbul - involved in building various sized naval and coast guard vessels up to and including large combatants, amphibious vessels and auxiliary vessels.

Italy and Turkey, with forecasted new platform spending over the next two decades in the range of USD 20-23 Bn, are making future naval investments at levels comparable to Germany (USD 24 Bn) and France (USD 29 Bn). Both countries are also investing to maintain, or even grow, capability in multiple mission areas, with programmes under construction encompassing high-end surface combat-

Table 6: Western Europe (2022-42)							
Country	Surface	Submarines	Patrol	MCMV	Amphibious	Aux	Total
UK							
Programmes	4 (DDG/ FFG)	3	0	0	1	2	10
New Hulls	14	8	0	0	1	5	28
Acquisition Cost	27,095	31,200	0	0	700	2,401	61,396
France							
Programmes	3 (CV/FFG)	2	3 (OPV/PV)	2	1	1	12
New Hulls	15	7	24	11	12	4	73
Acquisition Cost	13,700	10,900	1,450	950	480	1,600	29,080
Germany							
Programmes	3 (DDG/FFL)	1	0	1	0	2	7
New Hulls	17	2	0	10	0	5	34
Acquisition Cost	17,720	2,000	0	1,000	0	3,576	24,296

Note: Costs in USD M



Italian naval construction is dominated by Fincantieri. This photograph shows the amphibious assault ship Trieste at the group's Castellammare di Stabia yard.

ants, large offshore patrol vessels, and advanced conventionally-powered submarines. Large multi-purpose amphibious ships provide operational flexibility, whilst projects for auxiliary support ships ensure the ability to project and sustain naval forces for extended periods. Spain, at USD 8 Bn in forecasted spending, and especially Greece (USD 4.8 Bn), continue to struggle to halt steady declines in their naval force structures. Moreover, both navies show large gaps in projected MCMV, amphibious and auxiliary ship acquisitions, suggesting they are prioritising keeping at least some surface combatant and submarine warfare capability in place under current spending constraints.

In sum, shipbuilding capacity is southern Europe continues to be sized for current demand. Overall, this has remained steady but limited over the past decade. The region has yet to see any marked increases in naval building driven by the conflict in Ukraine. Turkey's naval expansion, while still ambitious, has been curbed of late by the country's economic issues, although somewhat offset by recent successes in export markets that have helped buffer pressures on the domestic naval budget.

Conclusion

The picture of Europe's naval shipbuilding appears to have changed little one year after Russia's attack on Ukraine. The NA-TO alliance has demonstrated robust abilities to coordinate policies and military aid deliveries, while reinforcing mechanisms for cooperation in response to the Ukraine conflict. The pending ascension of Sweden and Finland, both with highly professional naval forces, strengthens NATO maritime capability significantly. Moreover, the conflict has demonstrated the continuing relevance of maritime capabilities (offensive and defensive), ranging from sea-based anti-ship and land attack strike, mine warfare, air and missile defence and especially non-conventional and special operations. Yet the lessons being learned among Europe's navies from the Ukraine conflict have not - so far – translated into reversing the decline in Europe's naval shipbuilding spending. Europe's current naval shipyard infrastructure is capable of meeting today's market demand. Should the Ukraine conflict support keeping European new naval ship acquisition budgets at current levels, that in itself would be a positive outcome from the perspective of Europe's naval shipbuilders, large and small.

Table 7: Mediterranean/Southern Europe (2022-42)							
Country	Surface	Submarines	Patrol	MCMV	Amphibious	Aux	Total
Italy							
Programmes	4	1	2	2	3	4	16
New Hulls	15	4	10	12	10	6	57
Acquisition Cost	9,384	2,400	3,241	2,200	4,600	1,851	23,676
Spain							
Programmes	2	1	1	0	0	1	5
New Hulls	9	4	2	0	0	1	16
Acquisition Cost	6,500	1,360	180	0	0	150	8,190
Turkey/Greece							
Programmes	7	2	3	1	1	3	17
New Hulls	28	14	136	6	2	6	192
Acquisition Cost	12,330	7,100	2,308	720	1,900	1,200	25,558

Note: Costs in USD M



PIONEERING - IN PARTNERSHIP - PERFECT

Creating innovations and building perfect ships together with our customers: For almost 100 years, we have been a partner for navies all over the world.

> ABEKING & RASMUSSEN www.abeking.com

Offshore Patrol Vessels and Shipbuilders in Europe

Luca Peruzzi

undamental design requirements for the European shipbuilders of OPVs are changing. Potential operations can encompass a wide range of environments and missions, from patrolling Arctic regions to protecting underwater resources from economic exploitation in territorial waters as well as in Exclusive Economic Zones (EEZs). Traditional war-type tasks have to be taken into account alongside search and rescue, border control and the management of clandestine emigration, while simultaneously securing the safety of navigation. As a result, designs for offshore patrol vessels are moving towards larger units capable of accomplishing a wide range of missions. Flexibility, modularity, and lower lifecycle costs are emerging as fundamental requirements. The desirability of larger, armed platforms that can operate on the high seas, conduct operations with helicopters and unmanned autonomous vehicles, and deploy similar vehicles under and above the surface are becoming increasing design influences. At the other end of the spectrum, the capability of supporting disaster relief operations remains an important capability.

France

The French naval industry is the most prolific in building patrol vessels for navies, homeland security agencies and coast guards or similar bodies. A large number of programmes for domestic and international customers are currently underway: Patrouilleurs Hauturiers: In October 2021, the French defence procurement agency (DGA) awarded Naval Group a contract for the preliminary and detailed design of the Ocean Patrol Vessels or 'Patrouilleurs Océanique' (PO). Subsequently, the programme's terminology has changed to 'Patrouilleurs Hauturiers' (PH) or OPVs. Naval Group is in charge of the project architecture and therefore responsible for the new vessels design. Ship construction will be assigned to the Socarenam, CMN and Piriou shipbuilders. With an estimated displacement of over 2,000 tonnes and a length in excess of 90 m, the new platform will have an extended endurance. The combat



Naval Group, as prime contractor for Kership joint venture, delivered the last of four Bouchard class OPVs to the Argentine Navy in April 2022.



Kership offers a patrol vessel portfolio centred on two large families, one for navies and the other for coast guards. Here an OPV 85 is depicted.

system is expected to be provided by Naval Group. Sensors will include a multifunction radar and a hull-mounted sonar supplied by Thales. To replace the current nine A69 and three OPV54 class patrol vessels, the PH will have flight deck and hangar for at least one Airbus Guépard Marine type helicopter and either fixed-wing or rotary-wing UAVs. Armament will include a 40 mm remote weapon station (RWS) and machine guns. According to the French Military Programming Law 2024-2030 unveiled on 4 April 2023, shipbuilding contracts are expected to be awarded from 2023, with a total of seven platforms to be in service by 2030. According to complementary documentation presented to the French Parliament, three more PHs are planned by 2035.

Bouchard Class (OPV-90): Naval Group delivered the last of four Bouchard class OPVs to the Argentine Navy in April 2022. This platform – the OPV 90 – has a displace-

ment of 1,650 tonnes and is 87 m in length. It is constructed by Kership, Naval Group's and Piriou's joint venture. Equipped with Naval Group's 'Polaris' combat management system (CMS) and a 30 mm RWS, it features a flight deck for a 10-tonne helicopter, a hangar for a helicopter of 5 tonnes, UAV facilities and two stern stations for 9 m RHIBs.

During Euronaval 2022, Kership announced a new expansion of its patrol vessels portfolio, which is now centred on two large families, one for navies and the other for coast guards. The first family includes OPV models of 45, 60, 65, 70, 80, 85 m in length, alongside the OPV 90 m model. As a baseline, all are equipped with a combat system and offered with a 76/62 mm Leonardo Super Rapid gun, surface-to-air missiles (MBDA VL MICA or Simbad-RC with Mistral), Exocet or Marte anti-ship missiles and machine guns. The OPV 85 incorporates a flight deck for a helicopter of 12 tonnes and a hangar for a 6-tonne helicopter plus UAVs. Two 9 m RHIBs can be operated via stern ramps.

The coast guard family encompasses OPVs ranging from 45 to 85 m in length, with the larger OPV 85 CG having a displacement of 1,750 tonnes. It is 84 m length and features a 12-tonne flight deck (plus a hangar for a 6-tonne helicopter and UAVs).

OCEA-designed Patrol Vessels: Specialised in the design, construction and support of aluminium vessels, the French OCEA shipyard has further expanded its portfolio, adding a family of multipurpose offshore vessels (OSVs) to its range of OPV products, which include 83.6 m, 72 m, 58 m and 46.2 m platforms. According to OCEA, their OPV 270 model – with a length of 83.6 m – is the largest aluminium-hulled OPV on the world market. It offers a number of benefits



The largest aluminium-hull OPV on the world market according to OCEA, the 83.6 m OPV 270 model is in service with the Philippine Coast Guard.



The first new 80 m OPV delivered by Socarenam shipyard to the French Navy under the Patrouilleurs Outre-Mer programme arrived in the New Caledonia on April 2023.

compared to steel construction, including lower emissions and improved maintenance, acquisition and operating costs. The OPV 270 design is currently in service with the Philippine Coast Guard.



The Cherbourg-based CMN shipbuilder (CMN Naval group) unveiled its new Vigilante Mk II family of OPVs at Euronaval 2022. The larger CL75 MK II is depicted here.

With diesel or optional diesel-electric propulsion, the OPV 270 offers maximum speeds of 20 to 25 kn and a range of 8,000 nm at 12 kn. It can accommodate a crew of 35 (plus an additional 35 personnel). The OPV 270 features a 360° panoramic bridge with a separate large command and control centre, a flight deck for a helicopter of 10 tonnes, and a hangar for a helicopter of 5 tonnes. Small UAVs and two 9 m RHIBs can be operated. The armament is based on a 20 or 30 mm main gun. OCEA also offers its 72 m OPV 230. This model's hybrid propulsion package uses electric movers for about 60% of the time (resulting in a low environmental footprint) whilst still offering a top speed of 25-to-30 kn.

The new OSV family includes the 95 m OSV 315, the 75 m OSV 250 and the 40 m OSV 130 platforms. The two largest designs are modular platforms designed around a 125-220 m² mission bay. There is also a 64 m² laboratory on the OSV 315.



Credit: Fassmer

The MPV 70 Mk II is the latest Fassmer development. It is under contract for the Ecuadorian Navy.

Patrouilleurs Outre-Mer (POMs): Under

a contract awarded by DGA in late 2019 to an industrial team headed by Socarenam partnered by Mauric and CNN MCO, the French Navy is receiving six new 80 m OPVs to be based in the French overseas territories of Réunion. New Caledonia and French Polynesia. The new 1,300-tonne OPVs incorporate a hybrid diesel-electric propulsion system offering a 24 kn maximum speed and a range of 5,500 nm at 12 kn. Endurance is reportedly 30 days. The platforms are operated by a crew of 30 while additional 23 personnel can be accommodated. The OPVs have a flight platform and aviation facilities for unmanned fixed- and rotary-wing air systems. Two 8 m RHIBs are part of the equipment and one standard container can be accommodated. The combat system is based upon the Lyncea CMS by Nexeya France, an offshoot of Hensoldt group. The OPVs are armed with a Nexter Narwhal 20B 20 mm RWS and machine guns.

The first unit was delivered and arrived in Nouméa, the New Caledonia on 3 April 2023. The follow-on POMs will be delivered by 2025. CNN MCO is to provide inservice support.

Socarenam is also involved in other OPV programmes. Notably, in July 2022, the hull of a new 70 m OPV for the Polish Border Guard was launched by Polish NavireTech shipyard in preparation to its transfer to Socarenam in France. The contract was awarded in October 2020 and delivery is planned in 2023. The project is funded by the European Union and intended primarily to patrol EU's external borders. Featuring a reinforced hull and accommodation for up to 35 people, crew included, the OPV will operate a 10 m RHIB, a UAV and carry two TEU (20 ft equivalent unit) containers. The OPV is designed for one month's endurance. Up to 250 survivors can be hosted for 24 hours.

CMN-designed Patrol Vessels: The Cherbourg-based shipbuilder CMN (CMN Naval Group) unveiled its new 'Vigilante Mk II' design at Euronaval 2022. Based on the success of earlier platforms sold to Brazil, France, Oman and Gabon, the new OPV family ranges from 45 to 75 m in length. They feature new hulls with a sharp inverted bow and slender bulb. According to CMN, the design offers improved hydrodynamics, better seakeeping capabilities, reduced fuel consumption and prolonged endurance while providing greater comfort and safety for the crew.

The larger 75 m CL75 Mk II model can achieve a range of 7,000 nm at 12 kn. Accommodation for 65 personnel is available as well as space for positioning of TEU containers. The flight deck can carry a 12-tonne helicopter and UAVs. RHIBs up to a maximum length of 9 m can be operated via two stern ramps. The combat system includes a Leonardo 76/62 mm gun, two 30 mm RWS and lightweight anti-air as well as anti-ship missiles. The smaller 64.8 m CL65 Mk II and

54 m CL55 Mk II have landing platforms for Schiebel Camcopter S-100 UAVs as well as areas for containers storage. The 45.6 m CL45 Mk II has space for catapult-launched small UAVs, such as the Survey Copter Aliaca. The RHIBs can be launched from the stern or laterally. The main armament is one 20 mm or 40 mm gun.

Germany

Fassmer OPV Designs: The German shipbuilder Fassmer has enlarged its portfolio. OPV solutions range from platforms of between 50.90 m and 80.70 m in length. Another series of Littoral Mission Vessels are offered in lengths of between 60.20 m and 94.70 m. The baseline OPV 80 has a length of 80.70 m, a beam of 14 m beam and a displacement of 1,850 tonnes. Two other variants come to a displacement of 1,500 tonnes (OPV 80L) and 1,950 tonnes (OPV 80S) respectively. In December 2019, Fassmer succeeded in contracting another variant, the MPV 70 Mk II, for the Ecuadorian Navy. The unit will be completed at AS-TINAVE EP shipyard. Delivery is due in 2024. Conceived as a multipurpose combat vessel, the new vessel's design combines a forward part dedicated to the management of ship and combat functions, with the central and stern sections supporting other purposes. Other characteristics are a 360° panoramic bridge and an integrated mast with an extensive sensor suite. The latter is a development between Virtualabs of Italy, and ASTINAVE EP. The large flight deck can carry an 11-tonne helicopter. Two launch and recovery stations for interceptor craft are situated beneath it. Armament includes a Leonardo 76/62 mm Super Rapid gun and two Rafael 25 mm Typhoon RWS. The



The Australian DoD selected Lürssen Australia to complete the SEA 1180 programme for the construction of 12 Arafura class OPVs, the first of which was launched in December 2021.

combat management system is ASTINAVE EP's Orion.

NVL OPV Designs: The German NVL shipbuilding group (previously Lürssen) has strengthened its worldwide presence through a broad portfolio of naval units. NVL OPVs can meet evolving operational requirements, encompassing units with displacements of between 600 and 2,500 tonnes and lengths ranging from 60 to 120 m. The series ranges from the smallest-sized OPV 60 to the largest OPV 90. The Royal Brunei Navy's Darussalam class is typical of the family. It incorporates a flight deck for an 11-tonne helicopter, launch and recovery stations for two 9 m RHIBS and has space for two 20 TEU containers. A customised variant of this design has formed the basis of Lürssen Australia's contract with the Australian DoD for the SEA 1180 programme. It encompasses the construction of 12 Arafura class OPVs for the Royal Australian Navy. Lürssen Australia is operating in partnership with ASC and the Civmec group to complete the contract. The first unit was launched in December 2021. The platforms have a displacement of 1,640 tonnes and are equipped with a helicopter flight deck with a UAV capability. A stern bay for mission modules and launch/recovery stations for a 10 m RHIB and two 8.5 m booster boats are installed. The combat system is manufactured by Saab Australia and includes links to a sensor suite incorporating systems constructed by Saab, Terma and Safran. The armament package is to be finalised, with an interim outfit of a 25 mm RWS to be installed initially.

Italy

The Fincantieri group offers a portfolio of new generation FCX family vessels ranging from 60 m (FCX 07) fast attack and patrol vessels to 120 m (FCX 40) frigates.

The 88 m FCX 15 platform - with strong links to the pedigree of the Abu Dhabi class corvette and Cigala Fulgosi class OPV designs, is available in patrol and combatant variants. With a 1,500-tonne displacement and 25 kn speed, FCX 15 has a retractable hangar, a flight deck for a 10-tonne helicopter, a modular area for containers and two 7.5 m RHIBs. Characterised by a reduced manning requirement, the combat version is equipped with a Leonardo 76/62 mm gun, two 25/30 mm RWS, a RAMSys RAM system and four MBDA Exocet antiship missiles. The sensor suite consists of a 3D multifunction radar and fire control systems.

The larger FCX 20, of 95 m length and with a displacement of 2,300 tonnes, reaches a top speed of 25 kn. Her indicative range is



A rendering of the Italian Navy's PPX. The plan is to replace current OPVs and corvettes with a mix of smaller OPVs and future EPC/MMPC platforms.



The Norwegian Vard company is close to delivering the first of three 136.4 *m* OPVs specially designed for demanding Arctic operations to the Norwegian Coast Guard.

4,500 nm at 14 knots. The new dual-variant design features a stern flight deck for a 10-tonne helicopter with a fixed hangar for a helicopter and UAV. The combat system includes vertical launchers for surface-toair missiles, as well as surface-to-surface missiles.

The Italian Navy is looking to replace its OPVs and its corvettes with a mix of smaller OPVs and larger platforms, such as the future European Patrol Corvette/ Modular Multirole Patrol Corvette (EPC/ MMPC). The programme was previously known as PPX. The indicative requirement is for units of 90-100 m length and 2,200 tonnes displacement with dieselelectric propulsion. Other features include a flight deck and hangar to accommodate both a 10-tonne helicopter and a UAV. A 9 m RHIB launch/recovery station is located at the stern whilst two 7.3 m RHIB stations are positioned amidships on either side of the modular mission bay. To allow reduced manning, the combat system provides for a customised 'naval cockpit' and new generation sensors for surveillance and for fire control of a 76/62 mm gun and two 30 mm RWSs. An initial contract for up to 4 PPXs is expected to be signed later in 2023.

A subsidiary of Fincantieri, Norway's Vard, is close to delivering the first of three 136.4 m Norwegian Coast Guard OPVs designed for Arctic operations. KV Jan Mayen and her sister-ships will have an ice-strengthened hull, a helideck and hangar for either one Leonardo AW101 or one NH90 helicopter, accommodation for up to 100 persons and an endurance



The delivery of PNS Tabuk to Pakistan Navy. Damen built two units of this class.

of eight weeks. The combat suite includes state-of-the-art sensors and a 40 mm gun. Another Fincantieri company, Vard Marine, Canada, is offering its Vard 7 125 Next-Generation OPV design, which obtained Lloyd's Register 'Approval in Principle' in May 2022.

To satisfy Italian Coast Guard needs for search and rescue, maritime safety and environment protection, Fincantieri – as prime constructor - together with Cantiere Navale Vittoria – as shipbuilder – have won a contract for the construction of three 85 m multirole offshore support vessels to be delivered from the second guarter of 2025. In March 2023, Cantiere Navale Vittoria delivered the OPV P71 to the Armed Forces of Malta, thereby effectively entering the larger OPV sector. The OPV is 74.8 m long and has a displacement of 1,800 tonnes. Its prominent features include a 360° panoramic bridge, a hybrid propulsion system, a flight-deck for a helicopter of the size of Leonardo's AW139, two stations for 9.1 m RHIBs - one astern and one on starboard side – and a 25 mm RWS.

The Netherlands

Built by Damen Naval, the four Royal Netherlands Navy's Holland class OPVs are designed for trans-Atlantic deployments to the Dutch overseas territories in the Caribbean. Their displacement is 3,750 tonnes with a length of 108 m. A dominant characteristic is their Integrated Mast Module or I-Mast, which incorporates a sensor package provided by Thales. The class's armament consists of Leonardo 76/62 mm, a Marlin WS 30 mm and two Hitrole 12.7 mm RWS. The stern flight deck and hangar are equipped for a medium sized helicopter. These OPVs can deploy two FRISCs (Fast Raiding Interception Special forces Craft) - one from a launch/ recovery station in the stern below the flight deck, the other from a bay on port side.

Damen Naval also offers its globallyknown portfolio of StanPatrol vessels. This part of the Dutch shipbuilder's portfolio starts from units of 13 m length. The larger platforms of over 60 m are characterised by the Sea Axe bow. This is designed to reduce water resistance, enable superior seakeeping, and ensure sustained high speeds (max 25/26 kn) in high sea states.

Another platform in Damen Naval's OPV register is the Damen 1900 type. The Pakistan Navy has commissioned two of these units as the Yarmook class. The ships have a length of 90 m and a displacement of 2,300 tonnes. They can launch two RHIBs of, respectively, 11.5 and 6.5 m from stern and lateral stations, have a flight deck for both helicopter and UAV operations and can accommodate two TEU containers for special missions. The Yarmook class is armed with an Aselsan 30 mm Smash and two STAMP 12.7 mm RWSs, as well as a Phalanx Block 1B inner-layer defence system. Additionally, Harbah anti-ship missiles are to be installed at a later stage.

The performance and capabilities of these vessels has led to a new order for two larger platforms known as the OPVs 2600 Batch-II. According to released images, these OPVs have a more powerful combat system including a Leonardo Marlin 40 mm RWS, surfaceto-air missiles vertical launchers, an Aselsan Gokdeniz inner-layer defence system, Harbah anti-ship missiles and 12.7 mm RWSs.

Portugal

To complement the four in-service Viana do Castelo class OPVs built by West Sea shipyard, in late 2022 the Portuguese Government confirmed plans to build additional six platforms to be delivered by 2026-2030. A contract has not yet been signed.





The shipbuilder Navantia offers its Avante OPV family portfolio for both EEZ surveillance and maritime security missions. The 2,250-tonne Avante version is depicted here.



HMS Tamar, a River class Batch 2, built by BAE Systems Maritime.

Spain

The shipbuilder Navantia offers its Avante OPV family portfolio for both EEZ and maritime security missions. Platform sizes range from 300 to 3000 tonnes. A derivative of the Avante 3000 concept, the 2,860-tonne displacement Meteoro class is in service with the Spanish Navy. This design is also categorised as the 'Buque de Acciòn Maritima' (BAM). Navantia has also previously delivered four 'Patrulleros Océanicos de Vigilancia', of 2,250 tonnes, and four 'Buques de Vigilancia', of 1,500 tonnes, to the Venezuelan Navy.

The Avante 2200 patrol vessel has a displacement of 2,455 tonnes and is 98.9 m in length. It can reach a speed of 25 kn by means of a twin diesel-based propulsion package. The maximum range is 3,500 nm. With a flight deck and hangar for a 10-tonne helicopter and facilities for two 5.5 m RHIBs, the OPV can be armed with a 76 mm and 35 mm guns, as well as surface-to-surface missiles and vertical launched surface-to-air missiles. The Avante 1400 design, of 1,500 tonnes and 79.9 m in length, can reach 22+ kn and features a flight deck for a medium-size type Eurocopter AS 565 Panther helicopter and three RHIBs. The Avante 1400 is offered with a combat system and armament package that includes a 76/62 mm Super Rapid main gun, a Rheinmetall 35 mm Millennium innerlayer defence system and two 12.7 mm machine guns. Accommodation is available for a crew of 35 plus 29 extra personnel.

The Spanish shipyard is currently working on a contract for an OPV programme for

the Royal Moroccan Navy. No further details were provided on the selected platform. However, according to local media, the OPV is part of the Avante family, with a displacement of about 1,500 tonnes and a length of around 80 m.

Turkey

In April 2022, Turkey's state-owned company ASFAT announced the completion of the critical design phase (review) and the start of hull section production for the new Hisar class, a series of 10 OPVs for the Turkish Naval Forces. According to released information and drawings, AFSAT has derived the new platform from the MILGEM corvette. The Hisar OPVs will displace 2,300 tonnes and be 99.5 m in length. Their flight deck and hangar will support the operations of a 10-tonne helicopter. Configured in CODELOD (Combined Diesel-Electric Or Diesel) format, the propulsion package will be capable of providing a 24 kn top speed and a 4,500 nm range. Accommodation is provided for 104 persons. Armament includes a 76/62 mm and 12.7 mm guns.

The Turkish naval industry, including TAIS, Dearsan, RMK Marine, STM and Ares are also very active in the OPV and patrol vessel segments of the international markets. Dearsan is currently building two 1,100 tonnes and 76 m OPVs for the Nigerian Navy.

United Kingdom

BAE Systems Maritime offers an OPV family comprising 80 m and 90 m. The

Royal Navy currently operates five OPVs built to the River class Batch 2 standard alongside three remaining Batch 1 platforms. BAE Systems supports them under a logistics support contract. BAE's OPV designs have also been exported to Brazil and Thailand.

The Batch 2 platforms differ from the previous Batch 1 vessels in the shape of their hull form and full width superstructures. Their strengthened flight deck allows operations with the Leonardo Merlin (AW101) helicopter. The Batch 2 features BAE Systems' CMS-1, and a sensor suite centred on Terma Scanter 4100 2D radar, a 30 mm DS30M Mk2 RWS, two 7.62 mm miniguns and two general purpose machine guns.

Elsewhere in the British naval sector, BMT is proposing a concept for a utility auxiliary of 90-110 m. Named Salvas, it is designed to accomplish a range of missions including EEZ protection, salvage, maintenance, and search and rescue.

Among other European nations, the Danish OTM (part of of NavalTeam Denmark) developed the three Knud Rasmussen class Arctic OPVs. The ships were built by Karstensens shipyard and are in service with the Danish Navy today. Described as hybrid arctic working horses with worldwide capabilities, they have a displacement of 2,600 tonnes and are 72 m in length. Four Standard Flex container positions enable them to be fitted with a 76 mm gun, as well as Sea Sparrow Mk 56 surface-to-air and Harpoon anti-ship missiles.

The MILGEM Programme: Turkish Naval Procurement and Exports

Bob Nugent

Turkey's MILGEM programme represents a significant accomplishment in that country's sustained effort to become a designer, builder and exporter of advanced naval warships. The MILGEM's programme history highlights how Turkey has built on the initial domestic customer base for MILGEM corvettes to expand into the export market; a proven business model used by many other naval shipbuilders to add to revenue and market share, while reducing the cost of domestic construction programmes. Further, the MILGEM programme's initial objective to establish a partnership of Turkish government and industry that would prove capable of advancing to more complex frigate and destroyer designs appears to be on track. This is evidenced by the commencement of the MILGEM G, a small frigate design evolved from the initial MILGEM corvette, as well as the prospect of the TF 2000 destroyer programme.

This article draws on open source material and AMI International's proprietary naval market forecast and assessment data to review the MILGEM programme in detail. We describe the history of the programme, the design's capabilities and equipment fit, and provide a short description of current exports to Pakistan and Ukraine. We conclude with some comments on MILGEM's future in both the domestic and international naval markets.

Programme Background and Initial Results: The 'Ada' Class Corvette

MILGEM, derived from the Turkish 'Milli Gemi' or 'National Ship' describes a programme managed by the Turkish Navy to acquire locally designed, built and equipped surface combatants, ranging from corvettes to destroyers. The 'Ada' class corvette is the first project in the MILGEM programme.

Author

Bob Nugent is a member of the Strategy, Management and Operations faculty at the Busch School of Business at The Catholic University of America, and is a doctoral candidate in management at Virginia Tech. A retired US Navy officer, he consults on strategy, competition and management issues with aerospace and defence companies.



TCG Heybeliada was the first 'Ada' class corvette completed under the MILGEM 'National Ship' Programme.

In mid 1990s the Turkish Navy began surveying national resources and gaps related to the design, development, and construction of an indigenous corvette. In 2004, Istanbul Naval Shipyard Command established the MILGEM Project Office to execute and coordinate the design, engineering, and construction of the initial MILGEM ship, which was to be a patrol and anti-submarine warfare ship. The resulting 'Ada' class (MILGEM S) corvette design incorporated low observable hull and superstructure elements, as well as advanced sensors and combat management systems. In 2005, Istanbul Naval Shipyard Command commenced the construction of the first hull in the class, TCG Heybeliada.

Although constructed at the Istanbul Naval Shipyard, the 'Ada' class project has drawn heavily on the expertise of the wider Turkish defence sector. Notably, the Turkish defence conglomerate STM has been engaged throughout the project under a series of contracts related to design, classification, model testing and materiel procurement/integration. Other Turkish companies contributing to the 'Ada' class programme include Aselsan and Havalsan. A total of four 'Ada' class ships were ordered under the programme and are now in service, as listed in Table 1.

The Turkish Navy has integrated the Roketsan ATMACA anti-ship missile system into TCG *Kinaliada* the fourth and final hull of the 'Ada' class. The first three hulls are to be back-fitted with the indigenous missile system.
'Ada' Class List					
Pennant No.	Name	Launched	Commissioned		
F511	Heybeliada	27 September 2008	27 September 2011		
F512	Büyükada	27 September 2011	27 September 2013		
F513	Burgazada	18 June 2016	4 November 2018		
F514	Kınalıada	3 July 2017	29 September 2019		

Specifications & Capabilities				
Length Overall:	99.4 m			
Beam:	14.4 m			
Propulsion:	CODAG. Two shafts with CPPs. Maximum speed of 29+ kn. Endurance of 3,500 NM at cruising speed of 15 kn.			
Complement:	86 crew.			
Boats:	Two RHIBs.			
Weapons:	One 76 mm gun. Two 12.7 mm weapons stations. Eight Harpoon SSMs. One Mk 144 guided missile launcher for 21 RAM SAMs. Two Mk 32 triple launchers for anti-submarine torpedoes. One S-70B2 Seahawk helicopter.			
Sensors:	SMART-S Mk2 3D air/surface search. STING fire control. ALPER navigation. YAKMOS sonar.			

Table 1

Next Steps: The MILGEM G

Beginning in mid-2011, various Turkish sources indicated that the initial 'Ada' class programme - originally scoped as a class of 12 hulls - would be cut back to eight hulls. The requirement for the remaining four surface combatants would be filled by a new class of frigates known as the TF-100 class. By 2014, however, the TF-100 class programme had been restructured and four enlarged MILGEMs (the MILGEM G class) were envisaged to meet the requirements for units five to eight of the original MILGEM Programme. In 2017, the first hull of the MILGEM G or 'l' class, TCG Istanbul (F515), was laid down in Istanbul Naval Shipyard. The ship was launched in 2021 and is fitting out prior to an expected commissioning date of September 2023. The 'I' (Istanbul) class is classified as a small frigate, being an enlarged version of the 'Ada' class corvette displacing 3,000 tonnes compared to the previous vessel's 2,400 tonnes.

In late 2021, the acquisition authority for the program, the Savunma Sanayii Başkanlığı (SSB or Defence Industry Agency), issued a Request for Proposals (RfP) for the construction of *Istanbul* class frigates hulls two through to four. According to the RfP, only local shipyards or foreign sub-system suppliers partnered with local shipyards were allowed to participate. SSB's RFP further required that bidders must have previously built a surface platform or were currently engaged in building one in partnership with the Turkish Government. This further constrained the competition, and weighted selection in favour of suppliers with MILGEM or other Turkish Navy programme experience.

In January 2023 Turkey awarded contracts for hulls two-four of the *Istanbul* class to a team made up of STM and TAIS, the latter being a consortium of Turkish private shipyards Sefine, Anadolu, and Sedef. All three yards will build hulls twofour concurrently, with the construction period set for 36 months.

The acquisition strategy of awarding construction to three different shipyards for concurrent construction mitigates risks of delays or disruptions in a single yard affecting the whole programme. It also bolsters the potential exportability of the class in the future by qualifying all three yards as 'proven builders' for future potential exports. None of the three yards is currently identified as 'lead builder' comparable to the US Navy DDG-51 programme, which splits construction between two yards while identifying one as lead. Of course, future progress, and/ or difficulties, may see one of the three yards emerge as a de-facto lead builder as the construction phase unfolds. The acquisition strategy also has the potential to create some interesting competitive challenges for the prime contractor negotiating agreements between the



TCG Kinaliada, the fourth 'Ada' class corvette, is equipped with the indigenous ATMACA anti-ship missile system.

Istanbul Class Programme Schedule					
Name	Launched	Commissioned			
Istanbul	3 July 2017	[September 2023]			
İzmir	2026	2027			
İzmit	2026	2027			
İçel	2026	2027			
	Programme Scheo Name Istanbul İzmir İzmit İçel	Name Launched Istanbul 3 July 2017 izmir 2026 izmit 2026 içel 2026			

Table 2



A graphic of the Istanbul class frigate design. The lead ship is scheduled for delivery in 2023.

individual builders and leading systems suppliers on cost and delivery schedules for key equipment.

The leverage enjoyed by some Turkish systems suppliers will potentially be considerable, as the MILGEM G class will be equipped with mainly Turkish weapons and systems. A few European systems are found in main gun, torpedo and radar fits, listed below.

Istanbul Class: Specifications and Estimated Capabilities

(Source: AMI Worldwide Naval Projection Report)

Anti-Air Warfare (AAW) Systems: Two Rocketsan MDAS eight-cell vertical launch systems (VLS) for 16 Hisar surfaceto-air missiles (SAMs). One Aselsan 35 mm Gokdeniz CIWS (rather than the Raytheon Rolling Airframe Missile (RAM) found on the corvette variant). One Leonardo 76 mm/62 dual purpose gun. Detection and tracking will be provided by the Thales Naval Nederland SMART-S Mk2 air/surface search radar.

Anti-Surface Warfare (ASuW) Systems: 16 Rocketsan ATACMA surfaceto-surface missiles (SSMs) fired from four quad canisters.

Anti-Submarine Warfare (ASW) Systems: Meteksan TBT-01 YAKMOS sonar together with a Low Frequency Active Towed Array Sonar (LFATAS) installation. The torpedo launching system consisting of two twin BAE Systems Land and Armament Mk 32 torpedo tubes capable of launching Mk 46 torpedoes. The torpedo tubes, located to port and starboard, can either be fixed or trainable. The torpedoes are expected to be replaced by the Roketsan/Aselsan ORKA lightweight torpedoes currently being developed. For torpedo defence, the TNF class will use the Aselsan Hizir torpedo countermeasures (TCM) system.

Electronic Warfare (EW) Systems: Aselsan ARES-2N electronic support measures (ESM) system. Mechanical jamming will probably be provided by two BAE Systems Land and Armament Mk 36 SRBOC launchers for chaff and IR decoys.

Unmanned Systems (UMS): The frigate will not initially be equipped with an unmanned capability. However, given the recent advances in unmanned maritime systems (UMS) in Turkey, it is likely that UMS capability and systems will be added later. The most likely UMS candidates are unmanned air vehicles to increase surveillance range.



The initial MILGEM corvette design has been successful in both domestic and export markets.

Integrated Platform Management System (IPMS): The Yaltes EPKIS integrated platform management system (IPMS) will control platform machinery, electrical power generation and distribution, damage control and auxiliary systems. The IPMS also provides advanced automation for enhanced operational effectiveness and survivability of the ship including an on-board training system, fire detection system, fire-fighting and damage control stability system, and a closed circuit TV system, all to be integrated on one network.

Integrated Bridge System (IBS): Provided by OSI Maritime.

Integrated Communications Suite (ICS): The ICS will be the INCS provided by Aselsan.

Export Programmes

Pakistan: Initial reports of Pakistan's interest in the MILGEM date back to 2015, when the ship was identified as an alternative to building four units of the Chinese designed Type 054A frigate class. In May 2017, a Letter of Intent (LoI) was signed between the Turkish Under-secretariat for Defence Industries (SSM) and Pakistan's Karachi Shipbuilding and Engineering Works (KSEW) for the construction of four MILGEM corvettes. The announcement took place during the International Defence Industry Fair (IDEF) in Turkey. [1]

The agreement to purchase four MILGEM hulls was signed in July 2018 within the framework of USD 1 Bn contract calling for two hulls to be built at a shipyard in Turkey, and two at KSEW under a technology transfer agreement. Steel was cut on unit one in September 2019, with the keel being laid at ASFAT Shipyard in Turkey in June 2020. The keel for the first Pakistan-built hull (unit 3) was laid in October 2020 at KSEW. As of early 2023, work was underway on all four ships, with the first three already launched. The class, which incorporate a number of variations from Turkey's 'Ada' variant, will be known as the Babur class in Pakistan Navy service.

Ukraine: A December 2020 contract specified the construction of two MILGEM ('Ada') class corvettes for Ukraine, along with unmanned combat aerial vehicles (UCAVs), in a deal worth a reported USD 1 Bn. STM is the prime contractor, with the lead unit to be built in Turkey and the second unit at Okean Shipyard in the Ukraine. The keel for the lead unit was laid at STM on 7 September 2021, being



A graphic of STM's TS1700 submarine concept. The MILGEM approach serves as bridgehead for future Turkish exports of other warship types.

named *Hetman Ivan Mazepa* in August 2022 prior to launch in October of that year. [2] Both corvettes are scheduled to be delivered in 2025 if shipyard operations are not interrupted by the ongoing war with Russia. Each hull's acquisition cost is estimated to be USD 250 M, or USD 500 M for the two units of the class.

Conclusion

Thirty years on from its conceptual beginnings, Turkey's MILGEM programme is proving successful in both domestic and export settings. The evolution from the MILGEM S ('Ada') class corvette to the MILGEM G (Istanbul) frigate appears to be taking advantage of the lessons learned in operating the initial corvette hulls over the past decade. The next stage in the MILGEM programme, the TF-2000 class destroyer displacing up to 7,000 tonnes, will be a significant challenge, but one informed by continuity in the government-industry partnership (particularly with STM as design agent) and acquisition strategy.

From the export perspective, Turkey's choice of the corvette as an entry offering is a considered one. The corvette typifies a smaller and simpler 'starter' surface combatant that is particularly suitable to many prospective buyers on three counts: (1) corvettes of 2,000-2,500 tonnes represent an evolutionary rather than revolutionary step for navies expanding fleet structures up from coastal and local postures to a longer regional reach; (2) corvettes are a suitable first step for local yards to secure workshare and delivery for a parent design requirement, and (3) corvettes are more accessible (in cost, sustainability and future resource commitments) for budgetconstrained customers such as Ukraine, or Pakistan. Corvette designs such as the MILGEM inevitably face strong competition from European offerings, as well as Asian countries. However, Turkey's ability to offer a combination of lower prices, technically proficient and local suppliers of advanced weapons, sensor and control systems, and fewer restrictions on export conditions have all worked in favour of overcoming these competitive challenges and help explain MILGEM export successes to date.

In summary, the two ship classes so far making up the MILGEM programme have established Turkey as a reliable and professional supplier to both domestic and export buyers of surface combatants. The MILGEM approach also serves as bridgehead for future Turkish offers of more complex platforms to both domestic and foreign customers; notably submarines.

Notes

- 1. According to AMI, the Pakistan Navy also subsequently moved forward with its plans to acquire Type 054A frigates. The keel for the first hull, PNS *Tughril* (F261), was laid in December 2018 and commissioned in June 2022. All four hulls are to be delivered by the end of 2025. The MILGEM corvettes and Type 054A frigates are assessed as being complementary. The MILGEMs will serve mainly as ASW platforms, whilst the Type 054A/P has better AAW capabilities.
- 2. Some sources suggest Okean will be responsible for the final outfitting of both ships.

British Fleet Solid Support Ship Contract Award

Interview with John Wood, Group Chief Executive Officer, Harland & Wolff

Conrad Waters

On 18 January 2023, Britain's DE&S procurement agency announced that it had awarded a GBP 1.6 Bn (circa EUR 1.8 Bn) contract to the Team Resolute consortium to build three Fleet Solid Support Ships (FSS) for the Royal Fleet Auxiliary. Comprising BMT, Harland & Wolff and Navantia UK, Team Resolute had previously gained preferred bidder status in November 2022 after a lengthy competitive bidding and assessment process. The deal marks a further stage in the regeneration of Harland & Wolff as a major force in the British maritime sector. ESD took the opportunity of the contract announcement to ask Harland & Wolff's Group Chief Executive Officer John Wood, widely credited with the company's recent revitalisation, about the significance of the award to its future plans.

Contract Background

The FSS design is primarily intended to replenish the Royal Navy's Queen Elizabeth class aircraft carriers with munitions, provisions and other non-liquid stores. With a length of 216 m, a beam of 34.5 m and a displacement of circa 37,000 tonnes, the three ships will be second in size only to the carriers amongst ships built in British yards in recent years. Crucial to their new role will be provision of three heavy replenishment rigs controlled from a centralised Replenishment At Sea Control (RASCO) position. Up to two Merlin-sized helicopters will also be embarked to support vertical replenishment. Their main propulsion system is to incorporate four main diesels and twin shaft lines for a sustained speed in excess of 19 knots, whilst two hybrid electrical motors/ generators will assist low speed operation. An interesting feature of the BMT design is the provision of a midships integrated bridge that provides optimum visibility for both navigation and replenishment operations.

<u>Author</u>

Conrad Waters is a naval and defence analyst based in the UK. He is Editor of Seaforth World Naval Review, Joint Editor of Maritime Defence Monitor and a regular contributor to other Mittler Report publications



John Wood, Group Chief Executive Officer, Harland & Wolff (right), pictured with British Secretary of State for Defence, Ben Wallace, at the company's Belfast yard.

The FSS contract forms an important part in the UK's National Shipbuilding Strategy, which aims to revitalise the British maritime sector. The award is particularly significant for the defence operations of Harland & Wolff (formerly InfraStrata). They will be responsible for delivering GBP 700 M to GBP 800 M of work under the programme as manufacturing partner to project lead, Navantia UK. Harland & Wolff's involvement will result in the return of full-scale shipbuilding to the group's Belfast shipyard, perhaps best known as builder of the iconic liner Titanic, after a more than 20 year hiatus. There will also be considerable benefits for the group's other shipyards and wider supply train spread out around the UK.

Interview

ESD: First, congratulations to Harland & Wolff (H&W) and the other members of Team Resolute in signing this significant contract. Could you explain the importance of the contract to the group's overall business and also to its naval segment in particular?



The three new Fleet Solid Support Ships are primarily intended to replenish the Royal Navy's carrier strike groups. This graphic shows a FSS (left) and 'Tide' class fleet tanker (right) operating with a Queen Elizabeth class aircraft carrier.

H&W: The contracts will create 1,200 UK shipyard jobs, hundreds of graduate and apprentice opportunities, and an expected 800 further jobs across the UK supply chain. Around 900 jobs will be created at Harland & Wolff's Belfast site alone, so the contract is a welcome boost for Northern Ireland, bringing naval shipbuilding back to Belfast.

This is the last chance to capture the excellent shipbuilding skills that remain in Belfast and Appledore and pass them on to the next generation of UK shipbuilders before they are lost. The UK Government has seized this opportunity and in doing so ensured the long-term survival of our shipyards and significantly bolstered sovereign shipbuilding capability. FSS unlocks almost GBP 77M of investment by Team Resolute into new technology that will modernise Harland & Wolff shipyards across the UK. Our partners at Navantia are very proud of their 'Shipyard 4.0' technology that uses, among other advances, big data, the internet-of-things, 3D printing, AI, autonomous vehicles, UAVs and block-chain to make the whole shipbuilding process more efficient. The Team Resolute model means that technology will be coming to the UK, making us a strong contender for future naval contracts and allowing us to compete internationally. Harland & Wolff has a strategy of working across five sectors - defence, energy, re-

across five sectors – defence, energy, renewables, cruise and ferry, and commercial – so we are aiming to be resilient whatever the conditions in the market are. This multisector approach means that even if one or two areas are slower, the others should be stronger, meaning we are resilient.

ESD: Clearly, signature of the contract is a major achievement, particularly given Harland & Wolff's relatively recent return to the naval sphere. What factors do you attribute to Team Resolute's success?

H&W: We were delighted that Team Resolute's bid proposal was recognised as the strongest and most innovative way of delivering these vessels which are critical to the Navy's carrier strike programme. The award of the contract is a testament to the strength of the proposal we submitted, reflecting true value for the UK.



All three Fleet Solid Support Ships will be integrated at Harland & Wolff's Belfast shipyard.



As well as providing the Royal Navy with essential logistic support capabilities, the Fleet Solid Support Ship contract will help revitalise British shipbuilding as part of the National Shipbuilding Strategy.

Team Resolute's bid delivers value across the UK, rather than concentrating it in a central belt in Scotland. Current defence spend in Northern Ireland is GBP 30 per capita, whilst in Scotland it is as much as GBP 360. Team Resolute's bid puts investment directly into Northern Ireland by revitalising our Belfast shipyard, helping to level up defence spend across the whole of the Union, whilst generating GBP 1.4 Bn of value back to the Treasury.

We also engaged extensively with UK businesses, to maximise use of the UK supply chain in the FSS programme. That means not only working with existing suppliers to the defence industry but broadening opportunities beyond this, engaging with companies new to the sector who have the expertise to provide vital equipment but do not currently do so. To help achieve this, during early 2022 five regional events were staged allowing UK companies interested in partnerships to learn more about opportunities to get involved. The events were held in Appledore, Belfast, Bristol, Edinburgh and Gateshead and were attended by 290 organisations interested in working with Team Resolute. Of these organisations, 186 were SMEs. In total, the programme resulted in 259 one-toone meetings with procurement teams exploring how they could take part in the programme.

ESD: Could you elaborate on Harland & Wolff's specific role in delivering the project and how this interfaces with the responsibilities of the other members of Team Resolute? **H&W:** The majority of the blocks and modules for the ships will be constructed

at Harland & Wolff's facilities in Belfast and Appledore, following the entirely British-crafted design by the Bath-based company BMT. All integration and final assembly for all three 216-metre-long vessels – each the length of two Premier League football pitches – to be completed at Harland & Wolff's Belfast yard. Build work will also take place at Navantia's shipyard in Cadiz in Spain.

ESD: What roles will Harland & Wolff's various shipyards around the United Kingdom play in delivering the contract? Will the programme essentially be dominated by Belfast or will there also be significant benefits to the other group yards in England and Scotland?

H&W: As mentioned, all of Harland & Wolff's yards will play a part in the FSS and benefit from the contract. Components will be made at Arnish and Methil [Harland & Wolff's Scottish yards], which will go into blocks which will be built at Appledore. Blocks will be integrated into vessels at Belfast.

ESD: Clearly delivery of the contract will involve a large challenge in assembling and training a workforce to deliver the project given that the workforce in Belfast (and elsewhere) is currently relatively small. How do you intend to approach this challenge?

H&W: As part of the arrangement we will be investing around GBP 100 M into UK shipyards, including GBP 77 M of infrastructure at Harland & Wolff's Belfast and Appledore shipyards, and a further GBP 21 M in skills and technology transfer from Navantia UK. This will help to create one of the most

advanced shipyards in the UK at Harland & Wolff; a significant boost for future export and domestic shipbuilding.

ESD: What other major challenges do you envisage overcoming in delivering the project to time and budget?

H&W: This is certainly a complex programme but Harland & Wolff has shown it can flex quickly to take on challenging projects. Last year we had Cunard's Queen Victoria here in Belfast, the largest ship to ever dry dock in the UK. We carried out the work on that on time and on budget. We have the capabilities, the skills and a clear plan to deliver for the UK Ministry of Defence.

ESD: Finally, could you say a few words about your wider ambitions for Harland & Wolff's naval business?

H&W: The investment being made to develop H&W's sites in Belfast and Appledore will help to create some of the most advanced shipyards in the UK at Harland & Wolff. We expect this to boost the capacity and capabilities of H&W across the UK, creating opportunities to take on bigger and more complex project work in our areas of expertise. Investment in FSS will create a strong foundation of modern technology and build a skills base that we can leverage off to complete other contracts, and be competitive when bidding for work for export markets, not just for the UK.

ESD: Mr Wood, thank you very much for your most informative responses

Questions were asked by Conrad Waters.

Maintaining Deterrence and Defence: Italy's Improving Submarine Capability Strengthens NATO's Southern Flank

Lee Willett

Italy's new diesel-electric submarine (SSK) – being delivered under the U212 Near Future Submarine (NFS) programme – will arrive at a time when new submarine capabilities are having significant effect in an increasingly contested underwater domain. The boats' improved capabilities will reinforce the output the Italian Navy is already generating with its Todaro class Type 212A SSKs.

n February 2023, NATO hosted its annual, Mediterranean-based anti-submarine warfare (ASW) exercise, 'Dynamic Manta', in the Ionian Sea off southern Italy. As 'Dynamic Manta' takes place on the doorstep of the Eastern Mediterranean/Black Sea region, it is very much a real-world exercise. Since the return of great power competition and naval rivalry at sea, the region has become a critical stage within undergoing significant transformation, adding capabilities that support both national and international interests. This includes F-35s onboard the aircraft carrier Cavour, improved amphibious capability



NATO surface ships and submarines assemble in February 2023 for the alliance's Mediterranean-based anti-submarine warfare (ASW) exercise 'Dynamic Manta'. The Italian Navy Type 212A Todaro class submarine Scirè was present for the exercise.

Author

Dr Lee Willett is an independent writer and analyst on naval, maritime, and wider defence and security matters. Previously, he was Editor of Janes Navy International, senior research fellow in maritime studies at the Royal United Services Institute, London, and Leverhulme research fellow at the Centre for Security Studies, University of Hull. the wider Euro-Atlantic theatre, as NATO navies and the Russian Federation Navy use operational presence to joust for strategic position across the Eastern Mediterranean, the Black Sea, and the Bosporus/ Dardanelles straits maritime choke point that connects them. The region's geostrategic significance is being borne out in how it has become a critical access and presence point in the Russo-Ukraine War. For NATO, the Italian Navy provides major presence in Central and Eastern Mediterranean waters. The Italian Navy has been

based around the assault ship Giuseppe Garibaldi, surface punch provided for antiair warfare and ASW tasks by its Bergamini class FREMM multi-mission frigates, and a recapitalised and expanded submarine force built around its Type 212A fleet. One Type 212A was deployed on 'Dynamic Manta', according to NATO Maritime Command (MARCOM). MARCOM and the navies themselves tend not to release names of submarines operating at sea. However, social media outlets suggested the boat was the second-in-class Scirè (S 527). Photo: NATO



Scirè is pictured in the Mediterranean in 2018. The Italian Navy submarine presence in the Eastern Mediterranean is increasingly important, due to greater levels of naval activity in the region.

In a MARCOM press statement released as the exercise got underway, Rear Adm. Stephen Mack, a US Navy (USN) officer and Commander Submarines NATO, said "Strategic defence of the alliance must incorporate a planned, multi-threat response. 'Dynamic Manta' provides the framework to deliver that training in a wide range of maritime competencies. 'Dynamic Manta' is one of MARCOM's most technically challenging exercises, and is made possible by the outstanding support we have received from the Italian Navy as host country," Rear Adm. Mack added.

Such support included Scirè's presence. Scirè participated in several ASW serials, which built in complexity from basic to the advanced level, as the NATO maritime forces progressed during the exercise from unit-level training to focus on fully integrated operations, MARCOM told MDM. Scirè also participated in a serial dedicated to demonstrating interoperability between submarines and NATO special forces. The wide range of training that 'Dynamic Manta' provides to deal with a broad spectrum of threats underlines the complexity of the Eastern Mediterranean operating environment that the Italian Navy's Type 212As work in.

Several NATO and non-NATO countries operate submarines in the region. Moreover, since the return of state-based rivalry at sea and the growing strategic importance of the Eastern Mediterranean as the sole maritime access point into the Black Sea, Russia has sought to inflate an antiaccess/area denial (A2/AD) 'bubble' over the region to limit – and deny, if needed – NATO naval access into the Black Sea. With the onset of war and Turkey's decision (under the 1936 Montreux Convention) to close access through the Bosporus/Dardanelles to any warship not homeported in the Black Sea, naval congestion in the Eastern Mediterranean has increased. Russian 'Kilo' class SSKs homeported in the Black Sea have continued to move back and forth through the region. Russia has also reportedly deployed nuclear-powered submarines (SSNs) to the Eastern Mediterranean, alongside surface forces already operating there. Russian forces present in the region have used Tartus, Syria as a forward-deployment 'pit-stop'.

In February 2023, the Chief of Italian Naval Staff Adm. Enrico Credendino told the Defence Commission of the Italian parliament's lower house that the number of Russian ships in the Mediterranean was increasing to a level not seen even in the Cold War, bringing greater risk of tension and incident. The admiral noted that one Russian naval group was sailing near Ital-

SHIP DESIGN & TECHNOLOGIES

ian waters in the Ionian Sea. At the same time, four NATO carrier strike groups – French, Italian, Spanish, and US – were present in the Mediterranean, including to participate in the NATO 'Neptune Strike' carrier integration exercise.

From NATO's perspective, submarine capability is key to lancing A2/AD 'bubbles', for example around choke points, and to support wider sea control requirements including securing sea lines of communication (SLOCs) in wartime.

In peacetime, too, SLOC protection is a core role for Italian submarines. In the Eastern Mediterranean, commercial traffic heads not only towards the Black Sea but to the northern access point for the Suez Canal. Submarines of the Marina Militare play a key role in monitoring such traffic, providing surveillance which encompasses operational task requirements including countering terrorism and managing illegal migration.

The Eastern Mediterranean is also a choke point for critical seabed infrastructure like oil and gas pipelines and data and power cables. A number of cables funnel through the Suez Canal northern access point. Current and future submarines of the Italian Navy will play a critical role in securing such infrastructure. In July 2022, the Italian Naval Staff signed an agreement with stakeholders in Italy's communications sector for the navy to provide increased surveillance of seabed infrastructure.

In sum, in support of both national and NATO requirements, Italian Navy's submarines must be designed and equipped to deliver the full range of tasks to tackle the full range of threats, whether working independently or (as NATO submarines and surface ships are now doing to a greater degree) as part of national or multinational task groups.

Submarine capabilities of the Marina Militare

Set against this context, the development of future submarine capabilities is critical from both national and NATO perspectives. Thus the news, in February 2023, that the navy's latest submarine programme – to deliver four new boats under the U212 NFS (Near Future Submarine) project – had passed critical design review (CDR) was an important step in sustaining Italian Navy's submarine capability.

The essence of the critical design review is that the future submarine's design is certified as mature, delivering a boat that is safe and reliable for operations at sea, and able to meet its mission requirements. The programme is now set to move on to the next phase – build of the



The Italian Navy's lead Type 212A submarine Salvatore Todaro is pictured at the US Navy's (USN's) Norfolk Naval Station, prior to training with USN assets including a carrier strike group. Such training builds integrated ASW capability, which is increasingly important for operations in the Eastern Mediterranean.

submarines, and delivery of the boats into operation. In a statement released announcing CDR approval, OCCAR – the European defence procurement agency, and responsible for managing the U212 NFS contract including co-ordinating development and delivery of the boats - said that passing the CDR's formal assessment of platform design set against product specifications and operational reliability requirements was a "fundamental step for the realisation of the new generation of submarines". "The CDR has demonstrated that the design is mature and fully compliant to mission performance requirements," OCCAR said, adding "The system can now proceed with the manufacturing, system installation, integration, and trial test phase."

In 2016-17, the Italian Navy took the decision to maintain a force level of eight submarines. This force structure consists currently of four Type 212A Todaro class SSKs, which were commissioned in two batches of two boats in 2006-07 and 2016-17 respectively, and four older Improved Sauro class SSKs. The four U212 NFS boats will replace the Sauro submarines, again being delivered in two batches of two.

An eight-boat force level (compared to the Italian Navy's previous force level of six boats) will enable the navy to maintain more boats at sea. Under traditional naval roulement processes, three boats cycle through a rotational deployment to maintain one boat on station. So, a six-boat force level would generate two at sea on patrol. However, using alternative deployment postures and having eight boats in the flotilla may mean that operational availability will be higher than one boat in three.

In terms of providing technology and capability upgrades, the benefits of the 'batch' approach were demonstrated with the Todaro class. The second batch – boats three and four – were fitted with the new Kongsberg MSI-90U Mk 2 weapon control/combat management system (CMS), the STN Atlas Elektronik CSU 90-138 integrated sonar, the Cassidian OMS 100 optronics mast, and the Black Shark Advanced NPS (Nuovo Siluro Pesante) wire-guided torpedo.

In March 2021, a contract to design and build the U212 NFS submarines was signed, with the contract splitting development and delivery into two batches of two boats. The contract also covers development of training facilities and provision of support for a 10-year period.

Under this contract, the first boat, referred to by OCCAR as U212 NFS NR.1, was laid down in January 2022. According to OCCAR, the current delivery schedule will see boat one arrive by the end of 2027, and boat two (NR.2) at the start of 2029. In December 2022, a contract was issued for development of boat three. The last two boats (NR.3 and NR.4) are scheduled to arrive in 2030 and 2031.

In a statement to MDM, an OCCAR spokesperson said "The next significant programme milestones include the first steel cutting for U212 NFS NR.2 (in 2023), Lithium-Ion [Li-Ion] battery integration assessment, the Training Centre delivery (2025), and NFS NR.1 launching (in late 2026)."

The Type 212A boats were built by Italian shipbuilder Fincantieri, implementing Italian modifications to an original common design originally developed by German shipyards Howaldtswerke-Deutsche Werft and Thyssen Nordseewerke to meet German requirements. Known as 'Improved Todaro' submarines, the U212 NFS boats will provide design and capability upgrades over the Type 212As. "The new U212 NFS is a decisive evolution compared to the original Italian-German U212A programme," said the OCCAR spokesperson.

According to OCCAR, the U212 NFS boat design "has capitalised on the experiences of the current Type 212A and has exploited the cutting-edge technology of the mechanical, energy and sensor, structures, and projects sectors". Broadly, it will bring improved design, stealth, transit speed, endurance, surveillance, command and control (C2), and sensor/weapons payloads.

Much of the capability augmentation will be enabled by the U212 NFS boats being 59 m in length, compared to the 55 m Type 212As. The U212 NFSs will displace 1,995 tonnes when dived, compared to the Type 212A's 1,830 tonnes. When dived, the new boat's top speed will be 20 kn.

Improved design, technology, and capability is being introduced across the submarine, including: new hull, fin, rudder, and propeller shapes; low-profile electronic masts and periscopes, including an integrated radar/communications electronic support measures antenna; non-magnetic steel; a new air-independent propulsion (AIP) system; Li-Ion batteries; a re-designed control room, to enable installation of more operator consoles; a new CMS, in the form of the Leonardo Athena Mk2/U CMS system; a state-of-the-art integrated platform management system (IPMS), supplied by Fincantieri Nextech; an improved sonar suite; Elettronica electronic warfare (EW) capability; and a weapons load-out that consists of the Leonardo Black Shark NPS torpedo and, potentially, a stand-off cruise missile (of a still-to-be-determined type).

On the latter point, it should be noted that Germany and Norway (through tkMS and Kongsberg, respectively) are already cooperating on development of a Naval Strike Missile (NSM) capability for the German Navy.

In particular, the U212 NFS boats will have a higher degree of Italian design and technology input. In its statement to MDM, OCCAR highlighted several key capabilities here.

First, the Leonardo CMS brings nine dualscreen, interchangeable multi-function consoles plus a separate console for the boat's commanding officer. The CMS system and its set-up are designed to enhance picture compilation, data exchange, and task planning and execution. This will "enable NFS to operate as a main node of an underwater network that will extend the platform's overall surveillance capability", the OCCAR spokesperson said.

"The boats are designed to enter the 'system of systems' approach, meaning they will be capable of interacting with uncrewed systems," Johannes Peters, Head of the Center for Maritime Strategy and Security, Institute for Security Policy at Kiel University, told MDM. "To what degree this will be achieved remains to be seen, but the important thing is they will function as a bridging platform from traditional submarines to a 'system of systems' in the future." Second, the use of electric-drive universal modular masts, developed by L3HARRIS Calzoni, provides a basis to move towards future development of a full electric submarine, said OCCAR.

Third, a collection of Italian industrial companies including Fib, FAAM, and P4F are working together to develop the Li-Ion battery system technology. Li-Ion batteries are widely seen as one of the next key steps to be taken in submarine capability development.

AIP enables SSKs to generate dived endurance for several weeks at a time, as opposed the several days that a traditional SSK can spend below the surface. "This gives them a decisive tactical advance without having to cross the 'nuclear bridge'" – in other words, not having to develop a nuclear-powered attack submarine (SSN) capability – said Peters.

Li-lon batteries present the opportunity to take AIP capability and the advantage it offers a step further, Peters explained. "To exploit the potential of AIP even more, the switch from lead-acid to Li-lon batteries will be the next step. This technique offers further enhanced submerged endurance," he added.

The U212 NFS boats will also reflect design and capability developments for the Type 212 Common Design (CD) SSK being built by tkMS for the German and Norwegian navies. Such commonality offers options for co-operation on maintenance, and enhances interoperability, Peters noted.

Decision-making at Machine Speed: Bringing Al into the Command Chain

Richard Scott

The need to operate in increasingly complex and demanding operational environments threatens to overload the human-centred command chain on board a modern warship. Expanded use of rapidly developing AI techniques offers the potential to address this challenge, revolutionising decision-making in the command space. This article examines recent experimentation in this area, using the Royal Navy as an example.

Background

The combat information centre (CIC) serves as the focal point for picture compilation, mission management, and weapon control on board a modern warship. It hosts a team of human operators responsible for providing tacticians and commanders with rationalised information as the basis for real-time decisions. Members of the warfare team interact with computerised consoles, displays, communication devices, and other peripherals to build a collective appreciation of the tactical situation; evaluate and prioritise threats; and manage the 'battle' on, above, and below the sea surface.

Currently, the command chain in the CIC is based on a highly prescriptive and humancentred decision-making hierarchy, with compilers and operators building a tactical picture from a variety of organic and non-organic sources to enable timely and informed tactical decision-making: for example, courses to steer to open weapon arcs, or the execution of soft-kill countermeasure ploys. However, it is recognised that command teams are now at increasing threat of overload as naval forces are increasingly called upon to operate in ever more complex and demanding operational environments characterised by diverse and increasingly challenging threats.

At the same time, ships are in receipt of ever greater volumes of data from both organic sensors and non-organic sources, thus complicating the ability of command teams to identify, understand and react to the threat scenario. Operators are also

<u>Author</u>

Richard Scott a well-known author and commentator on naval operations and technology.



An Electronics Technician tracks surface and air contacts aboard the guided-missile destroyer USS Paul Hamilton (DDG-60). Command teams increasingly face cognitive overload as threats grow in complexity, environments become more challenging, and data volumes grow.

subject to increasing strain: staring at a screen for several hours at a time on defence watches requires intensive human concentration, even with break periods. Any lapse could mean a contact is missed or misidentified.

It is against this backdrop that naval practitioners, operations staff, defence scientists, industry and academia have all begun to consider how increased automation and greater use of artificial intelligence (AI) techniques can improve the acuity and speed of decision making in the command and control space. Definitions vary, but in broad terms AI can be characterised as 'intelligent behaviours' displayed by machines. In essence, this describes the ability of machines to mimic the cognitive functions employed by humans for reasoning, planning, learning and problem solving tasks.

AI has already started to enter the mainstream in the commercial and consumer sectors as corporations have seen the potential of AI to improve productivity, increase efficiency, and simplify task execution. Navies are now also keen to harness the power of 'machine-speed' AI in command and decision-making, recognising that AI techniques are good at extrapolating patterns, trends and signals from noisy and dynamic data. At the same time, there is an understanding that integrating human operators and computers in an effective and efficient socio-technical organisation brings with it a myriad of technical, operational and ethical complexities.

Al in Context

High-level automation is by no means new to naval warfare. For instance, self-defence



The CIC of the Visby class corvette HSwMS Karlstad. Future AI-enabled command and control systems will require human and machine teaming to be considered as a fundamental part of the design process.

weapon systems set to 'auto' mode will automatically engage when pre-determined engagement threshold conditions are met. This represents is a very rudimentary form of AI in so far as the weapon system has the ability to assume a function otherwise performed by a human. However, it should be made clear that this is not a learning system as it only functions to pre-programmed rule sets.

Initial thinking on the implementation of early forms of AI into the command environment goes back to the 1980s. Royal Navy (RN) ship losses in the South Atlantic, the anti-ship missile attack on the frigate USS Stark (FFG-31) in the Gulf, and the inadvertent shoot-down of an Iranian A300 airliner by the cruiser USS Vincennes (CG-49) all provided evidence as to the fragility and fallibility of action information organisations reliant on large and hierarchical human-centric command chains. In some situations, a combination of high workload and battle stress overwhelmed the cognitive capacities of operators, leading them to incorrectly assess a situation and/ or miscalculate the appropriate response. In others, a lack of attention by operators and warfare officers meant threats were ignored even when there were clear clues that an attack was imminent.

By the 1990s, some limited attempts were made to introduce forms of AI into the command chain. However, these so-called 'expert' systems – implementing a form of AI based on a knowledge base containing embedded doctrine or rules – encountered a number of shortfalls and limitations. For example, constraints imposed by the computing throughput and accessible memory of the era necessarily limited the complexity of software implementation. Also, these knowledge-based techniques were very rigid in their implementation – relying on rules that had been distilled from operator experience – and so very narrow in their application.

Renewed interest in the implementation of Al in naval command and control reflects the significant advances in technology and techniques over the last decade - most importantly, the revolution in deep learning that today enables computers to learn and generalise in a more human-like way on a specific task. At the same time, there is a better appreciation of where Al could add value in the command process: for example, by helping to alert operators to potential threats at an earlier stage, or to support threat evaluation and weapon assignment (TEWA) in complex multi-threat scenarios. It should also be understood that, for the foreseeable future at least, the idea of completely replacing human beings by machines is not being countenanced. Rather, the focus is on the exploitation of AI techniques to cut down the workload of decision-makers, and thereby give humans more time and improved clarity when they plan missions, estimate adversary capabilities, or consider taking a particular course of action. In short, AI can deliver critical decision support when time is limited or when the number of choices is too large for humans to be able to analyse all alternatives.

One example of such a decision aid is the hard kill/soft kill (HK/SK) Performance Assessment Tool (HaSPAT) prototype developed by the Johns Hopkins University Applied Physics Laboratory (JHU APL). Designed to help operators understand the planned defensive posture and evaluate combat system performance before an enemy attack, HaSPAT also balances weapon inventory by advising what resources are available and ensuring adequate magazine capacity is retained for self-defence. Engineers from JHU APL developed HaSPAT after a June 2019 visit to the US Navy Aegis cruiser USS Bunker Hill (CG-52). After discussions with the ship's commanding officer, the decision was made to undertake rapid development of a tool that could help the warfare team on board better plan and coordinate the use of hardkill and soft-kill effectors.



Johns Hopkins University Applied Physics Laboratory's hard kill/soft kill (HK/SK) Performance Assessment Tool (HaSPAT) prototype was deployed aboard the US Navy Aegis cruiser USS Bunker Hill (CG-52) in early 2020.



Intelligent Ship Phase 2 saw a total of 10 intelligent agents funded and an 'integrator' selected to manage the development of the ISAIN environment.

HaSPAT incorporates information about weapon effectiveness to support weapon assignment and scheduling, and embeds a simulation to produce analytics and performance metrics to inform the user of possible risks associated with configurations. It was also designed such that users could set up different force battlespace configurations for area and self-defence experiments.

The prototype tool was deployed on board USS Bunker Hill in early 2020 so that crew on board could evaluate HaS-PAT functionality and offer feedback for further updates. According to JHU APL, this initial demonstration has provided a stepping stone to a much more significant hard-kill/soft-kill coordination capability at force level.

Across the Atlantic, prototype decision aids designed to accelerate and improve command team situation awareness and threat analysis in stressing above-water warfare scenarios have also been subject to operational experimentation at sea by the British RN. For example, a number of AI tools were evaluated by the RN and the Defence Science and Technology Laboratory (Dstl) during the At-Sea Demonstration/'Formidable Shield 21' exercise in May 2021. One was Roke's STARTLE application, which is designed to help ease the load on operators monitoring the air picture by providing realtime recommendations and alerts. Another was CGI UK's System Coordinating Integrated Effect Assignment (SYCOIEA) automated platform and force TEWA application.

The Intelligent Ship

It is recognised that a central challenge going forward is how to engineer the interaction and teaming of human operators with computers and Al software programs so as to minimise the 'friction' between human intent and the execution of that intent using automated or autonomous systems. This integration – the seam of which is the human-computer interface – must recognise that humans are not just 'users' or 'operators' but are themselves part of the decision-making loop, and so integral to function and output.

This need to examine some of the key issues around the potential for AI to transform command decision-making was, in 2019, the catalyst for the UK's Dstl to launch a multi-phase science and technology project (S&T) known as the 'Intelligent Ship'. Funded by the Ministry of Defence (MoD) as part of its wider autonomy S&T programme, this ongoing effort represents a ground-breaking attempt to engineer a collaborative 'system of systems' in which automation and AI are more closely integrated and teamed with humans to enable more timely and better informed planning and decision-making. Importantly, the Intelligent Ship project set out to demonstrate a future command and control concept where humans and AI 'agents' were designed in at the outset, rather than simply have AI added in to a traditional action information organisation. Furthermore, it also recognised that the system of systems would include machine-machine teaming as well as human-machine teaming.

Phase 1 of the Intelligent Ship programme involved a series of 'challenge' themes – mission planning and decision aids, information fusion, sensor and information management, novel human-machine interfaces, human-machine teaming, and integration – representative of the various functions and capabilities found in a typical warship. These included components supporting platform systems, as well as command planning and decision aids.

A core part of this initial six-month phase was a task to develop an Intelligent Ship AI Network (ISAIN) framework. Developed under the leadership of CGI UK with support from DIEM Analytics, Human Factors Engineering Solutions and Decision Lab, ISAIN is an environment within which human-machine teaming can be explored in different scenarios, enabling the development and evaluation of new organisation and workflow structures that capitalise on the use of Als working alongside humans. This offers the potential to dynamically shift workload between human, AI, or both, depending on the situation and its complexity. In addition, the ISAIN framework offers a proving ground for system of systems studies, and to promote research into innovative mechanisms that support and facilitate the activities and interactions of all members of the team (both human and AI). For example, how different Als and humans collaborate, the most appropriate mix of AI and human capability, the best ways to organise Als and humans to achieve goals as a team, and the means to arbitrate or de-conflict contrary advice/ actions from multiple Als.



The Command Lab at Dstl's Portsdown West facility served as a testbed environment for Intelligent Ship Phase 2 evaluations.

Alongside ISAIN, Phase 1 of the Intelligent Ship also funded the maturation of Als – or Agents for Decision Making (ADeMs) – that could be integrated into ISAIN for the demonstrations. ADeM is a term adopted by the project to describe either a human, or a machine-based intelligence agent operating within a mixed human-AI machine or AI machine-AI machine team.

A call for Phase 2 of the Intelligent Ship project was issued through the MoD's Defence and Security Accelerator (DASA) in June 2020. DASA funds innovative and potentially exploitable S&T ideas that could lead to a cost-effective advantage for UK armed forces and national security. A total of nine Phase 2 contracts - cumulatively valued at around GBP 3 M - were awarded in November that year. Approximately half of that figure went to CGI UK as ISAIN integrator and developmental lead. In this role, CGI UK partnered with Dstl for ISAIN integration, installation of ISAIN into a Command Lab established at Dstl's Portsdown West site, design development for how the various aspects of the Intelligent Ship would come together within the ISAIN environment, and integration of selected ADeMs into the ISAIN architecture.

DASA committed the remainder of Phase 2 funding to the development of specific 'trained' Als. Individual contracts were awarded to Decision Lab, DIEM Analytics, Frazer Nash Consultancy, Montvieux (which received two awards), Nottingham Trent University, Rolls Royce and SeeByte. CGI UK produced a software development kit, based on industry standards and tools, which was provided to the various ADEM suppliers.

Alongside the DASA contracts, the Tactical Navigation (TacNav) agent previously developed under Dstl's 'Progeny' framework was pulled through into Intelligent Ship Phase 2. Developed by CGI UK, TacNav has been developed to plan, execute and monitor tactical navigation for the Intelligent Ship. Also featuring in Phase 2 was CGI's SYCOIEA TEWA decision aid.

Because the project was unable to fund all the proposals arising from the DASA call, the decision was taken to select a broad spectrum of AI agents spanning a range of platform and combat system functions. For example, Rolls-Royce developed a decisionmaking control system known as ACE (Artificial Chief Engineer) designed to make condition-based decisions about how best to operate ship machinery - engines, propulsion system, electrical network and fuel system - according to command priorities. Another AI, called IBIS (Internal Battle Intelligence Reinforcement Learning for Damage Control and Firefighting) was conceived by Frazer Nash Consultancy as a predictive damage control tool using novel AI-based reinforcement learning techniques.

The Intelligent Ship team also selected a Decision Lab-developed AI known as CIAO (Advanced Compounded Intelligent Agents for Optimisation) that could be employed to arbitrate conflicting outputs delivered by two different agents. For example, it might come into play if TacNav recommends a course based on underwater obstacles or local shipping traffic but a TEWA agent suggests an alternative course in order to open weapon arcs against an incoming threat. CIAO was implemented in a number of parts of the system so as to offer compounded advice in different parts of the decision chain.

Command Lab

ISAIN was integrated within a Command Lab facility established at Dstl's Portsdown West site. This facility – hosting a live, virtual, and constructive simulation made up of open and flexible hardware, software, networks, databases and protocol interfaces – has been co-funded by a number of parts of Dstl. It serves as a configurable testbed affording the capability to conduct experimentation and integrate new systems in all warfighting environments.

To support Intelligent Ship experimentation and evaluation activity, the Command Lab was outfitted with operator terminals resembling CIC multifunction consoles, allowing military advisors to interact with AI agents in a pseudo-operational setting. Four separate evaluations have been performed at the Command Lab, during 2021 and 2022, with the complexity of scenarios, the number of agents and the maturity of those agents increasing over time.

The evaluations were run against a notional scenario, developed by Dstl military advisors, which allowed ADeMs to be demonstrated in a representative operational setting. This began with a planning phase. After this, the 'ship' - operating ahead of a larger task group - made a transit to undertake intelligence-gathering operations close to contested waters. With tensions running high, a confrontation ensued with an adversary Red Force. This culminated in an anti-ship missile attack in which ownship damage was sustained. For the purposes of the evaluations, this end-to-end scenario was broken down into a series of shorter vignettes, each consisting of about half an hour of 'operational' activity. These were scripted so as to maximise the interactions between agents.

Phase 2 completed at the end of March 2022. The research and experimentation provided valuable early insights into the opportunities and benefits of bringing multiple AI applications together to make collective decisions, both with and without human operator judgement. At the same time, it identified a number of new guestions about how AI-enabled automation is best implemented and managed in a complex command environment. The conclusion was that true operational advantage could only be derived by addressing the design and operation of teams of multiple intelligent machine agents, and to enable and optimise the integration of humans within those teams to form effective Human-Autonomy Teams (HATs).

DASA, working in partnership with Dstl, announced its plans for Phase 3 of the Intelligent Ship in early 2023. Building on the collaborative AI concepts previously developed and evaluated in Phase 2, this followon S&T programme is being structured so as to explore the benefits of earlier and more focused consideration of the human components of a HAT to support future naval command and control. Phase 3 aims to design an integrated system for a HAT that can deliver aspects of above-water naval command and control, and make more detailed consideration of the arbitration needs of collaborative Albased HATs. This will drive a greater focus on systems design, as opposed to AI agent development; the integration of the human within the HAT system; and an understanding of arbitration approaches for potentially conflicting recommendations from different AI agents. The intention is that the existing ISAIN environment will be used for integration and evaluation.

A competition for Phase 3 is expected to begin in April 2023. The intention is that a single collaborative and multi-disciplinary team will deliver the entirety of all outputs, including system design, build, integration and evaluation. Current plans envisage the award of a contract in the third quarter of 2023, with Phase 3 activity expected to run through to December 2024.

Conclusion

The coming years will see AI employed in numerous contexts across the naval domain. At the same time, it is recognised that the use of AI raises a number of pro-



Personnel in the CIC of the guided missile destroyer USS Dewey (DDG-105). The coming years will see AI employed in numerous contexts across the naval domain, melding humans and machines together.

found ethical, legal and governance issues. The challenge facing navies, defence science and industry today is to identify operational shortfalls and capability gaps where AI may form part of the solution, and to understand how best to meld humans and machines together so as to combine human cognition, intuition and responsibility with machine-speed analytical capabilities.

In the longer term, the introduction of AI into the command chain may demand a

paradigm shift. Instead of designing systems, and then engineering an interface with a human operator, the command and control system of the future will be designed such that human and machine teaming interaction is a fundamental part of the underpinning concept and design. Furthermore, careful attention will be required to determine the optimal balance between human and machine elements within a command team across a range of operational scenarios and tasks.

DNV NAVAL SERVICES



DNV

Assurance and Advisory -Tailored to the challenges of today's navies

Naval forces are not just facing a moment of change, but an era of transformation. The decisions have never been so complex, nor the consequences so impactful. DNV offers navies unique solutions, on everything from finding an appropriate assurance approach, dealing with regulatory compliance, next generation fuels, through to platform and operational optimization, and in-depth advice and insight. As the maritime industry's most trusted voice, at DNV we help decision-makers throughout the naval world to make purposeful and assured choices.



Utilising Uncrewed Platforms for Persistent, Cost-Effective ASW in the North Atlantic

Willem Hendrik Wehner, Jens Ballé and Klemens Ehret

Given the heightened likelihood of inter-state conflicts and the proliferation of submarines around the world, anti-submarine warfare (ASW) has returned to the minds of military planners and decision-makers. Traditional ASW is cost-intensive and implies a high level of expenditure; in terms of personnel and materiel. Forward-thinking industry and military stakeholders anticipate that large uncrewed surface vehicles (LUSVs) and extra-large uncrewed underwater vehicles (XLUUVs) will relieve crewed ASW assets from 2025 onward.

his article presents a naval systems' OEM perspective on the operational and economic benefits of utilising nonorganic uncrewed maritime systems in an ASW mission. Its intent is to accelerate the creation of operational concepts considering teams of large uncrewed systems. The ASW mission that we consider is performed in the North Atlantic to protect sea lines of communication (SLOC) from North America to Europe. However, the methodology and results of this article can be transferred to other regions, such as the South China Sea and the First Island Chain. A comparison of the analysed ASW operations shows a significant economic benefit (80% savings) compared to the use of maritime patrol aircraft.

The Scenario and Assets

Overlapping geographic spheres of interest shape naval deployments in the North Atlantic, in particular in the Norwegian and Greenland Seas. From a defensive point of view, NATO seeks to protect its SLOC from America to Europe, as well as critical maritime infrastructure for energy supply and data distribution in the North and Norwegian Seas. The Russian Armed Forces mainly seek to protect their nuclear at-sea deterrent in the Barents Sea, often called a

<u>Authors</u>

Willem Hendrik Wehner develops new submarines and XLUUV at thyssenkrupp Marine Systems. Jens Ballé is a leading designer for frigates and future surface concepts at thyssenkrupp Marine Systems. Klemens Ehret develops future antisubmarine warfare concepts at Atlas Elektronik.

Situation

- North Atlantic SLOC need to function 24/7 in peacetime and conflict to supply Europe with goods and troops.
- Submarines approaching from the north threaten the SLOC.

Challenge

- ASW is a continuous task binding capable and expensive assets in the North Atlantic.
- In conflict, current ASW assets cannot protect the Bear gap.

- Approach



Assessments leading to the proposed approach.



Map of Bastion Defense, Bear and GIUK Gaps.

both parties undertake every effort to hold each other's assets at risk. The continental land mass and large islands frame this area of operation and form gaps of approximately 200 to 400 nautical miles (see map). These encompass the Bear Gap between Svalbard and continental Norway, and the Greenland-Iceland-UK or GIUK Gap. As submarines must pass through these gaps, these choke points offer the best chance of forming a submarine detection barrier. NATO needs an all-year-round, persistent submarine detection capability in all weather conditions. The required capability can be provided by large uncrewed vehicles classified as XLUUVs and LUSVs. Such vehicles are not yet active performing the described task. However, prototyping such a capability within a timescale of three years seems to be a realistic prospect when viewed as a joint effort between the user and the system integrator.

'Bastion'. From an offensive point of view,

The illustration below shows a concept for a small water-plane area single hull (SWASH) type LUSV able to operate in high sea states. It can deploy active and passive towed sonar and works in teams with other LUSV and XLUUV to create a bi- or multistatic sonar situation.

As examined in the comparison in the Fact Sheet, uncrewed solutions bring real advantages. In a further examination, we contrast traditional methods for ASW barrier operations with uncrewed options. The figure below shows the assets employed. The assets in the scenario form detection barriers in the GIUK Gap, in the Bear Gap and towards the entrance to the North Sea (where its multitude of infrastructure is covered). MPA-based detection uses 15 MPAs deployed from three airports. At every point in time five MPAs are on scene, deploying a combined total of 480 sonobuoys per day.

For the uncrewed scenario, a sonar performance simulation-based assessment of asset quantities leads to the need for 27 XLUUVs and ten LUSVs at sea. An expert assessment of typical usage upkeep cycles leads to a total need for 35 XLUU-Vs and 13 LUSVs. The Bear Gap is not protected by LUSVs due to the proximity of sophisticated anti-ship systems available to the opposition, instead depending on seven XLUUVs at sea. The XLUUV can achieve good sonar performance while remaining stealthy.

Operational Performance

The graphic illustrations below show the calculated results of a multi-asset low-frequency active sonar operation leading to a high



SWASH-type LUSV deploying active and passive towed sonar.



Fact Sheet - Uncrewed Multi-Static Active ASW Team.



MPA-based detection barrier scenario.



In this scenario, XLUUVs with typical conventional submarine towed array sonars patrol the Bear Gap. They operate in passive mode, listening for specific submarine signatures. The graphic illustrations below represent the lowest detection range results for winter and summer from more than 20 simulation runs with varying target and receiver depth, signal processing and in different seasons. The detection ranges of 41 nautical miles in March (best month) and 18 nautical miles in August (worst month) imply that seven XLUUVs at sea achieve a reasonable likelihood of detecting a submarine crossing the 370 nautical mile-wide Bear Gap.

The calculations shown verify the chosen number of assets for the uncrewed concept, providing a surveillance performance comparable to an MPA-based solution.

Mission Economics

Today's ASW is cost-intense in both capital expenditure (CAPEX) and operational expenditure (OPEX) terms. It binds capable assets with highly trained crews to an area of operations. This section compares the well-





Passive sonar line detection signal access (max. dB) of one XLUUV in Bear Gap at SS 2; Top: March, Receiver Depth (RD) 150 m, Target Depth (TD) 50 m; Bottom: August, RD 20 m, TD 150 m.



Active sonar signal access (max. dB) of one transmitting/receiving (TX/RX) and two receiving (RX) assets with spacing of 54 NM in two sea areas in summer and winter.

probability of detection across a wide area. One receiving (RX) XLUUV on each of the port and starboard sides of a transmitting (TX) and receiving (RX) LUSV form a team of three assets. The transmitter is a towed low frequency transmitter. The receivers are towed sonar arrays. The spacing between assets is 54 nautical miles. All the coloured areas indicate a detection of the submarine. With the suggested spacing, one uncrewed team could form a detection barrier in excess of 100 nautical miles. Differences between winter and summer water conditions seem to be negligible for this area and type of operation. established MPA approach cost-wise to the uncrewed concept.

MPA mission costs consist of CAPEX for aircraft procurement and OPEX for operating the aircraft as well as sonobuoys, treated as a separate OPEX position. A representative mix of active and passive sonobuoys and prices from US Department of Defense publications yields realistic sonobuoy costs. For the P8-A Poseidon both CAPEX and OPEX derive from official US publications. [3]

For the uncrewed concept, an estimated CAPEX of EUR 2.5 Bn procures 48 assets – 13 LUSVs and 35 XLUUVs – as well as rel-

evant infrastructure at three service hubs. OPEX for the LUSV / XLUUV solution considers fuel, spares, salaries, and significant capability enhancement activities at a total EUR 45 M per annum.

The graph below illustrates the cost advantage offered by a LUSV/XLUU concept compared with the traditional MPA approach. A striking feature is the inverted proportion of OPEX and CAPEX. MPA operations are OPEX-intensive whereas, for the uncrewed vehicle operation, CAPEX is higher than OPEX. In absolute figures, the monthly Total Cost of Ownership (TCO) for the MPA/sonobuoy approach amounts to approx. EUR 58 M whereas the monthly TCO for the LUSV / XLUUV concept amounts to approx. EUR 10 M.

Conclusion

An uncrewed anti-submarine warfare detection barrier seems to be an approach worth pursuing. The concept is adaptable and scalable towards different areas of operation and threat situations. It is affordable and based on near-future technology, delivering at sea capability within less than five years. Implementation is possible by individual or teamed countries or organisations such as NATO or the European Union.



Total Cost of Ownership comparison for Detection Barrier Variants; *) annualised.

Notes

1. Hudson Institute, Sustaining the Undersea Advantage: Disrupting Anti-Submarine Warfare Using Autonomous Systems. Washington D.C., 2020. 2. RAND Corporation, Enhancing deterrence and defence on NATO's northern flank. Santa Monica, 2020

3. Department of the Navy, Department of Defense Fiscal Year (FY) 2022 Budget Estimates: Other Procurement, Navy May 2021.



Do you have specific requirements? Contact our experts at defence@litef.de.

LITEF.COM

Underwater remotely operated Vehicles in Europe: an expanding Market

Luca Peruzzi

nderwater operations, ranging from the simpler hull inspection to the mine and improvised explosive device countermeasures, in addition to war ordnance disposal, have always represented a dangerous business for divers and boat operators. The spread of remotely operated vehicles (ROVs) has significantly reduced the risks and workload associated with underwater operations, and while the unmanned technologies continue to advance, ROVs will continue to play a key role where the positive identification due to different factors continues to be paramount. The European industry has made important strides in the niche segments such as the mine countering, but smaller vehicles continue to come mostly from outside the Old Continent.

Smaller vehicles

The Norwegian Blueye Robotics company offers a family of portable, rugged and commercial-grade vehicles. They include the 9 kg Pioneer model capable of operations to depths of 150 m and in currents up to 2 kt, with an endurance of 2 hours for normal operations. A powerful light allows for night operations and its full HD camera is capable of recording with a wide angle. The images can be visualised on Android or iOS smartphones and managed by the Blueye Xbox controller bundle. The Blueye Pro model, with a similar weight and endurance, can reach depths up to 305 m and operate in up to 3 kt currents. The more capable Blueye X3 can be equipped with a variety of sensors, manipulators, sonar and positioning systems. The Blueye ROV family has found applications in civil, research and military sectors; customers include the Norwegian and Royal Australian Navies, among others.

The latest addition to the Exail (formerly ECA Group) family of ROVs is represented by the R7 model, which combines the compactness and ease of deployment of mini-ROVs with the performance, speed and payload carrying capacity of professional observation class ROVs. The 300 m depth rated R7 is equipped with four horizontal vectored and three vertical thrusters allowing for a high manoeuvrability alongside operations at speeds up to 3 kt. The R7



Even the smaller ROV, depicted here by the Blueye Robotics Pioneer vehicle investigating the wreck of the Helge Ingstad frigate, is key to reducing potential risks and workload to divers and on-surface operators.

possesses a full digital architecture and weighs 32 kg. The full HD camera is controlled with a main 15" touch screen and secondary screens. It can also be equipped with a manipulator as well as a USBL (ultrashort baseline acoustic positioning system) and/or DVL (Doppler Velocity Log) to accurately track its position in real time.

Another key French manufacturer is Subsea Tech with its range of mini as well as the larger 37.5 kg *Tortuga* inspection class ROVs, the latter family capable of operating in up to 4 kt currents, regardless of the direction, and at depths up to 500 m. In April 2020, the UK-based Saab Seaeye announced an order from the Netherlands Defence Materiel Organisation (DMO) for its *Sea Wasp* ROV. Weighing 75 kg with its modular and portable system, it can be operated by a small team – as few as two



The latest addition to the Exail family of ROVs is the R7 model. It combines capabilities of mini-ROVs with the performance, speed and payload of professional observation class vehicles.

people – it is easily deployed from ships, shore and smaller boats. Tethered for power and communications and equipped with multifunctional manipulator arms and other add-ons for mission tailoring, together with camera, sonar and other navigational sensors, the *Sea Wasp* is highly manoeuvrable with six degrees of freedom and can operate in high currents (2.5+ kt) and depths up to 250 m.



The Netherlands Minister of Defence's DMO (Defence Materiel Organisation) is the launch customer for the Saab Seaeye Sea Wasp ROV.

With thousands of portable and rugged ROVs delivered in more a decade, the Canadian-based Deep Trekker company offers a commercial-grade, battery-powered (direct power alternatively) family of vehicles. The 8.5 kg DTG3 mini observationclass vehicle provides operators the ability to quickly deploy and visually inspect underwater environments within minutes. Equipped with a full HD video recording camera with a 270-degree rotating field of view, the DTG3 can reach depths up to 200 m and a speed of 2.5 kt. The larger and heavier (16.8 kg) Pivot is equipped with six thrusters powered by guick-changeable lithium batteries and a 97-degree rotating tool platform for manipulator, sonar and other equipment. It can reach a depth of 305 m and a speed of 3 kt. Furthermore, the HD 1080-pixel camera can rotate. Optional payloads include imaging and side scan sonar, alongside an USBL positioning. The 305 m depth-capable and 26 kg heavy Revolution vehicle can operate for up to six hours and is equipped with a 260-degree revolving 4K camera head, manipulator and the same optional equipment as the Pivot. The larger Deep Trekker products have found worldwide success among its



The Deep Trekker Pivot ROV is being used by US Navy operators on both SSN and SSBN fleets, while the more capable Revolution model has found international success in Europe.

customers, including the US Armed Forces and homeland agencies, as well as European operators, including the UK (*DTG3*), German Navy (*Revolution*) and the Italian Carabinieri (*Revolution*).

The mission specialist Defender ROV from US company VideoRay is the most diffuse US product worldwide, in particular among armed forces and agencies. In addition to the US Navy, it is in service or under firm order from 20 other navies and coast guards from allied nations, including European operators such as the Royal Navy and others. With a depth rating up to 400 m (2,000 m as an option) and weighing 32.5 kg (including control equipment), the Defender has four vectored horizontal and three vertical thrusters. In addition to its HD camera, it possesses a wide range of systems, including a rotating manipulator (five heads), multi-beam and scanning sonar, and additional navigation equipment (USBL, DVL and autonomous control) can be integrated.

The US Strategic Robotic Systems (SRS) Fusion ROV is another product widely distributed among US and Allied armed forces. The 25 kg heavy ROV has a depth rating of 300 m, and is equipped with four horizontal and two vertical thrusters. The *Fusion* can achieve speeds of 4+ kt, with its typical endurance being up to 3-4 hours duration. Equipped with an HD camera, it also features a forward and sidescan sonar, USBL, DVL, altimeter, GPS (vehicle), Wi-Fi and AHRS.

Mine identification and disposal systems

ROVs continue to play a key role as mine identification and disposal systems (MIDS). The MuMNS (Multi-Shot Mine Neutralisation System) is the latest development from Saab in this sector. The system has been acquired both by the French Navy and the Royal Navy.

Despite its dimensions (415 kg fully loaded weight, a length of 2.7 m and 1 m width), MuMNS is highly manoeuvrable with six Degrees of Freedom (DoF) and can dive to 300 m. The ROV is equipped with advanced sensors for mine identification and operates with a maximum of three charges of its mine neutralisation system (MNS). Thus, multiple missions before returning to the unmanned mother platform are possible. Proceeding automatically or manually controlled at speeds reaching 4 kt to a waypoint, it locates the target using its on-board sonar and cameras. The pilot manually controls the final approach to the target. Once positively identified, the pilot attaches the charge to the mine and releases the mine neutralisation system from the vehicle. It remains suspended midwater until a configurable timer releases a float to the surface. Once the deployable floats reach the surface, the charge can be remotely initiated on command. A coded radio signal unique to each MNS is used to neutralise the mine. This allows it to activate one or many mines together.





Using a commercially available Defender ROV from VideoRay, and the new OPENSEA Edge system, Greensea has successfully proven untethered operation of an ROV at sea.



The Saab MuMNS provides a mine identification and disposal system capability in the Maritime Mine Counter Measures (MMCM) programme for both the French and UK navies.

In November 2022, Seatronics, a brand within the UK-based Acteon's Data and Robotics division, announced it had delivered. installed, and commissioned the first two Valor ROVs in MIDS configuration on Elbit's Seagull unmanned surface vehicle (USV). The latter is a multi-shot, configurable and reusable mine disposal solution that can detonate multiple charges acoustically. The Valor ROV has a weight of 80 kg with a payload of more than 21 kg and a depth rating of 300 m. It is capable of deploying and operating in up to Sea State 3. The MIDS configuration features a multi-sensor package together with an ECS CobraMDS and an intervention capability with four charges. The combination between the multi-sensor package, including an inertial navigation system, sonar and cameras, and an onboard object classification system allows for the accurate detection and classification of objects. The target classification system uses machine learning and AI algorithms to categorise the seabed and floating items

Photo: Acteon



The Valor ROVs in MIDS configuration developed by UK Seatronics is a multi-shot, configurable and reusable mine disposal solution that can detonate multiple charges acoustically, using state-of the art technology.

such as mine-like objects or potential mines. In the latter case, the triggering command is sent from the control station with the umple off-board MCM systems. Each of the 12 motherships is equipped with two lateral stations for launch/recovery of a provided Inspector 125. Exail's USV can autonomously deploy and recover either the A18-M autonomous underwater vehicle (AUV) equipped with the UMISAS synthetic aperture sonar, or the towed vehicle with the T18-M towed sonar. Other elements of the MIDS suite include the Seascan Mk2 and the K-ster C ROVs, provided by Exail. For mine detection and relocation, the Seascan Mk2 is using a sonar. Cameras, remotely controlled by operators on the mothership, help to identify the type. The K-Ster C is specifically designed for mine clearance. Each of the ROVs is linked to its USV by a thin cable. Given that K Ster C has its own battery pack, the cable does not include a power wire, which is essential for the overall concept pursued by Exail since a thin cable means less drag. Thus, currents have less effect on the ROV. This solution is not



The Exail brand offers the MIDS suite including the Seascan Mk 2 and the K-ster C ROVs, being at the heart of the MCM solution provided by the Belgium Naval and Robotics consortium between Naval Group and Exail to the defence ministries of Belgium and the Netherlands.

bilical, and then acoustically telemetered to the detonation device on the Cobra, using encrypted signals. According to Seatronics, the *Valor* MIDS is currently the only vehicle of its size able to offer a multi-shot capable, reusable solution.

Exail (formerly ECA Group) offers its MIDS suite including the *Seascan Mk 2* and the *K-ster* C ROVs. It is at the heart of the MCM solution provided by Belgium Naval and Robotics (BNR), a consortium between Naval Group and Exail, to the defence ministries of Belgium and the Netherlands for the next generation BE/NL stand-off MCM capability. It encompasses motherships that will employ a 'toolbox' consisting of multi-

only more economical, but also superior in operational terms given that power cables are both more expensive and a drain on USV power, thereby limiting its operational capabilities, claims the manufacturer.

The Italy-based L3Harris Calzoni is currently working on the Hunterwater programme. It is based on an unmanned system-ofsystems to perform the complete standoff minehunting operation by means of a lightweight simple-to-use unmanned MCM module. The package consists of a USV, 8 m in length, capable of carrying and operating a dedicated suite with two main components: the ROVSCAN and the VGA. The hybrid ROV and sidescan sonar combine typical functions of a ROV with those of a sidescan sonar performing site survey, identification, and acoustic localisation of the threats. It also deploys multiple markers that allow the mine neutralisation, according to Calzoni. The VGA, a disposable acoustic guided vehicle, which is both compact and lightweight, features an automatic target reacquisition and neutralisation capability by means of an innovative precise acoustic localisation. It is carried and launched from the USV in at least four units for each mission.

The MIDS segment is covered by the Atlas Eletronik *SeaFox* system, which comes in inspection, disposal and training versions. It is in service with more than ten worldwide customers, including the navies of Finland, Germany, Japan, Sweden, US, and the Royal Navy.

Saab is offering the heavier but more capable Double Eagle family, which in addition to both MkII Mine Disposal Vehicle (MDS) and MkII/MkIII Propelled Variable Depth Sonar (PVDS) Mine Reconnaissance Vehicle, includes the newer Double Eagle SAROV semi-autonomous version. The latter has been acquired recently by Poland's Remontowa shipbuilding company in additional batches of vehicles to equip the Kormoran II class MCMVs of the Polish Navy. Italy's Gaymarine Pluto ROV family have been sold to different customers including the Algerian Navy. It also exists in a later version, the Pluto Gigas, with enhanced capabilities and sensors for operations from a non-equipped mothership.

Larger multi-role observation and working ROVs

The growing attention for seabed warfare operations triggered by the sabotage inci-



In April 2021, the NATO Support and Procurement Agency (NSPA) acquired a Saab Seaeye ROV system (ROVS) for the Spanish Navy.

dents of the Nord Stream pipelines in the Baltic Sea is leading to a greater use and procurement of new working ROVs.

The UK-based Saab Seaeye manufactures a range of electric powered ROV systems for a wide range of professional applications. The workhorse of the SAAB Seaeye ROVS is the *Leopard*, an innovative mid-size electric ROV that provides optimised transportability and operational capability in a reduced footprint.

In April 2021, the NATO Support and Procurement Agency (NSPA) acquired *Leopard* for the Spanish Navy. The system provides for improved diving support capabilities and facilitates the execution of responsibilities for the International Submarine Escape and Rescue Liaison Office. Connected to the ROV is a launch and recovery system, tether management system, hydro acoustic positioning capability and a shipboard con-



Italy's Saipem Sonsub offers its family of commercial inspection and working vehicles, including the new generation FlatFish drone capable of reaching 3,000 m with up to 12 hours endurance.

trol module. *Leopard* has a launch weight of ca. 1,200 kg. Fitted with manipulators, it can carry a payload of 105 kg, and without, 205 kg. Depending on the model, it can reach 2,000 m and 3,000 m depths.

Other variants within the Saab Seaeye family of ROVs are the *Panther, Cougar, Tiger, Lynx* and *Falcon*.

The Seaeye portfolio also includes the eWROV electric full-sized Class III B ROV system and the *Sabertooth* family. The latter is a hybrid AUV/ROV capable of working in deep water either as an autonomous vehicle or via tether. Its power, tether-free operation and its 360° hovering manoeuvrability make the *Sabertooth* an ideal option for autonomous inspection or maintenance and repair tasks, as well as offshore survey work.

The Sabertooth is available as a single hull or double hull vehicle capable of operating at depths of 1,200 m or up to 3,000 m for the double hull vehicle. It can be based for more than six months at an underwater remote docking station ready for operations. Also based in the UK as part of Forum Energy Technologies providing submarine rescue systems, Sub-Atlantic offers a range of electric observation-class ROVs that extends from the versatile *Mohican* to the powerful work-class *Comanche* capable of reaching depths of 6,000 m.

Italy's Saipem Sonsub offers a series of commercial working subsea drones, including the Innovator 2.0 ROV, rated for depths to 3,000 m. It has been acquired by the Italian Navy for its new capability, a special forces and diving operations/submarine rescue ship (SDO-SuRS). FlatFish and Hydrone are other deep-water dual-role ROV/drones in Saipem Sonsub's portfolio. The new generation drone FlatFish is capable of reaching depths of 3,000 m and has an endurance of up to 12 hours. Likewise, the units of the Hydrone family can operate at depths of 3,000 m. An underwater docking station allows them to stay on the seabed for up to 12 months. Through a remote control network any surface platform of opportunity can operated a *Hydrone*. The *Hydrone-R* is already in service, while the complete electrically operated version (Hydrone-W) will be available by the end of 2023.

The Italian Navy operates two models of L3Harris Ageotec ROVs: *Sirio* for observation missions and the multi-purpose ROV *Perseo*.

In addition to Exail, with its H-family ranging from the *H300V* (300 m) to the *H800* (800 m) and H-ROV (2,500 m), the French Forssea Robotics offers its Argos ROV with a 500 m depth rating (1,000 m as an option), weighing 170 kg, including a payload of 20 kg.

AUKUS Sets Sail in the Indo-Pacific

Peter Layton

Australia's acquisition of a replacement for its *Collins* class conventional submarine fleet is proving remarkably complicated. The 2009 Australian Defence White Paper agreed to by the then Labour Party Government announced the six *Collins* would be replaced by 12 new submarines, possibly of an evolved *Collins* design. In 2013, a conservative Liberal National Party (LNP) government was elected, and the new Prime Minister Tony Abbott now became focussed on buying Japanese designed submarines. Instead in 2016, his replacement, Malcolm Turnbull, awarded a large contract for eight very-large, French designed conventional submarines to be built in Australia. In 2021, Turnbull's replacement, Scott Morrison terminated the contract. Now the solution was to be acquiring nuclear attack submarines (SSNs) under a remarkable tri-nation agreement titled the Australia United Kingdom United States (AUKUS) partnership.

n 2022, a new Labour Government led by Prime Minister Anthony Albanese was elected vowing to continue this SSN decision. It was now formally a bi-partisan initiative although the LNP, now in opposition, does criticise and grumble. On 13 March 2023, the leaders of the US, UK and Australia announced the detail of this latest Australian submarine plan.

A Grand Plan

The plan encompasses two levels and involves much more than equipment purchases. At the strategic level, the primary intent is to deter Chinese adventurism, particularly in the current decade and especially against Taiwan. The secondary aim is to increase the three nations' presence in the Indo-Pacific. At the acquisition level, the purpose is to buy eight SSNs and transition Australia's submarine crews and maintenance teams into, what is for them, the wholly new technology of nuclear propulsion. In so doing, Australia believes it will gain a submarine capability advantage over potential adversaries through the stealth, speed and range characteristics that SSNs bring.

Author

Dr. Peter Layton is a Visiting Fellow, Griffith Asia Institute, and a RUSI Associate Fellow. He has extensive defence experience and writes frequently on geostrategic matters, force structure issues and emerging technologies.



The Collins class submarine HMAS Rankin conducts helicopter transfers in Cockburn Sound, Western Australia in the course of preparing for deployment. Replacing the Royal Australian Navy's submarines had proved to be a complex affair.

The plan's initial phase started this year with the embedding of Australian military and civilian personnel with the UK's Royal Navy (RN), the US Navy (USN) and within the British and American submarine industrial bases. As part of this, the US Congress in the FY2023 National Defense Authorization Act consented to Royal Australian Navy (RAN) submarine officers training at the Naval Nuclear Power Training Command and eventually serving on operational USN SSNs to gain experience and expertise. Less visible but no less important, Australia also aims to send hundreds of dockyard workers to US and UK shipyards, as well as scientists and engineers to US and UK technical facilities, for specialised skills training and to gain the know-how required to build and sustain nuclear-powered submarines.

This first phase will also involve the USN (in 2023) and the RN (in 2026) making longer and more frequent SSN port visits to Australia. This will strengthen Australia's existing experience in hosting such visits and support planned later expansion.

In the second phase, beginning as early as 2027 but dependent on Australia having established the necessary infrastructure and expertise, USN and RN SSNs will be rotated through HMAS *Stirling*, the Royal Australian Navy's base in Western Australia. This new Submarine Rotational Force-West (SRF-West) will gradually grow to comprise a rotational presence of one



The US Navy Los Angeles class submarine USS Ashville (SSN-758) pictured at Australia's HMAS Stirling base in Western Australia at the time of the latest AUKUS announcement. USN and RN SSNs will be rotated through the base from 2027 onwards.

British Astute class SSN and up to four USN Virginia class SSNs. Australian sailors will deploy on the British and American SSNs rotating through SRF-West to develop atsea experience with naval nuclear propulsion, while Australian maintenance personnel will support the SSNs ashore.

Each submarine will be deployed on Indo-Pacific operations followed by periods of around three months at HMAS *Stirling* for maintenance activities. These maintenance activities will help build Australia's 'sovereign ready' capabilities. In this, SRF-West will accord with Australia's longstanding bipartisan policy of having no foreign bases on its soil. Australia will retain ownership and access to all facilities, and all activities will be transparent and mutually determined.

In the third phase – and subject to US Congressional approval (probably this year) – the US intends to sell Australia three second-hand *Virginia* class submarines, with the potential to sell up to two more if needed. Once Australia has met the necessary conditions to safely operate them, the three former USN *Virginia* class submarines will be delivered in 2033, 2036 and 2039 respectively. This will ensure there is no capability gap after the retirement of Australia's existing *Collins* class submarine fleet in the 2030s.

The USN Virginia's have a large crew, 132 compared the Collins class's 42. It is possible that in the 2030s, the RAN Virginia's crewing may include some USN sailors on secondment. Irrespective, the Australian Government has been emphatic that the Australian Virginia class SSNs will be a sovereign Australian capability, commanded by RAN officers under the Australian De-

fence Force's (ADF's) chain of command. Decisions on the deployment, missions and operations of these Virginia class SSNs will be matters for the Australian Government. Importantly, the Virginia boats' nuclear reactors will be in sealed compartments inaccessible by Australia so as to comply with nuclear non-proliferation requirements related to highly enriched uranium. While Australia will be responsible for the radioactive waste its Virginias' generate, the country will not reprocess spent nuclear fuel as part of the AUKUS project and will ensure it remains compliant with the International Atomic Energy Agency directions, guidelines and protocols.

In the final phase, which is effectively already underway, Australia and the UK will collaborate on the design and later the building of the newly named SSN-AUKUS class. The UK has for several years been working on a successor to the *Astute* SSNs and this forms the basis of the SSN-AUKUS design. Vice Admiral Jonathan Mead, the head of Australia's AUKUS task force, has stated that: "SSN-AUKUS is actually quite mature in the design; it's about 70% mature."

SSN-AUKUS will incorporate US technology in specific areas including the propulsion plant systems and components, some weapon types and in the common vertical launch system used by Tomahawk and other cruise missiles. The AUKUS partners will also develop a joint combat system for SSN-AUKUS that builds on the existing US-Australian combat system used by US SSNs and the RAN's Collins class. The SSN-AUKUS nuclear reactors will all be provided by Rolls-Royce Submarines Ltd. The company expects to start manufacturing work for the SSN-AUKUS class in the later 2020s, delivering the first reactor components into the programme in the mid-2030s.

The first SSN-AUKUS will be made for the RN and be built at Barrow-in-Furness, with initial delivery and testing planned for the late 2030s. The plan then envisages production across the UK and Australia ramping up, potentially to a rate where a SSN-AUKUS boat is delivered at a rate of more than one every two years from the early 2040s through to the late 2050s. Australia's boats are all planned to be assembled in South Australia, with each incorporating the sealed nuclear propulsion systems delivered from the UK. The RAN will receive its first SSN-AUKUS in 2042, with five delivered by the middle of the 2050s, and all eight in service in the 2060s. The main areas of work that now need to come together to meet the envisaged timelines include: refinement of the SSN-AUKUS design to be ready to build; development of an integrated build strategy, creating an enhanced trilateral shipbuilding capability and supply chain; and concluding agreements on a joint delivery model.





The Virginia class SSN USS North Carolina docking at Pearl Harbor. The Royal Australian Navy will begin to operate the type from 2033 onwards.

MARITIME POLICY, STRATEGY & FORCES



The Virginia class submarine USS New Jersey (SSN-799) is prepared for launch at Huntington Ingalls Industries' Newport News shipyard. Australia will make proportionate financial investments in the US and UK industrial bases to support its SSN ambitions.

Industry Matters

The enhancement of each nation's defence industrial base is a key element of AUKUS. All three nations will make significant investments to expand their industrial capacity. Australia will invest significantly to improve its domestic industrial base, including expanding the Australian industrial workforce and vendor base, and building state-ofthe-art manufacturing facilities. To realise a nuclear-powered submarine capability in the 2030s based on the USN *Virginia* Class, and the first Australian-built SSN-AUKUS in the early 2040s, Australia will also make proportionate financial investments in the US and UK industrial bases.

Complementing this, Australia's AUKUS partners will also make significant investments. The UK intends to build on the recent investments in its submarine industrial capability, such as the GBP 2 Bn commitment to BAE Systems, Barrow-in-Furness and Rolls Royce, Derby, announced in 2022 as part of the Dreadnought class strategic submarine programme. For the US, AUKUS will mean higher demand for the specific American systems that will feature in SSN-AUKUS, as well as possibly sustaining the Virginia class SSNs longer to meet Australia's new needs. The US has been making additional investments to improve submarine production rates, including a decision last year to invest an additional US\$2.4bn in its submarine industrial base.

In the nearer term, the UK and US will identify specific opportunities for Australian industry to participate in SSN supply chains. Such involvement will allow Australia to build manufacturing experience and achieve early certification of its facilities and workforce. This will help ease pressure on the supply chains of the UK and the US, leverage the existing strengths of Australian suppliers and boost their capacity ahead of the commencement of Australia's build programme. AUKUS partners will focus on key components where Australia has demonstrated industrial capability including pressure hull steel, valves, pumps, batteries, switchboards, lighting and additive manufacture.

Infrastructure development will begin shortly. HMAS *Stirling* and other supporting facilities in Western Australia will be expanded to support the scale of infrastructure required for the visiting and rotational SSNs. Some AUD 1 Bn has been allocated for this over the next four years. Meanwhile, Australia will begin initial works this year at the future SSN-AUKUS Submarine Construction Yard in Osborne in Adelaide, South Australia with about AUD 2 Bn allocated. An important aspect of Australia's industrial base development is that this will build maintenance and repair capabilities that US and UK submarines could also use, increasing the three nation's capacity to enhance their forces in peacetime and meet operational needs in times of crisis.

Not All Smooth Sailing

The *Collins* class's replacement project has already been drawn out but is now being stretched further into being a multigenerational project, seen as a whole-ofnation endeavour by the Australian Prime Minister. Having already dragged on for 14 years with little tangible progress, the latest plan now foresees another 40 years before completion. Costs are estimated as being between AUD 270 Bn and AUD 370 Bn but such long-term assessments are inherently dubious. There are already misgivings about the plan, with several areas of identified concern.

There are worries over the SSNs project's impact on the RAN and the wider ADF. The project will, over time, change the navy's overall balance away from surface warships, possibly cutting into destroyer and frigate numbers. Moreover, having adequate SSN crewing in the 2030s seems an insuperable problem, albeit one for the future. The initial impact on the wider ADF is likely to be in cuts to forthcoming army armoured vehicle programs to free up funding. Of note, the SSN project will cost AUD 9 Bn over the next four fiscal years; the ADF is being asked to find AUD 3 Bn in savings to help meet this cost.

The project is considered high risk by almost everybody. The Australian Defence Department is perceived, fairly or not, as managing major acquisition projects poorly and often exceeding cost and schedules. The submarine project's history supports this with cost estimates continually rising and delivery times extending.

There are higher level worries. In terms of sovereignty, the SSN partnership is seen as locking Australia into supporting future US policies and actions. The principal issue is Taiwan, to whose defence Australia is now seen as effectively committed. In March, a senior US Administration official declared that the SSN plan would make Australia a major contributor to Indo-Pacific security and strategically bind the US and Australia "together in ways almost unimaginable for the foreseeable future."

In terms of technology, some argue that in the 2040s large crewed platforms like SSNs will be of declining usefulness as autonomous air, land and sea vehicles enter service in significant numbers. Indeed, the USN, RN and RAN are running extensive experimentation programs that may lead to capable autonomous vessels entering service well before Australia's first *Virginia* class boat.

More broadly, there are a range of nuclear safety concerns that need solving. Australia has committed to disposing of



An early graphic of the potential AUKUS submarine design. Time will tell if Australia's ambitious SSN plan succeeds.

the nuclear waste the SSNs generate but the practicalities of this are unknown. The Australian Radiation Protection and Nuclear Safety Agency advised late last year that the emergency management arrangements in Australia "...are not fit for purpose for a future with nuclear powered submarines" and will need significant improvement. SSN basing on Australia's east coast is also undetermined, with Port Kembla regarded as the most likely location. The decision is in its final stages and will seemingly be made without consultation with the local community; it will inevitably draw some criticism.

AUKUS is a high-risk, high-payoff plan. It may eventuate. However, in the 1980s Canada had a plan for SSN acquisition that ultimately proved stillborn. Time will tell if Australia's ambitious SSN plan succeeds. Even so, this decade's increased SSN visits and force rotations are almost certain. Only China becoming noticeably less belligerent will stop these early phases. AUKUS has set sail.



The Astute class submarine HMS Anson departs Barrow-in-Furness in February 2023 on its maiden voyage. The British government will spend significant sums supporting the Royal Navy's participation in the AUKUS programme.

The Pakistan Navy: Operating in a Resource-constrained Environment.

Photo: Pakistan Navy



In an interview with MDM, Admiral Muhammad Amjad Khan Niazi, Chief of Naval Staff, Pakistan Navy, outlines how his force is stepping up efforts to modernise its inventory in order to continue to cope with the challenges of meeting operational requirements. At the same time, as the biggest stumbling block, the conundrum of finding cost-effective solutions needs to be circumnavigated. Adm. Niazi explains how the Pakistan Navy is looking for 'good enough' yet 'affordable' solutions. In this interview with MDM he also points out that the appropriate course of action for the Pakistan Navy is to gain self-reliance in developing capable naval platforms.

Admiral Muhammad Amjad Khan Niazi NI(M) S Bt. has been Chief of Naval Staff of the Pakistan Navy since 7 October 2020. His previous appointments include command of two Type 21 ships, Commandant PNS Bahadur (the largest training establishment of Pakistan Navy), Director Naval Operations at Naval Headquarters and Commander Pakistan Fleet. He has also served as Commander 18th Destroyer Squadron, Commandant of the Pakistan Navy War College, Lahore, and Director General Naval Intelligence.

MDM: During recent years, the Pakistan Navy has been experiencing a significant rejuvenation. Could you update our readers on its status?

Admiral Niazi: With evolving traditional and non-traditional threat dynamics, the induction of new platforms and the modernisation of existing assets has become an imperative for the Pakistan Navy. Accordingly, Type 054-A/P frigates from China, 'Milgem' class corvettes from Turkey and OPVs from Damen Shipyards, Romania, were contracted to augment the surface fleet. Two ships of Tughril class, frigates of Type 054-A/P and equipped with state-ofthe-art weapons and sensors, have been commissioned. Two Yarmook class OPVs have also been inducted to fulfil our maritime security requirements. Indigenously, we have built the largest fleet tanker, PNS Moawin, at Karachi Shipyard & Engineering Works (KS&EW) in collaboration with

Turkey to enhance our logistics capabilities. Fast attack craft (missile) equipped with cruise missiles are also being inducted gradually through indigenous construction. This has given significant boost to our ship building capabilities.

In the sub-surface domain, we are focusing on modernising our existing submarine force through a mid-life upgrade programme for the 'Agosta 90B' submarines. This is currently underway in collaboration with Turkey. Furthermore, eight Hangor class submarines with an air independent propulsion (AIP) system are under various stages of construction in China and in Pakistan. In naval aviation, we are operating Sea King helicopters, CH-4 MALE UCAVs and 'marinised' ATR aircraft to enhance our maritime domain awareness and our capabilities in airborne anti-surface warfare. The Pakistan Navy has also acquired jetpowered maritime patrol aircraft for highspeed surveillance and deep-sea strike capabilities. They are currently undergoing a modernisation.

In short, the Pakistan Navy is being transformed into a modern and balanced fleet suitably configured to deal with emerging threats and challenges in the maritime domain.

MDM: Western experts have reported that additional Chinese and Turkish designed naval assets are to be delivered to your navy but will be built in Pakistan. Could you share more insights?

Admiral Niazi: Our strategy with regard to new inductions is to collaborate with foreign construction yards and exploit their experience as well as their expertise to enhance our own ship building capabilities gradually. Transfer of technology is thus included in the contracts. Two 'Milgem' class corvettes are being constructed at KS&EW. Furthermore, four Hangor class submarines are also being constructed in collaboration with China. Indigenous construction of new platforms is enabling capability enhancement at KS&EW in terms both of human resources and also its capacity to construct an expanded variety of platforms. The successful manifestation of this approach is evident through the commissioning of PNS Haibat in March 2022. This fast attack craft (missile) will be our first ever completely 'Made in Pakistan' vessel of the type in terms of design and construction. It has evolved after gaining experience from the earlier construction of three similar vessels at KS&EW. The focus of these efforts is to acquire new capabilities in line with our operational requirements while gradually enhancing our ship building capabilities to achieve self-reliance.

MDM: What about future procurement? **Admiral Niazi:** My Vision of the Pakistan Navy's development is based on 'progressive capability enhancement'. In addition to those projects I have already expounded, two larger and more capable OPVs from Damen Shipyards are presently under con-



Pakistan Navy Agosta 90B-submarine out at sea.

struction in Romania. We are also developing frigates. The 'Jinnah' class ('Jinnah' class frigates, JCFs) will be based on our experience of building 'Milgem' class corvettes with Turkey. The design is in final stages and its construction will be undertaken at KS&EW. Thus, JCFs will be our first frigate-sized warships locally designed and constructed. With this project, I envisage a substantial boost to Pakistan's domestic ship building capability to meet our future needs. We are also constructing indigenously designed gunboats at KS&EW to gain experience in ship construction and induct low-cost platforms into the Pakistan Navy. In the next 10-15 years, our focus is to present modern platforms and forcemultipliers by expanding our indigenous capability and where appropriate, through collaboration with foreign OEMs. Development of naval systems is also being undertaken by our research and development (R&D) organisations.

In short, our aim is to modernise our fleet and transform it into a balanced, effective, and combat ready force while remaining within the budgetary constraints. **MDM:** In your submarine flotilla, one sees a mix of Chinese and French constructions. What are the challenges with respect to logistics and training? And how do you cope with them?

Admiral Niazi: The Pakistan Navy has always looked to maintain an offensive sub-surface capability through indigenous development in collaboration with foreign naval yards. You may be aware that the third submarine of the 'Agosta 90B' series was constructed in Pakistan through a transfer of technology granted by France. She was commissioned in the Pakistan Navy in 2006. The expertise gained during this 'home-made' construction of an 'Agosta 90B' submarine helped us significantly in maintaining and operating these submarines. Following the same trend, a prominent feature of the Hangor class submarine project is the transfer of technology. Four submarines are being constructed in Pakistan. This will be a valuable experience and a significant capability enhancement that will enable us to operate and maintain Hangor class submarines effectively, as has been the case with the Agosta class sub-

marines. I would agree that having a submarine force which is a mix of two different technologies can be challenging in terms of logistics and training. However, given restrictions and the high cost of modern military technology, naval forces – especially in developing countries – are compelled to look for economic and cost-effective solutions to meet their security needs. The Pakistan Navy is no exception. Therefore, whilst remaining within the confines of our budgetary allocations, we endeavour to find 'good enough' yet 'affordable' solutions, at the same time aligning our logistics and training setups in collaboration with the relevant OEMs.

MDM: Likewise, your surface combatants will be a mix of Chinese, Dutch and Turkish designs. Their inherently diverse design conceptions, as well as different supply chains, will stress logistics and training. What answers has the Pakistan Navy found in order to manage the associated challenges?

Admiral Niazi: As I already mentioned, naval forces – especially in the develop-



Multinational ship formation during Exercise AMAN 2021.

ing countries - operate in a resource-constrained environment and have to look for cost-effective solutions to meet their security needs. In Pakistan, we have modest in-country facilities to build modern naval platforms and systems. We are therefore, modernising our fleet by diversifying our collaboration with foreign OEMs, thereby mitigating our external dependencies and progressively strengthening our indigenous capabilities. In this regard, the Pakistan Navy already has extensive experience of operating surface combatants with diverse Western and Chinese technologies. Our training arrangements as well as our logistics infrastructure is geared towards dealing with this configuration. Furthermore, during the construction of new platforms, our teams liaise with the OEMs to streamline logistical and technical aspects. This is mainly achieved through the development of integrated logistics support packages as part of the contractual scheme for through-lifesustainment. The aim is to make best use of our available resources and modest industrial base to maintain and operate Pakistan Navy platforms effectively.

MDM: Admiral, you may understand that in our part of the world there are a lot of questions concerning a potential nucleararmed submarine for the Pakistan Navy. Could you unveil the cover of secrecy a little?

Admiral Niazi: The Pakistan Navy currently operates Agosta class conventional submarines, which are armed with antiship/land-attack missiles and heavy weight torpedoes. These submarines are primarily employed for anti-surface and antisubmarine roles. Our future Hangor class submarines that are being acquired from China are also conventional submarines. Although it is my personal desire that the Pakistan Navy should have a nuclear submarine to restore the growing strategic imbalance in our neighbourhood due to the development and acquisition of nuclear submarines elsewhere, this decision will be taken at the national, political level.

MDM: A question about the progress in transitioning towards local construction at KS&EW. Could you please give an insight of what is the current status quo, and which new projects are envisaged?

Admiral Niazi: As I already mentioned, strengthening the indigenous capabilities of KS&EW in collaboration with friendly countries has remained my primary focus. In this regard, valuable experience gained during the construction of Azmat class fast attack craft (missile) through transfer of technology enabled us to achieve the mile-



PNS Halibat patrolling off Karachi.

stone of commissioning an indigenously designed and locally built vessel, PNS Haibat. Currently, we are building upon the same experience with respect to an indigenously designed gunboat. Thus, we further develop our local industry and improve the shipbuilding skills of our workforce at KS&EW. We intend to capitalise on our ongoing experience of building 'Milgem' class corvettes, which will lead to the construction of the JCFs at KS&EW. Building four Hangor class submarines at KS&EW will also provide a significant capability enhancement. Our aim is to achieve self-reliance in developing capable naval platforms to meet our operational requirements, in line with contemporary maritime environmental standards.

MDM: Finally, concerning your co-operation with European and Asian Navies, what are the intentions for 2023 and the longer term?

Admiral Niazi: In line with our national policy of co-existence and peaceful relations within the region and beyond, the Pakistan Navy has been actively pursuing naval diplomacy in different parts of the world. Our efforts include participation in regional and international efforts for maintaining good order at sea, participation in bilateral as well as in multilateral exercises, overseas deployments, humanitarian assistance and disaster relief missions, and undertaking non-combatant evacuation operations of stranded individuals from conflict zones. Our contributions to Combined Task Force 150 (CTF 150) since 2004 and Combined Task Force 151 (CTF 151) since 2009, under the ambit of Combined Maritime Forces (CMF), are well known and recognised at international level.

The Pakistan Navy also engages with friendly countries through collaborative defence forums, key leadership engagements and navy-to-navy expert level staff talks (ELSTs). We have formally established navy-to-navy ELSTs mechanisms with 21 Navies across the world, including navies from Europe and Asia. Our objective is to pursue bilateral collaboration in a structured manner and to advance collaboration covering operational, training, and technical aspects. The Pakistan Navy will also continue to avail itself of courses offered by European countries for training our officers and personnel. The Pakistan Navy is a member of the Indian Ocean Naval Symposium and an observer in the Western Pacific Naval Symposium. In future, the Pakistan Navy intends to continue playing an active role in collaborative maritime security constructs in the region and strengthen naval cooperation with regional and international navies.

MDM: Admiral Niazi, thank you very much for your informative and comprehensive answers.

MDM's questions were asked by Hans Uwe Mergener

Coast Guard Operations: Emerging Challenges and Responses

Scott Savitz

The world's coast guards are a motley crew, whose missions, authorities, and responsibilities vary greatly by country. Some nations have a single maritime service with both coast guard and naval responsibilities; others have a separate coast guard. Separate coast guards can be military services (or not), and may or may not have law-enforcement authorities. They are overseen by various ministries or departments, and their institutional relationships with other government agencies, including naval forces, vary greatly. Mostly, what they have in common is authority for handling some subset of a broad range of maritime missions. Iconic missions include helping to prevent, mitigate, and responding to incidents and disasters at sea. Many coast guards contribute to safe maritime movements through regulation, inspections, and other oversight, as well as providing aids to navigation and addressing hazards, such as ice. They are often called upon to counter illegal fishing, piracy, smuggling, and a range of other illicit activities. Some protect civilian and/or defence assets from possible attack, while many have responsibilities for pollution prevention and response

eqardless of their precise missions, most coast guards face an array of emerging challenges, some of which also entail opportunities. These include the use of various technologies, changing environmental conditions, the expanding scale of illegal fishing, evolving maritime movements of drugs, increasing maritime migration, increasing overall levels of maritime activity, continuing maritime insurgencies, piracy and terrorism, an increasingly strained geopolitical situation, and decreasing pools of recruits. Below, we discuss each of these in turn, before drawing some overarching conclusions.

Author

Dr. Scott Savitz is a senior engineer at the RAND Corporation. He has led numerous studies for the US Navy and Coast Guard on Arctic operations, the effective use of uncrewed vehicles, naval mine warfare, and many other subjects. He earned his bachelor's degree in chemical engineering from Yale University, as well as a master's degree and PhD in the same field from the University of Pennsylvania. He recently published a book, *The Fall of the Republic*, on a historical conspiracy in ancient Rome.



US Coast Guard Vessels pictured on counter-narcotics exercises with the Royal Canadian Navy. The world's coast guards comprise a diverse range of maritime forces that maintain varying institutional relationships with other government agencies, as well as overseas partners.

Expanding Use of Technologies

Several broad types of technologies are becoming increasingly available to both the legitimate maritime actors that coast guards regulate and to malefactors. One of the most important of these is the use of uncrewed vehicles. They are already used for logistics and inspection by the oil and gas industries; sending an uncrewed aerial vehicle (UAV), uncrewed surface vehicle (USV), or uncrewed undersea vehicle (UUV) to a remote location can be far less expensive than sending a vehicle designed to protect and support humans. The absence of a need to support humans increases the amount of payload that the vehicle can deliver, while eliminating human-induced limitations on vehicle endurance.

The capabilities of uncrewed vehicles are greatly enhanced by three related areas of technological development. The first entails improvements in autonomy. While many uncrewed vehicles remain remotely controlled or restricted to simple behaviours, over the next couple of decades, increasingly capable autonomy will enable vehicles to undertake complex missions without human direction. This is particularly valuable in situations where communications are attenuated, such as in the undersea environment. A second development involves rapid improvements in sensors, which are becoming smaller, less expensive, lighter, more durable, and more perceptive. The third key development is artificial intelligence, which can make sense of the masses of data that uncrewed vehicles' sensors collect, transmuting it into useful information for human consumption.

Coast guards will increasingly need to regulate maritime operators employing uncrewed vehicles. For example, while uncrewed cargo ships are not yet in use, they likely will be when there is a sufficient level of trust in the technology, given potential cost savings. Coast guards will face the challenge of communicating with them and influencing their behaviours: there will be no human crew that can be directed to divert the ship's course or accommodate a boarding. [1]

Unfortunately, criminals or violent extremists can also use uncrewed vehicles in a variety of nefarious ways. They can be used to smuggle goods: a UUV or lowprofile USV laden with drugs can be hard to detect and interdict. Even if it is captured, attribution may be difficult, and the absence of a person aboard eliminates the possibility of an individual providing copious intelligence in return for leniency. UAVs can be used to spy on law enforcement, to create distractions, or



A ScanEagle uncrewed aircraft system (UAS) is launched from the National Security Cutter Hamilton (WMSL-753). The expanding use of various technologies such as uncrewed vehicles offers both challenges and opportunities to the world's coastguards.

to deliberately interfere with operations. Explosive-laden uncrewed vehicles can be used with devastating effect against ships or maritime infrastructure.

Coast guards can also benefit from the use of uncrewed vehicles. UAVs can monitor areas for potential illegal activity, maintaining wide-area coverage at a relatively low cost, and can approach suspect vessels to collect both imagery and electronic data. UAV-based imagery can also help in disaster response or the clean-up of oil spills. USVs could be used to help skim oil from



Changing environmental conditions have vast consequences for coast guard operations. Here, a US Coast Guard motor lifeboat makes its way through a tropical storm.

those spills. They could also be used to protect physical infrastructure or key assets from attack: even an unarmed USV can physically interpose itself between the attacker and the target. UAVs and USVs can also be used in search and rescue: UAVs can locate missing people and drop inflatable devices, while USVs may be able to get on the scene faster than crewed vessels. The EMILY USV system has been used for that purpose for over a decade. [2]

Coast guards can also use UUVs to survey undersea infrastructure for damage after a storm, earthquake, or attack. Eventually, they may even be able to employ UUVs to assist with or perform repairs. While undersea infrastructure is not new – intercontinental cables have existed since the midnineteenth century – the volume of information moving via such cables has grown exponentially in recent decades, playing a critical role in the global economy. Undersea pipeline capacity is also growing rapidly and, like cables, pipelines are vulnerable to natural disasters, accidents, or attacks.

The advent of inexpensive satellites and fee-for-service usage of satellites can help coast guards with their missions. They can use satellite imagery to observe vessels and their behaviour, as well as important aspects of the physical environment. They can also employ satellite-based communications to improve reliability and bandwidth in remote regions where other types of communications may not function.

Increasing threats from cyberattacks are already impinging on the operations of coast guards. They need to protect their own systems, and some also have regulatory authority to oversee private companies' cyber defences, thereby aiming to prevent or mitigate physical damage. Various other types of information technology, from 'big data' processing to enhanced human-machine interfaces, can enable coast guards to conduct their missions more effectively by being better able to characterise their operational environments and interact with them.

Other technologies that can benefit coast guards include advanced materials and additive manufacturing (3-D printing). Materials that are more corrosion-resistant, lighter, less expensive, or otherwise better can be used in various equipment and vehicles. Additive manufacturing can reduce logistical burdens: instead of a ship or a remote aircraft depot having to stock room-filling quantities of spare parts, it can store powder occupying a fraction of that volume and produce the parts on demand.

Changing Environmental Conditions

Climate change affects coast guards in a variety of ways. Their own infrastructure is subject to increased damage and flooding, requiring additional investments to protect, repair, or replace it. Extreme heat in some places can degrade human performance and damage equipment. At the same time, climate change will intensify demand for coast guard services. Flooding from increasingly frequent and severe storms increases demand for search and rescue from coastal communities. Maritime infrastructure designed for moderate temperatures and/or fresh water will degrade more rapidly if extreme heat causes parts of it to buckle or saltwater intrudes, so coast guards that regulate infrastructure may need to adjust required maintenance cycles and planned lifespans. Coast guards that oversee bridge designs to enable waterway traffic, or regulate the sizes of ships transiting under bridges, may find that rising waters elevate accident risks. While demand for some coast guards' icebreaking efforts to enable winter traffic may be less necessary, increased calving of icebergs may elevate the risk to vessels transiting, for example, the North Atlantic. This will necessitate increased monitoring and, possibly, long-range rescues.

Illegal Fishing

Growing populations in many countries are becoming prosperous enough to want more animal protein, increasing demand for both wild-caught and farmed fish. At



A Royal Jordanian Navy patrol craft conducts counter illegal fishing training in the Gulf of Aqaba. The depletion of fish stocks will contribute to growing rates of illegal, unreported, and unregulated (IUU) fishing.

the same time, climate change, pollution, and overfishing have diminished – and continue to diminish – fish populations. This increases the temptation for domestic fishing vessels to violate regulations regarding where, when, how, and what they fish. Coast guards will need to be increasingly vigilant as they enforce rules about areas that are closed to fishing, legal types of nets, or which species or sizes of fish are permitted to be taken.

The depletion of fish stocks elsewhere will also contribute to growing rates of illegal, unreported, and unregulated (IUU) fishing by foreign vessels inside other nations' exclusive economic zones, which can extend up to 370 km from shore. Monitoring and responding to fishing incursions at such distances can be challenging for any coast guard, but particularly for those of nations with small populations or economies, such as Pacific island states. While China's fishing fleet has recently been the worst offender in terms of IUU fishing in other nations' waters, fleets from a number of other countries do the same on a smaller scale.

The Evolving Maritime Movements of Drugs

Despite half a century of concerted efforts to counter consumption of illegal drugs, these substances are widely used around the globe, often far from their source countries. Maritime drug flows are continually adapting to shifts in supply, demand, and law-enforcement capabilities. For example, large-scale cocaine flows from South America through Africa to Europe are a relatively recent phenomenon, as are the trans-shipment of precursor chemicals and the increasing use of synthetic drug additives. While the maritime drug flows of the 2030s and beyond are unpredictable, coast guards will continue to battle against them; both sides may employ uncrewed vehicles and other emerging technologies to detect and monitor targets of interest. Other types of maritime smuggling – largely to evade tariffs or domestic taxes – will also continue.

Increasing Maritime Migration

While annual flows of maritime migrants are highly variable, the numbers of people migrating by sea are likely to rise in the next several decades. Swelling populations (especially of young people), instability, violence, and poverty in some nations are being matched by declining populations of young people in others, enhancing the economic opportunities associated with migration. The effects of climate change are likely to exacerbate the extent of migration, as hotter areas of the globe experience more extreme weather and less economic viability from agriculture or fisheries, further contributing to conflict. Paradoxically, moderate economic improvements in some sending countries may stimulate migration rather than decreasing it, as people become more capable of paying for long-distance travel. Family members who are already in developed nations can also fund migration through remittances, while both demonstrating that the journey is possible and increasing the attractiveness of arrival. However, developed nations are unlikely to want to permit the levels of im-



The numbers of people migrating by sea are likely to rise over coming decades. Here a US Coast Guard fast response cutter embarks Cuban migrants for repatriation.

migration desired by migrants, even if such movements strengthen their own economies. The result is that substantial numbers of unauthorised migrants are likely to cross the Mediterranean, the English Channel, the Caribbean, and various Asian waters over the next few decades.

As we have seen in past mass migrant flows, many of the vessels involved in unauthorised migration are unseaworthy. The mix of people seeking opportunity and refuge aboard them may have a plethora of medical needs after long, dangerous transits. The result is that coast guards will need to rescue them, provide food, water, and medical care, then interview them regarding potential asylum claims. They will also need to cooperate with various authorities, often across multiple countries, to enable these individuals either to disembark or to be repatriated. Collectively, these efforts can be resource-intensive in terms of both personnel and ships.

Expanding Maritime and Coastal Activity

Increases in several types of maritime activity will likely lead to long-term growth in demand for coast guard search-andrescue operations. Although the volume of maritime shipping has been variable over the last several years due to the pandemic and various trade restrictions, long-term volumes will likely grow alongside the global population and economy. Economic factors may shift some cargo ships to more treacherous routes. For example, some vessel owners have reduced timelines and fuel costs by transiting from Europe to Asia across the Arctic, rather than via the Suez Canal and Indian Ocean, despite risks due to ice and insufficient bathymetric charting. Similar dynamics are evident with respect to fishing vessels. The previously cited rise in demand for fish, even as fish populations decline, might well stimulate ship captains to operate at sea longer and in rougher conditions than they would formerly have tolerated.

Nearly 40% of the world's growing population lives within 100 km of a coastline,

and much of the rest lives within a short distance of large rivers or lakes. [3] These populations use the waters around them for sustenance, recreation, or both. Coast guards need to be prepared not only to rescue people on the water, but also those on the land who find themselves inundated by increasingly fierce storms. In developed countries, much of the population has limited physical mobility due to age, curtailing those individuals' ability to extricate themselves or to cooperate effectively with their rescuers. For all of the above reasons, coast guards will need to expand their capacity for conducting search and rescue.

Continuing Terrorism, Piracy and Insurgency

After interventions in Somalia, Afghanistan, Iraq, the Sahel, and elsewhere, many nations are weary of fighting terrorists, pirates, or insurgents. Unfortunately, these threats are not going away. Maritime infrastructure and traffic still need to be protected from both domestic and international terrorists, with the domestic threat likely exacerbated by the intense political divisions and frustrations in many societies. Piracy persists along Africa's East and West coasts, with coast guards and navies from developed nations deploying in response to it. While some insurgent groups with maritime



A hall of illicit weapons seized in the North Arabian Sea. Terrorism, piracy and insurgency remain an ongoing scourge with significant maritime security implications.

ioto: US Coast Guard

capabilities have been quelled, such as the Revolutionary Armed Forces of Colombia (FARC), the Tamil Tigers of Sri Lanka, and the Free Aceh Movement in Indonesia, other such groups persist. Outside powers currently play limited roles in addressing those insurgencies, but coast guards may be ordered to deploy to help other nations to counter the threat they pose.

Elevated Geopolitical Tensions

The last year has witnessed a vast, destructive war in Ukraine, including a substantial maritime element that has affected Ukraine's neighbours in the Black Sea. Russia has also attacked undersea infrastructure far from the conflict, damaging pipelines in the Baltic Sea. At the same time, nations feel increasingly compelled to choose sides in the growing confrontation between China and the United States. In response to geopolitical tensions and outright conflict, coast guards need to redouble their efforts to protect civilian targets from possible attack, as well as to respond to attacks that do occur. They also often need to support naval forces in time of war, protecting them from attacks in their homeports and, sometimes, overseas.

Decreasing Pools of Potential Recruits

All of the growing demand signals for coast guards that were described above will increasingly collide with intense constraints on the supply of personnel. While only a few nations' populations are currently shrinking, most developed nations have declining cohorts of young people, and are aging rapidly. There are ever fewer people who can do the hard physical and mental work of operating at sea, some of which requires the personal courage and spirit of adventure that are most often found among the young. Potential pools of recruits are diminished by the increasing prevalence of obesity and asthma among the young, as well as widespread illegal drug use. Coast guards also need to find young people who want to serve. While older adults have been lamenting the state of their younger counterparts for millennia, many of today's young people may not want to trade a comfortable view of the world through a screen for one that involves the hard work of being in a coast guard. Those with specialised technological and linguistic skills are in high demand in the private sector, making them particularly



Graduates from Recruit Company India-203 complete basic training at US Coast Guard Training Center Cape May in March 2023. The growing demand signals for coast guards will increasingly collide with intense constraints on the supply of personnel.

challenging and expensive to recruit. One way in which coast guards can offset the shortage of potential recruits is to ensure that they reach out to populations that might have been previously underrepresented in their ranks, such as women or members of ethnic minorities. [4] There may also be cases in which technology can reduce the number of personnel needed. For example, autonomous uncrewed vehicles may require fewer personnel than their crewed counterparts, or advanced algorithms that periodically cue humans may obviate the need for individuals to continually monitor information streams.

Concluding Remarks

Coast guards around the globe face a tremendous confluence of challenges. Some are simply ongoing, such as drug-smuggling. Others are becoming increasingly dire, such as illegal fishing and migrant rescue. The need for search-and-rescue operations is likely to rise. So too will requirements to regulate and counter the use of new technologies, even as cohorts of potential recruits shrink. However, some of these same technologies may also help to diminish coast guards' woes if they can be used effectively. By anticipating these challenges and finding ways to overcome them, coast guards around the globe can continue to protect both people at sea and the maritime environment.

Notes

- 1. See further: Savitz, Scott, Aaron C. Davenport, and Michelle D. Ziegler, The Marine Transportation System, Autonomous Technology, and Implications for the U.S. Coast Guard. Homeland Security Operational Analysis Center operated by the RAND Corporation, 2020. https://www. rand.org/pubs/perspectives/PE359.html
- 2. The EMILY website is at https://www.emilyrobot.com/
- 3. Factsheet: People and Oceans, The Ocean Conference, United Nations, New York, 5-9 June 2017, https://www.un.org/ sustainabledevelopment/wp-content/ uploads/2017/05/Ocean-fact-sheet-package.pdf
- 4. Lim, Nelson, Kimberly Curry Hall, Kirsten M. Keller, David Schulker, Louis T. Mariano, Miriam Matthews, Lisa Saum-Manning, Devon Hill, Brandon Crosby, Leslie Adrienne Payne, Linda Cottrell, and Clara A. Aranibar, Improving the Representation of Women and Racial/Ethnic Minorities Among U.S. Coast Guard Active-Duty Members. Homeland Security Operational Analysis Center operated by the RAND Corporation, 2021. https://www.rand.org/ pubs/research_reports/RRA362-2.html

A Combined Approach: NATO Navies Develop Seabed Warfare Operations and Capabilities

Lee Willett

A spate of recent incidents on the seabed, culminating in the Nordstream pipeline explosions in the Baltic Sea, has sharpened NATO navies' focus on seabed warfare. Operational and capability developments are being accelerated, but can more be done faster through a more integrated approach?

n September 2022, the ruptures to the Nordstream pipelines that carry gas across the Baltic Sea brought to international public attention the real security risks that threaten critical national infrastructure on the seabed. Such infrastructure includes oil and gas installations and pipelines, power and communications cables, wave power and windfarm set ups, scientific research nodes (including oceanographic and hydrographic installations and instrumentation), and facilities for accessing critical minerals below the seabed.

The importance of such infrastructure has been well known – amongst naval and commercial sub-sea communities, senior military officers in key armed forces around the world, and national and international political leaders – for some time. However, the Nordstream incidents – reported by NATO, for example, as an act of sabotage – brought the threat firmly into the public domain. The reality of the threat was enhanced by the possibility that the incident related to the ongoing Russo-Ukraine war.

Critical seabed infrastructure is of course vulnerable to natural events like seismic activity. However, recent incidents have demonstrated that human interference – accidental or, maybe, otherwise – is be-

Author

Dr Lee Willett is an independent writer and analyst on naval, maritime, and wider defence and security matters. Previously, he was editor of Janes Navy International, senior research fellow in maritime studies at the Royal United Services Institute, London, and Leverhulme research fellow at the Centre for Security Studies, University of Hull.



A pool of bubbles is pictured on the surface of the Baltic Sea above the two Nordstream gas pipelines that suffered ruptures in September 2022. The incident brought to prominence the real risk of threats to critical national infrastructure on the seabed.

coming an increasingly prominent factor in the security of such infrastructure.

In March 2013, it was reported that Egyptian naval forces had arrested three divers who, deploying from a fishing boat, were attempting to cut an internet cable on the seabed outside the Port of Alexandria. In more recent years, incidents appear to have multiplied. In November 2021, reports emerged that 4.3 km of fibre-optic cable that was part of an environmental sensor network located off Lofoten, northern Norway had been removed: some parts of the removed cable were found later, some distance away. Habitually, data gathered by this network is sent first to the Norwegian Defence Research Establishment: the data could give indications of submarine activity in the area, for example. In January 2022, fibre-optic cables connecting the Norwegian island of Svalbard to Norway's mainland were damaged; these cables were reported to serve the SvalSat satellite ground station on Svalbard. According to regional media reports, Norwegian police stated that investigations indicated potential human involvement. In October 2022, communications cables connecting Scotland, the Shetland Isles, and the Faroe Islands were also damaged.

In the case of the two incidents in Norwegian waters, the dividing line between the Barents and Norwegian seas that runs down from Svalbard, past Bear Island, to the Norwegian mainland is today a new maritime choke point – the Bear Island Gap – that could be seen as a focal point for monitoring submarine activity between the relatively shallow Barents waters and the deeper Norwegian Sea.

In the incidents off Svalbard and Scotland, fishing vessel activity was reported to have
USI

Photo:

been prominent in these areas at the time. In the Nordstream case, some media reports noted Russian surface ship, support ship, and submarine presence in the region in the days preceding the incident (although it should be pointed out that the broad location, to the east of Denmark's Bornholm island, is a very busy one for routine naval activity).

Thus, the possibility that various different vessels could be deployed across a range of regions as platforms from which to conduct such interference underlines the extent of the challenge for navies and other forces seeking to deter and defend against such risks.

Risk and Response

As noted, the risk to critical seabed infrastructure was something that Western navies and wider defence forces had been conscious of for some time. However, like almost all things relating to subsurface operations, very little was ever said publicly relating to the potential risk and likely response.

Back in 2017, in one of the first public discussions, then-UK Chief of the Defence Staff (CDS) Air Chief Marshal Sir Stuart Peach told the annual Royal United Services Institute (RUSI) CDS lecture that Russian operational and capability emphasis on 'grey zone' warfare was creating "a new risk to our way of life" through potential exploitation of "the vulnerability of the cables that criss-cross the seabed". Senior officers, for example from the UK and the United States, began to discuss the theoretical risk at public events like conferences. However, the risk became real with the Nordstream incident. The incident also prompted an increase in open discussion of the threat and an acceleration of the response.

In a statement following the incident, NATO pointed to sabotage as the cause, adding that "Any deliberate attack against allies' critical infrastructure would be met with a united and determined response." NATO moved quickly to put in place its own response co-ordination infrastructure. In February 2023, it established the Critical Undersea Infrastructure Co-ordination Cell at alliance headquarters in Brussels: the centre's remit is to facilitate engagement and co-ordination between industry and key military and civilian stakeholders.

Commercial industry, of course, leads the way in much of the technology and capability development for monitoring and operating on the seabed.

The European Defense Agency (EDA) is understood to be leading the European

The offshore support vessel Topaz Tangaroa, purchased by the UK to provide the first of its two Multi-Role Ocean Surveillance Ship (MROSS) vessels, is pictured undergoing modification work prior to being available for operations. The vessel features large deck space on which container-

ised uncrewed underwater vehicles could be embarked.

multinational focus on seabed warfare. According to media reports, in January 2023 the EDA commenced studies designed to look at capability gaps in seabed security, identify emerging technology in industry that could fill these gaps, and establish small military/industry teams within the European Union's (EU's) Permanent Structured Co-operation (PESCO) framework to cover these gaps with the right capabilities.

A February 2023 paper published by the

EU Council General Secretariat's analysis and research team, looking at the EU's seapower role, noted "The seabed, which is the subject of scientific, technological, and military competition, could end up being a new area of conflict." The paper also pointed to the geophysical challenge inherent in effective seabed operations, identifying the need to operate in what it referred to as "the deep seabed", which ranges from depths greater than 200 m down to 6,000 m.



is pictured speaking at the 'West 23' symposium in San Diego, in February 2023. Here, CNO spoke of the need to take any fight to an adversary in all domains, from space to the seabed.

National Moves

Nationally, a number of NATO navies have been moving quickly to address the challenge. The response has been a mix of operational deployment and capability development, in turn responding to the immediate risk and building longer-term operational capacity.

France is already moving into a leading position in developing and deploying capability to respond to seabed threats. Speaking at the inaugural Paris Naval Conference, which took place at IFRI (The French international relations institute) in January 2023, Admiral Pierre Vandier – the French Navy's Chief of Naval Staff – noted that countries able to operate down to 4,000 m in depth will be in a dominant strategic position.

In February 2022, France published its strategy for seabed operations, and began putting this into practice in October 2022 during Operation 'Calliope' in the sonnel training to conduct such tasks, the navy told *MDM* on 18 April. Further operational trials are planned.

These developments reflect the direction set out in France's seabed operations strategy. The strategy's broad thrust is that France will develop the capacity to carry out seabed warfare operations in its exclusive economic zone, and that such capacity includes both the technological capability and personnel skills required to conduct such operations.

According to media reports, France plans to procure two new, sovereign-designed UUVs – one autonomous underwater vehicle (AUV) and one remotely operated vehicle (ROV) – by 2025; France's future hydrographic vessels – being delivered under the Capacite Hydrographique et Oceanographique Future (CHOF) programme – provide a possible platform for supporting UUV capability deployed to conduct seabed operations.





The USN's Improved 688/Los Angeles-class nuclear-powered attack submarine USS Springfield visits the UK Royal Navy submarine base in Faslane, Scotland. The growing seabed threat in the North Atlantic underlines the importance of the already-increasing co-operation between the US, UK, and French navies on anti-submarine warfare operations in the region.

Bay of Biscay, where it deployed a Kongsberg HUGIN Superior uncrewed underwater vehicle (UUV) from the survey vessel *Beautemps-Beaupre* to practice developing the capability to deliver sea control with new technology like UUVs.

It should be noted that, in several of the incidents mentioned where seabed cables were disrupted, UUVs were deployed down to survey the situation.

In 'Calliope', deploying the *Hugin Superior* UUV down to depths of 4,500 m enabled the French Navy to refine its operational concept for using such capability, and to increase its operational ability through perThe UK is also pursuing two capability programmes as high priorities to help address the seabed and wider deep-water subsurface threat.

First, under the Multi-Role Ocean Surveillance Ship (MROSS) programme, the UK Royal Navy (RN) is procuring two commercial vessels to deliver seabed operations capability via the use of UUVs. The first ship, the offshore support vessel (OSV) MV *Topaz Tangaroa*, was purchased off-the-shelf from the commercial market – where it had been supporting underwater tasks including maintenance and inspection work, and autonomous submarine operations - and arrived in January 2023. The 98 m, 6,000-tonne ship currently is undergoing modification, to fit what the RN referred to in a statement on 19 January as "critical military equipment" to support operations. The vessel "will act as a 'mothership', operating remote and autonomous offboard systems for underwater surveillance and seabed warfare", the statement added. It features a helipad, a crane, a large working deck, and a 'moon pool': its two dozenstrong Royal Fleet Auxiliary (RFA) crew will be augmented by around 60 RN specialists bringing skills in using undersea surveillance systems and other survey and warfare equipment.

The vessel will be renamed and assigned as an RFA platform, prior to planned operational availability in mid-2023. The UK plans to build a second MROSS vessel onshore, and for that ship to be available in 2025: the programme to acquire this second ship currently is in the concept phase.

Second, to address offshore – in other words, deep water – threats in the form of mines and other risks, the RN has purchased (again, from the commercial market) the OSV MV *Island Crown*, which also arrived in January 2023. The relatively rapid arrival of both ships underlines clearly the concern about a present danger.

Island Crown has been renamed as the auxiliary vessel RFA Stirling Castle. In a statement on 31 March, the RN said Stirling Castle "will act as an offshore forward operating base, deploying mine countermeasures maritime autonomous systems (MCM MAS), drones, and other crewless systems to find and neutralise sea mines and other seabed threats". In particular, the ship and its embarked capabilities are designed to enhance operational resilience in protecting UK territorial waters and core sea lines of communication, the statement added. The RN said the ship is currently undergoing "minimal conversion work, primarily to support installation of military communication systems", and will be available for operations later in 2023.

The use of auxiliary ships provides several operational benefits in addressing seabed operations requirements. First, the fact that they are not dedicated to a specific military operational task like anti-submarine warfare (ASW) means they are usually more able to be used against an emergent requirement. Second, their relatively larger size and flexible design space enables straightforward deployment onboard of containerised capabilities like UUVs.

Alongside their own direct responses, navies are also actively seeking to cooperate with other stakeholders to bring naval capability to bear in securing subsea infrastructure. The Italian Navy (ITN), for example, signed an agreement in July 2022 with stakeholders in Italy's communications sector to provide increased surveillance of seabed infrastructure.

The Royal Netherlands Navy (RNLN) is looking at how its future force structure might provide a 'toolbox' within with seabed security capability can be developed. Speaking at the Undersea Defence Technology conference in Rotterdam in June 2022, RNLN Deputy Commander Rear Admiral Huub Hulsker said that the navy's new MCM programme (being developed in collaboration with the Belgian Naval Component) could provide a medium-term option for addressing the seabed threat. "Although the RNLN does not have and will not have a dedicated seabed warfare ship in the near future, these new MCM vessels will have enough flexibility for an optional payload," he said

In late March 2023, the German Navy set out future force structure plans under the 'Navy 2035+' programme. Here, the navy detailed greater focus on new technology – including UUVs – within modernisation required to enable the navy to do more to support national and NATO interests in key waters. In particular, the Nordstream incident demonstrated the threats that critical seabed infrastructure is exposed to, Vice Admiral Jan Kaack, the navy's Inspector General, told the German daily newspaper *Frankfurter Allgemeine Zeitung*.

One navy with capacity to bring a different perspective to seabed operations is the US Navy (USN). While most of the NATO navies developing seabed operational capability appear to be focused in the near term on developing capacity to deter and defend against threats to critical national infrastructure, the USN is already looking at the role that using the seabed can play in offensive operations. Speaking at the AFCEA/US Naval Institute 'West 2023' symposium in San Diego in February, Admiral Michael Gilday, the USN's Chief of Naval Operations (CNO), highlighted several key attributes that enable naval operations to be adapted against an evolving, pacing threat: these attributes include reach, deception, stealth and concealment, manoeuvrability, and distribution. "It's ... thinking about ways to defend our fleet that we haven't before," said CNO. "It's about coming at an adversary not by amassing forces, but by spreading those forces out, not just in the physical domain but in all domains from seabed to space."

Questions for Navies

The nature and reality of the seabed security threat, when set in the context of there being a current conflict in which one of the protagonists has a well-known capability for conducting seabed operations, means there is a somewhat unprecedented urgency to deploy capability in the immediate term that can provide deterrent and defensive impact. submarine numbers over the past few decades, but sharing information about where submarines are and what they do has been a difficult national political hurdle to get over. The USN, RN, and French Navy have made some progress here, for example with establishing a strategic partnership on ASW in the North Atlantic. The more prominent presence of USN and French submarines visiting the RN submarine base at Faslane, Scotland, and



The Nordstream incident underlined to the German Navy the increased risk posed to critical national infrastructure on the seabed. Here, in the wake of the incident, the navy's Type 123 Brandenburg-class frigate FGS Mecklenburg-Vorpommern conducts patrols close to a Norwegian oil platform.

The challenge for navies and other maritime security agencies involved in seabed operations is covering vast waters when faced with a geographically unpredictable threat, with only limited capability to use, and with the significant geophysical challenge of monitoring infrastructure as deep as 6,000 m down.

Western navies have often led with intelligence-based analysis of where the next threat may occur, and then positioning assets accordingly to counter it. At this time, the vast scope of the threat and the relatively limited capacity at national levels may point to near-term need for greater-still co-operation. However, such contexts could be politically uncomfortable. Navies may need to look at how they can 'pool' capability - whether submarines or UUVs - to provide better coverage (which can mean difficult conversations about sharing information on national sub-surface asset locations). Navies may also need to look at how they can 'pool' information (which can mean difficult conversations about sharing national information).

The question of submarine operations is an interesting one here. Many NATO navies have struggled with reduced of USN and RN boats visiting Norway's new submarine support facility at Grotsund, just outside Tromsø, underlines the increasing importance of dealing with the sub-surface threat. In the longer term, the increasing tempo of the operational drumbeat demand on submarines raises the question of if and when these three navies – and others – will be able to successfully make a case for building more submarines.

Much closer in, it appears Western navies have what is termed in the UK an urgent operational requirement for more UUVs, including extra-large UUVs (XLUUVs), to provide the surveillance capability. There is also the question of how concepts like NATO's developing 'ASW Barrier' have application for seabed surveillance.

The seabed domain is creating a particular challenge, here. The sensitivity that has persisted about operations and capabilities in the underwater domain could be seen as having created seams in the coverage – politically and operationally – that an adversary can exploit. Closing these seams – at a political level, as much as at an operational and capability level – seems to be a significant priority.

Amphibious Assault Vehicles and Beach Defence

Christopher F Foss

Troops, vehicles and other equipment can be transported to the beach by a variety of means including helicopters, landing craft, hovercraft and amphibious assault vehicles (AAVs). This article concentrates mainly on the latter.

Getting to the Beach

While some armoured fighting vehicles (AFVs) do have an amphibious capability, such as the Russian BMP-1, BMP-2 and BMP-3 infantry fighting vehicles (IFVs), this is limited to rivers and lakes. In the past some countries, including the United Kingdom, fitted their vehicles with floatation screens. For example, these included all members of the Alvis Scorpion family of Combat Vehicle Reconnaissance (Tracked) and the Swedish S-tank.

These floatation screens were carried retracted around the top of the hull and erected when required, but in the end all of these were removed. Some AFVs were also fitted with bags which are inflated for crossing rivers and lakes. A good example is the South Korean K21 IFV. Its flotation bags are folded in travel mode and inflated as soon as the vehicle goes into the water for amphibious operations. All these devices are very vulnerable, not only to small arms fire but also to damage from objects floating in the water. Moreover, they are considered dangerous even in peace time training, as vehicles and their crews have been lost.

Getting out of the water is the main challenge for amphibious vehicles. Inland water operations involve steep riverbanks and fast flowing rivers. Vehicles that are launched offshore have to cope with the effects of wind, tide and currents. Crossing the surf line may also pose some risk while in some parts of the world coral reefs may have to be overcome.

Key Players

USA

For many years the standard amphibious assault vehicle used by Western countries has been the US BAE Systems AAV7A1, which was originally developed by the then FMC Corporation as far back as 1965/1966. The first production vehicles



South Korean K21 IFV ready for amphibious operations with floatation bags in position on the sides and front.



US Marine Corps AAV7A1 being launched at sea.

INTELLIGENCE FOR THE INTELLIGENT

European Security & Defence

- Politics
- Armed Forces
- Procurement
- Technology

me Actual Signs of Progress



Politics · Armed Forces · Procurement · Technology

EUROPEAN SECURITY & DEFENCE is a specialist magazine tracking events and developments in the defence and security arena. One of the magazine's objectives is to describe, explain and interpret European, transatlantic and global security policy – which extends far beyond conventional defence with military forces – in all its complex and sophisticated correlations.

EUROPEAN SECURITY & DEFENCE provides answers to questions on international affairs, business, technology and defence/security matters. Our analysis is based on neutral and in-depth investigation.

Annual Subscription Rate:

€113.00 (International)

(print format; postage included)

Annual subscription includes at least 11 issues.

TEST EUROPEAN SECURITY & DEFENCE and order a free copy now!

Mittler Report Verlag GmbH – Subscription/Reader Service PressUp GmbH · Postfach 70 13 11 · D-22013 Hamburg Phone: +49 40 38 66 66-319 · Fax: +49 40 38 66 66-299 · mittler-report@pressup.de www.euro-sd.com



US Marine Corps Marine Amphibious Combat Vehicle – Personnel shown leaving the rear ramp.

were completed in 1972 at the San Jose facility and called the Landing Vehicle, Tracked, Personnel, Model 7 (LVTP7). This was later changed to Amphibious Assault Vehicle 7 (AAV7). Beyond the US Marine Corps, it is also used by Argentina, Brazil, Italy, Japan, South Korea (local production), Spain, Taiwan, Thailand and Venezuela, amongst others.

The baseline AAV7A1 has a crew of three and can carry 25 Marines who can rapidly dismount through the power operated ramp at the rear. Armament comprises a one-man turret armed with a 40 mm automatic grenade launcher (AGL) and a 12.7 mm machine gun.

Specific versions of the AAV7 are the AAVC7 command vehicle and AAV7R recovery vehicle. Moreover, prototypes of further specialised vehicles included a variant for mine clearance and one fitted with a turret mounted 105 mm gun. Over the years the US Marine Corps AAV7 and variants were upgraded on a number of occasions to extend their operational lives and include the AAV7A1. SAIC were awarded a contract to upgrade these through the AAV Survivability Upgrade (AAV-SU) but in the end this programme was cancelled after a few prototypes were completed.

In March 2023 the US Defense Security Cooperation Agency notified Congress of the possible sale of AAVs to Greece with a total value of USD 268 M. This included 63 AAVP-7A1s, nine AAVC-7A1s, and four AAVR-7A1s plus weapons, support and training. BAE Systems would not confirm as to whether these are new build vehicles or upgrades of older ones. In a statement to MDM Garrett Lacaillade, Vice President of Amphibious Programmes at BAE Systems, said "BAE Systems is committed to supporting the US Government and allied partners by providing critical capabilities to aid them in achieving their priority missions, AAVs will provide a long proven amphibious capability supporting the Hellenic Army's mission and protecting Greece's maritime interests." It was expected that the AAV7A1 would be replaced by the General Dynamics Land Systems Advanced Amphibious Assault Vehicle (AAAV), subsequently renamed the Expeditionary Fighting Vehicle (EFV). It was designed for a maximum WATER speed of 25 kn and, in addition to a crew of three, could carry 17 Marines. It was fitted with a remote weapon station armed with a Northrop Grumman 30 mm MK44 Mod 1 dual feed cannon and a 7.62 mm machine gun. However, this was ultimately cancelled in 2011 due to cost and reliability issues.

Following cancellation of the EFV, the



FNSS Marine Assault Vehicle in the APC leaving the water and clearly showing the trim vane erected at the front of the hull.

HAMBURG SÜD

150 YEARS ON THE WORLD'S OCEANS

MATTHIAS GRETZSCHEL

HAMBURG SÜD

THE HISTORY OF A GREAT SHIPPING COMPANY

The history of a great shipping company

€ 39,90 ISBN 978-3-7822-1505-3 Order directly from us at koehler-mittler-shop.de or by telephone +49 (0)40/70 70 80 322

Koehler



Scan & Order now!



Maximilian Verlag GmbH & Co. KG | Stadthausbrücke 4 | 20355 H



FNSS Marine Assault Vehicle in the APC role and fitted with a Cake remote weapon station armed with a 40 mm AGL and 12.7 mm machine gun.

US Marine Corps ran a competition for a less sophisticated and costly marine personnel carrier (MPC). SAIC and BAE Systems were ultimately shortlisted for this contract. SAIC proposed a vehicle based on the Terrex from Singapore and BAE Systems offered an IDV (formerly Iveco Defence Vehicles) SuperAV (8x8). After trials between prototypes, BAE Systems was selected.

The MPC is now called the Amphibious Combat Vehicle (ACV) and the US Marine Corps approved full rate production in 2021 for the first variant, the ACV-P. It is already being delivered to US Marine Corps units. The second version to enter production is the command version, ACV-C which will be delivered in 2023. BAE Systems is also under contract for the ACV-R (Recovery) and the ACV-30. The latter will be fitted with a Kongsberg remote controlled turret armed with a 30 mm cannon and 7.62 mm machine gun.

Turkey

The Turkish FNSS Savunma Sistemleri, jointly owned by BAE Systems (49%) and Nurol of Turkey (51%), could have manufactured the US AAV7A1 under licence. Instead, the company developed a new vehicle to meet the specific requirements of Turkey for a vehicle to be deployed from its new amphibious assault ship (LHD) TCG Anadolu. This is called the Marine Assault Vehicle (MAV), or 'Zaha'. Like the US AAV7A1 it is propelled whilst afloat by two waterjets positioned one either side at the rear, just above the suspension. These provide a maximum water speed of 7 kn. Before entering the water, the trim vane is hydraulically extended at the front of the hull and the bilge pumps activated.

The MAV's power pack consists of a Cummins diesel coupled to an Allison fully automatic transmission which gives a maximum land speed of up to 70 km/h. The power-to weight ratio is 20 hp/tonne. For comparison: the Leopard 2A7 has a ratio of 22.22 hp/tonne, the Leopard2A1 27 hp/tonne, the Chieftain MBT 13.63 hp/tonne.

The hull is of all welded aluminium ar-

mour with add-on ceramic armour plates. According to FNSS, the vehicle's most significant distinguishing feature, which differentiates the vehicle from its predecessors, is its ballistic and mine protection capability. Mounted on the roof is a Caka remote weapon station (RWS) developed by FNSS. It comprises a laser rangefinder, a stabilised 40 mm AGL and a 12.7 mm machine gun. Standard equipment for the MAV also includes a smoke generator. Together with smoke grenade launchers, this provides a capability for smoke screening.

The MAV also has a communications/



Norinco's VN16 Tracked Amphibious Assault Vehicle is fitted with a three person turret armed with a 105 mm gun



Italian VBA (8x8) with the trim vane extended at the front of the hull and the snorkel extended above the engine compartment and with two hydraulically operated propellers at the rear



Brazilian Guarani (6x6) APC seen from the rear showing the two propellers for amphibious operations at rear of hull.



Scale model of the missile used in the Neptune coastal defence missiles deployed by the Ukraine.

battle management system and situational awareness cameras, whilst an LI/ LLTV image fusion camera can provide vision to the driver in conditions of complete darkness with depth and terrain detail. Life support equipment includes a fire detection and suppression system, a NBC system, as well as heating and air conditioning.

A total of 27 production MAVs had been completed by 2022, of which 23 were in the armoured personnel carrier (APC) variant. In addition to its crew of commander, gunner and driver, it can carry 21 men who can rapidly leave via a power operated ramp in the rear. In addition four dedicated versions have been delivered: two command post and two repair and recovery variants. The crane fitted to the recovery vehicle is situated on top of the hull and is capable of lifting the complete power pack when required. As the MAV's design is flexible, other versions could be developed for particular purposes, such as mine clearance.

The MAVs are operated by the Turkish Naval Command's Amphibious Marine Brigade. FNSS is also trying to market the MAV internationally. It is, for example, a potential replacement for some of the older vehicles deployed by the Indonesian Marines. The Turkish company is well placed in Indonesia as they are working with the local company of PT Pindad on the Kaplan Medium Tank (MT), locally called the Harimau.

France

For many years the standard infantry fighting vehicle of the French Army was the Giat (today Nexter) AMX-10P. To meet the requirements of export customers a specialised version was developed called the AMX-10P Marines. It was sold to Indonesia (34) and Singapore (44) in different variants.

China

While the US Marine Corps cancelled their EFV, China has pushed ahead and fielded significant numbers of similar vehicles. Indeed, these are already being offered on the export market by Norinco (China North Industries Corporation).

The baseline version is called the VN18 'Tracked Amphibious Infantry Fighting Vehicle'. It has a crew of four, consisting of commander, gunner, loader and driver and can carry 11 personnel who can rapidly leave via a ramp at the rear. The turret is armed with a 30 mm cannon and a 7.62 mm co-axial machine gun. A HJ-73D antitank guided weapon (ATGW) is mounted on either side. The power pack consists of a 4-stroke water-cooled turbo charged diesel developing 440 kW on land and 1,176 kW whilst afloat. Maximum land speed is being quoted as 65 km/h. When afloat, the vehicle is propelled by two water jets – positioned one either side at the rear – which give a maximum speed of up to 25 km/h. It has a gross vehicle weight of 28.5 tonnes. Before entering the water the bilge pumps are activated, the trim vane extended at the front of the hull and the adjustable hydro pneumatic suspension raised to reduce drag.

The VN16 has a similar hull to the VN18 and is called a 'Tracked Amphibious Assault Vehicle'. It is fitted with a threeperson turret armed with a 105 mm low recoil rifled gun, 7.62 mm co-axial machine gun and a roof mounted 12.7 mm machine gun.

Both vehicles have a welded aluminium hull with applique armour which provides protection from small arms fire and shell splinters

Japan

Japan purchased some AAV7A1s from the US but is now pushing ahead with its own AAV. In some respects, the design is similar to the cancelled US EFV. A number of testbeds have already been completed. The vehicle is expected to weigh around 40 tonnes, be powered by a V-12 diesel developing 3,000 hp and be propelled by water jets. Other features will include in-arm suspension which can be raised for amphibious operations, composite rubber tracks and an extendable trim vane at the front.

Other Amphibious Vehicles

IDV has developed the 'Veicolo Blindato Anfibio' (VBA) using internal research and development funding and based on experience with their SuperAV 8x8 vehicles. Compared to them, the VBA has increased buoyancy. In the water it is propelled by two propellers situated one either side at the rear. The power pack consists of an Iveco FPT 'Curso' 16 engine developing 700 hp coupled to an automatic transmission. When afloat, the vehicle is powered by two hydraulically operated propellers which - according to IDV – give it a top speed of 6 knots and a capacity of operating beyond Sea State 3. Late in 2022 IDV were awarded a contract by the Italian Director of Land Armaments covering the supply of 36 VBAs for the Italian Navy. These will be fitted with a Leonardo Hitrole. The remotecontrolled weapon system is armed with a 12.7 mm machine gun. According to



Naval Strike Missile Coastal Defence missile system includes this cross-country truck with four missiles.

IDV, the vehicle is supposed to reinforce the fleet of San Marco Marine Brigade and will effectively increase national sea projection capability.

In addition to these specialised vehicles, some mainstream AFVs are simply adapted for amphibious operations when necessary, typically through additional buoyancy. Other AFVs have a, built-in integral amphibious capability. A typical example is the Brazilian Guarani (6x6) which is already in production for the home and export markets. In the water, it is propelled by two propellers mounted at the rear.

Defending the Beach

The days of well protected beaches have long gone, with the USA scrapping its coastal guns just after the Second World War and the UK having disbanded coastal artillery in 1956, apart from some guns defending the Straits of Gibraltar.

The Nordic countries invested heavily in fixed coastal artillery batteries. Finland, Norway and Sweden all had fixed coastal guns, with the latter two including the Bofors 'Ersta' 120 mm turret mounted weapons. Denmark had older turret mounted guns. Sweden had 20 batteries equipped with three, turret-mounted 75 mm rapid fire guns coupled to a computerised and radar supported fire control system. All of these have now been decommissioned.

Other countries deployed truck-mounted coastal defence missile systems using MBDA Exocet and Otomat missiles, as well as the Swedish Saab RBS 15 and the US Harpoon. In the Falkland Islands campaign Argentina used trailer-mounted Exocet missiles to damage the Royal Navy County class

destroyer HMS Glamorgan. Subsequently the UK deployed trailer mounted Exocet missiles to defend the straights of Gibraltar. This role was subsequently taken over by Spain with its General Dynamics European Land Systems Santa Barbara Sistemas 155 mm 155/52 APU SBT towed artillery systems optimised for the coastal defence.

Other short-range missiles were also deployed by some countries, such as the Hellfire two-round launcher that is still used by Sweden. China and Russia deployed coastal defence systems based on missiles as well as mobile guns.

Ukraine has developed and deployed Neptune (360ST), a coastal defence missile which supposedly hit the Russian cruiser RFS Moskva in the Black Sea in 2022. The truck mounted system has four missiles which are elevated to fire position. The missiles have a nose mounted active guidance seeker and are claimed to have a maximum range of over 300 km.

The Norwegian Kongsberg Naval Strike Missile was originally developed to be launched from surface ships. However, is now being marketed for coastal defence operations. These include use by the US Marine Corps, with the missiles being strapped to a Joint Light Tactical Vehicle.

Early in 2023 Romania ordered the coastal defence version which is called the Naval Strike Coastal Defense System under a contract which will eventually be worth up to USD 217 M. It is understood that the contract covers the supply of two batteries, each with four mobile launchers. In turn, each launcher has four missiles mounted on a cross-country truck. There is an associated command control system. Prior to launch, the launchers are elevated.

European Security &Defence

•

AJAX

OPVs

•

MEDIA UPDATE 21st Anniversary Edition • 09/23



BONUS DISTRIBUTION

- MSPO, Kielce, Poland (5-8 September)
- DSEI, London, UK (12-15 September)

Programme Subject to Modification

ESD Online: <u>www.euro-sd.com</u> - International News, Reports, Analysis and Comments



REPORT

SKYNET Update: The Terminator gets closer

The "Special Relationship": America in the UK

Type 26 Global Combat Ship Programme Report

 Sniper 1: Weapons and Ammunition Tactical Secure Communications

VTOL / Tiltrotor Developments

TEMPEST Update

Type 31 Sitrep

A meaningful and constantly updated complement to the expert articles published in print with news from:

 politics, the armed forces, government organisations, industry, associations and scientific institutions.

Supported by a global network of correspondents.

MITTLER **MITTLER REPORT VERLAG GMBH** Beethovenallee 21 • 53173 Bonn • Germany Phone: +49 (0)228-35008-70 • Fax: +49 (0)228-35008-71 info@mittler-report.de • www.mittler-report.de • www.euro-sd.com



NAVAL HISTORY

NAVAL GROUP DESIGNS, BUILDS AND MAINTAINS SUBMARINES AND SURFACE SHIPS ALL AROUND THE WORLD.

Leveraging this unique expertise and our proven track-record in international cooperation, we are ready to build and foster partnerships with navies, industry and knowledge partners.

Sovereignty, Innovation, Operational excellence : our common future will be made of challenges, passion & engagement.

POWER AT SEA