ESD

European Security & Defence

€19.90
D 14974 E

5/2024

International Security and Defence Journal

ESD/MDM Combined Issue

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May 2024 • www.euro-sd.com • ISSN 1617-7983

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Cautious hope

With the long-awaited US aid package for Ukraine now approved, prevailing conditions on the battlefield could be expected to shift somewhat out of Russia's favour, albeit probably not to the extent many will be hoping for.

Perhaps the most cogent and succinct summary of the current situation I have recently encountered came from Luke Mogelson's article 'Battling under a canopy of Russian Drones' published in The New Yorker. Interviewing the former platoon leader of two Ukrainian soldiers he had been in contact with, Mogelson wrote, "In his view, if the West maintains its current level of assistance, Ukraine can hold out for a few more years; if the assistance diminishes, "We're screwed in a matter of one year"; if aid increases, "there will be a stalemate until we run out of soldiers.""

This assessment broadly aligns with that of many analysts studying this conflict, and highlights the extent to which Ukraine's possible futures are contingent upon the political decisions taken by its allies. In this vein, the roughly USD 60.8 billion provided by the US aid package will go some way toward pushing the balance back toward a stalemate, yet it is important to note that this aid package does not directly translate to USD 60.8 billion worth of military equipment.

The largest portion of the budget is earmarked for spending within the US itself, with USD 23 billion for replenishment of US weapons stocks. This notionally frees up the country to donate more of its older weapon stocks to Ukraine, however, it remains to be seen what portion of this value Ukraine actually receives in military aid. A further USD 11 billion will be used to fund ongoing US operations in the European theatre, much of which is expected to take the form of reconnaissance and intelligence gathering and sharing with Ukraine. In terms of more direct aid, around USD 14 billion is due to go to the Ukraine Security Assistance Initiative (USAI), which would largely be used to provide weapons and training to Ukraine, while an additional USD 8 billion has been allocated for non-military aid such as paying salaries. Lastly, the bill also increased spending limits for several US Presidential drawdown authorities, freeing up further funding for reactive aid packages.

Once they begin arriving, the most likely immediate impact of these deliveries will be that Ukrainian units become able to hold ground more effectively. Key pieces of equipment in this regard include artillery and air defence systems, along with ammunition for both. The additional air defence in particular would be expected to result in at least a partial scaling-back of Russian glide bomb attacks and UAV reconnaissance (along with associated UAV-cued artillery and Iskander SRBM strikes) behind Ukrainian lines, as Ukraine will be able to provide more coverage of key sectors of the battlefield.

All told, the aid may be sufficient to effectively freeze the lines where they are in many places, and perhaps allow for Ukraine to make minor gains in other areas, as well as inflicting sporadic losses of high-value Russian equipment, but probably not much more. Those hoping for a more dramatic result, such as a large-scale reversal of Russia's recent territorial gains, will likely be disappointed. Firstly, because it will take time for all of the aid to be delivered, meaning that a sizeable portion is likely to have been used up by the time all deliveries are completed. Secondly, not all of Ukraine's battlefield problems can be reduced to a lack of materiel.

Ukraine has been facing acute manpower shortages for some time, and these have only worsened in recent months, leading to Zelensky signing a controversial mobilisation law on 16 April 2024, which is due to enter force on 18 May 2024. While the law stops shy of mass mobilisation, it is intended to make it easier to identify draft-eligible members of the population by obliging males to update their draft status with authorities within 60 days, and adds heftier punishments for draft dodging. The latter has been a major problem for Ukraine, with many military-age males avoiding contact with the authorities at home, or fleeing abroad. To tackle the problem of draft-dodging abroad, on 23 April 2024, Ukraine suspended consular services for its military-age male citizens until 18 May 2024. These measures potentially impact a sizeable population – according to Eurostat data, as of 31 January 2024, of the roughly 4.3 million Ukrainians living in the EU, around 20.7% (~890,000) are adult males. It remains to be seen whether these measures will end up having the desired effect.

Looking ahead, there is reason for some optimism that later in the year we may see a stabilisation of the front line, which has been slowly edging westwards for the past several months. However, while the US' aid package is a critical lifebuoy to Ukraine, it is a short-term fix, and will take time to fully implement. Given Russia's current momentum on the battlefield, things will likely get worse for Ukraine before they get better.

Mark Cazalet

Contents

Masthead

European Security & Defence
Issue 5/2024, May 2024
ISSN 1617-7983 · www.euro-sd.com

Published by

Mittler Report Verlag GmbH
A company of the TAMM Media Group

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Cover Photo: A Romanian Piranha V infantry fighting vehicle fires rounds downrange during the Anakonda 23 live fire training exercise at Nowa Deba Training Area, Poland, on 15 May 2023.

Credit: US Army/Pfc Jason Klaer

Annual subscription rate: €119.00 incl. postage

Reduced annual subscription rate for distribution in Germany:
€99.80 incl. postage

Index of Advertisers

Speaker Johnson carries House bill containing USD 60.8 billion in military aid for Ukraine

(pf) A much-delayed package of US security aid bills that included USD 60.8 billion (EUR 57 billion) to support Ukraine in its two-year-old battle to repel Russia's invasion of the country has finally been voted through the US House of Representatives.

Credit: US Congress

The bill was passed on 20 April 2024 after Republican House Speaker Mike Johnson defied the 'America First' cabal of Republican Representatives who support former president Donald Trump, who have continually opposed US military support for Ukraine.

The Ukraine aid bill includes USD 23.2 billion to replenish US weapons, stocks and facility funds diminished in supporting Ukraine, USD 11.3 billion for current US military operations in the region (training of Ukrainian troops and readiness presence across Europe), USD 13.8 billion for the purchase of advanced weapons systems for Ukraine and USD 26 million to "continue oversight and accountability" of aid provided to Ukraine.

It is the first new funding approved by the US Congress since Republicans took control of the House in January 2023.

The bill now proceeds to the Democratic-majority Senate, which passed a similar measure more than two months ago and is expected to vote on 23 April, before being signed off by US President Joe Biden.

Given the lengthy delays to US military support to Ukraine, the Biden administration is already finalising its next assistance package to meet Ukraine's urgent battlefield needs.

The House vote on the Ukraine funding was passed by 311 votes to 112, with more Republican voting against it (112) than those who supported it (101) and all 210 Democrats voting in favour. Speaker Johnson brought the vote despite considerable political risk to his own position; he is at risk of being ousted from his position as House Speaker by the 'America First' Republicans, who have already ejected his predecessor.

Expressing his thanks for the military assistance as soon as it was passed, Ukrainian President Volodymyr Zelenskyy wrote on social media channels, "I am grateful to the United States House of Representatives, both parties, and personally Speaker Mike Johnson for the decision that keeps history on the right track. Democracy and freedom will always have global significance and will never fail as long as America helps to protect it.

"The vital US aid bill passed today by the House will keep the war from expanding, save thousands and thousands of lives, and help both of our nations to become stronger," Zelenskyy added.

Given the situation on the ground in Ukraine, the US military aid is expected to be focused on frontline air defences, long-range fires and other artillery capabilities. The aid is likely to step any further Russian gains since US support dried up and most obviously prevent Russia from prevailing in Ukraine.

The package of bills that passed through the House on 20 April also included around USD 26 billion for supporting Israel and providing humanitarian relief in Gaza, as well as around USD 8 billion to help US allies in the Indo-Pacific region, most obviously Taiwan, in countering China.

Russian death toll in Ukraine War has passed 50,000, according to BBC/Mediazona analysis

(pf) The death toll among Russian military personnel serving in Ukraine has passed 50,000, according to a joint investigation by BBC Russian, independent Russian media group Mediazona and associated volunteers, published on 17 April 2024.

The figures, which counted Russian military deaths in Ukraine since the Ukrainian invasion began in February 2022, were derived by investigators combing through open-source information from official reports, newspapers and social media as well as the examination of new graves in 70 cemeteries across Russia.

The analysis does not include the deaths of pro-Russian militia in the Russian-occupied Donetsk and Luhansk regions of Ukraine.

The investigation found that the body count was more than 27,300 in the second year of the Russian campaign – 25% higher than in the first year – mainly due to the Russian 'meat grinder' strategy of throwing thousands of poorly trained conscripts into the campaign.

A sharp spike in Russian deaths occurred around January 2023, when the Russian military began a large-scale offensive in Donetsk using ineffective 'human wave' frontal assaults.

Credit: BBC Russian_Mediazona

Another significant spike occurred in the spring of 2023, when the Wagner mercenary group helped Russia capture the city of Bakhmut.

The BBC estimates at least two in five of Russia's dead soldiers are people who had nothing to do with the country's military before the invasion.

When the Wagner Group recruited prisoners for the war and gave them a few weeks of military training under a scheme led by Wagner leader Yevgeny Prigozhin, half of those prisoners died within three months, the analysis found.

Prigozhin then staged an aborted mutiny against Russia's armed forces in June 2023 and subsequently died in a suspicious plane crash on 23 August 2023.

When the Russian Ministry of Defence (MoD) then took up the Wagner strategy of recruiting prisoners, however, half of those troops died within two months. The Russian MoD's 'Storm platoons', consisting almost entirely of convicts, generally received very little training, the BBC/Mediazona analysis found, with some prison recruits sent directly to the front line.

Wagner prison recruits were contracted for six months of fighting, after which they would then be given their freedom, while prisoners recruited by the Russian MoD since September 2023 are expected to fight until they die or the war is over.

The Russian death toll of 50,000 in Ukraine in just over two years of fighting compares with the total 14,453 official fatalities suffered by the Soviet military during its campaign in Afghanistan, which ran for more than nine years from December 1979.

Iran plays down Israeli airstrikes as world hopes the two countries will de-escalate

(pf) Reports of apparent Israeli airstrikes on the Iran cities of Isfahan and Tabriz during the night of 18/19 April 2024, in response to the Iranian attack on Israel on the night of 13 April, left a confused picture of what ac-

tually happened and what its effects were. Video footage of explosions over Isfahan posted by local residents on social media channels appeared to only show shell bursts from Iranian anti-aircraft fire, with Iran subsequently playing down the raids, claiming its air defences had shot down three unmanned aerial vehicles (UAVs) close to an airbase in Isfahan province that were possibly launched from inside Iran.

Isfahan contains a number of potential targets for Israel, including nuclear facilities and an airbase, but the International Atomic Energy Agency confirmed that there had been no damage to Iran's nuclear sites, while satellite imagery obtained by CNN from Umbra Space appeared to show no damage at the air base at Isfahan.

The Israeli Defence Forces (IDF) do not typically acknowledge the attacks they conduct, but US officials told the G7 nations that the US government had received last-minute indications from Israel that an attack would take place.

In the wake of the substantial but ineffective Iran barrage launched against Israel on 13 April, which involved more than 300 missiles and UAVs, the Israeli attack on Iran appears very modest in comparison. Given that an Israeli war cabinet had been debating for days how to response to the Iranian attack on Israel – itself a response to an Israeli air strike on the Iranian Consulate in Damascus on 1 April that killed Quds Force commander Brigadier General Mohammad Reza Zahedi – the Israeli response thus appears to be more of a message to Tehran, suggesting that a much more lethal attack could be mounted if Israel chose to do so.

Unlike Israel's air and missile defences (combined with actions by Israeli allies), which were claimed by the IDF to have thwarted 99% of the Iranian air threats on 13 April, Iran's mix of older Russian, Chinese and indigenously produced air defence assets would struggle to cope with a significant Israeli barrage.

Meanwhile, the international community observing from the sidelines are hoping the modest Israeli attack will ultimately prove to be a de-escalation – rather than an escalation – of the current hostilities, especially given Tehran's playing down of the attack.

Argentina signs purchase agreement for former Danish F-16s

(pf) The fighter fleet of the Argentine Air Force (Fuerza Aérea Argentina – FAA) is finally being reconstituted with the acquisition of 24 former Royal Danish Air Force (RDAF) Lockheed Martin F-16s.

The purchase agreement for the aircraft was signed in Copenhagen on 16 April 2024 by Argentine Defence Minister Luis Petri, who was accompanied for the occasion by head of the Argentine Armed Forces Joint Chiefs of Staff Brigadier General Xavier Julián Isaac, FAA chief Brigadier Major Fernando Luis Mengo and Argentine Secretary of International Defence Affairs Juan Battaleme.

A letter of intent (LoI) regarding the sale was signed in Buenos Aires on 26 March 2024 by Petri and Danish Defence Minister Troels Lund Poulsen, with Poulsen noting at the time that the sale has been conducted in co-operation with the United States as the original manufacturer of the aircraft. The US State Department cleared the sale in October 2023.

The aircraft in question are F-16AM single-seaters and F-16BM twin-seaters, although the mix of the two types being sold to Argentina has not been reported.

As well as the aircraft themselves, the sale includes the delivery of four flight simulators, eight spare powerplants, the provision of spare parts for five years and the training of pilots and maintainers.

"Today we are completing the most important military aircraft acquisition since 1983," said Petri in Copenhagen. "We are talking about 24 F-16 aircraft that have been modernised and equipped with the best technology, and that today are at the level of the best aircraft flying in the skies of the South American region and the world.

"With these new aircraft we are taking a transcendental step in our defence policy, recovering the supersonic capacity of our aviation and achieving the definitive entry of our air force into the technological challenges of the 21st century," Petri added.

Argentina had for years struggled to find a replacement for the FAA's dwindling fleet of Douglas A-4AR Fightinghawk attack aircraft that entered service from 1998, of which only a handful are likely to remain airworthy. The FAA does also operate a small fleet of around seven indigenously produced FAdeA IA 63 Pampa III advanced jet trainers adapted for the light attack role, but this fleet was originally intended to be 40 strong.

Previous Argentine attempts to procure a new fast jet type, including the Korean Aerospace Industries FA-50 and the Chinese/Pakistani-produced CAC/PAC JF-17 Thunder, failed to materialise. This was down to a lack of funding but also a UK veto on military exports to Argentina, given the historic tensions between London and Buenos Aires since the 1982 Falklands War. This meant that any fighter sold to Argentina would have to be free of UK components.

Credit: Argentine MoD

As the RDAF transitions to the Lockheed Martin F-35A Joint Strike Fighter, Denmark is donating the remaining 19 aircraft of its 43-strong F-16AM/BM fleet to Ukraine to help recapitalise the Ukrainian Air Force amid the Russian invasion of that country. The RDAF began training Ukrainian pilots and technical specialists on the F-16 in August 2023.

Boxer production contract delivers Australia's largest foreign military export to Germany

(pf) On 10 April 2024 Australia signed a production contract for 123 Boxer 8×8 Heavy Weapon Carrier vehicles. With more than 100 of those vehicles to be exported from Australia for use by the German Army, the contract constitutes Australia's largest foreign military export to Germany.

"Deliveries are scheduled to start in 2025," Nathan Poyner, managing director of Rheinmetall Defence Australia, was quoted as saying in a Rheinmetall press release, "with the first Australian-built vehicle to be delivered in 2026."

The Heavy Weapon Carrier, or 'Schwerer Waffenträger Infanterie' vehicle, is based on the Australian Army's Boxer Combat Reconnaissance Vehicle (CRV). It is intended to replace the Wiesel tracked light weapon carrier vehicles used by the German Army's light infantry units. Australia ordered 211 Boxer vehicles under its Land 400 Phase 2 project in March 2018, with 133 of these vehicles being the CRV variant with a crewed digital Lance modular turret system.

Credit: Rheinmetall

The German Boxers are to be produced at Rheinmetall's Military Vehicle Centre of Excellence at Redbank in South East Queensland, Australia.

The Boxer vehicle more generally is produced by the Munich-based ARTEC industrial group, of which the parent companies are Krauss-Maffei Wegmann and Rheinmetall Military Vehicles in Germany and Rheinmetall Defence Nederland in the Netherlands, giving Rheinmetall a 64% stake in the joint venture. The programme co-ordinated by Europe's Organisation for Joint Armament Cooperation (OCCAR).

Armin Papperger, chairman of the executive board of Rheinmetall, was quoted in a company press release as stating, "We appreciate to have been selected to supply the Heavy Weapon Carrier vehicles for an essential element of the German Army's new force category: the 'medium forces'.

"We are integrating the expertise and capabilities of our Australian MILVEHCOE colleagues from our global Rheinmetall network to provide the German Army with the required combat vehicles as quickly as possible. This further deepens defence ties between Australia and Germany and enhances a sustained sovereign defence capability in Australia.

"We welcome the close partnership between Australia and Germany in strategic defence activities as the two nations work together to increase global security," Papperger added. "The German Boxer programme from Australia has been made possible by Rheinmetall's long-term Australian investment in product development and advanced manufacturing."

Unlike its competitors, the Boxer multi-role armoured vehicle consists of a drive platform module and interchangeable mission modules that allow various different configurations to meet customers' operational requirements.

As well as the armies of Germany, Australia and the Netherlands, the Boxer has additionally been ordered by the United Kingdom and Lithuania. Thirty-six RCH-155 self-propelled gun variants of the Boxer have also been procured for Ukraine using German military aid.

Naval Group cuts steel on French Navy's first third-generation SSBN

(pf) Steel cutting for the first third-generation French Navy nuclear-powered ballistic missile submarine (SSBN), known as the SNLE 3G, took place at Naval Group's yard in Cherbourg on 20 March 2024, the French shipbuilder announced the same day.

Credit: Naval Group

Launched in February 2021, the SNLE 3G programme will deliver four SSBNs to form France's future sea-based nuclear deterrent. The programme brings together the armed forces; France's defence procurement agency (Direction Générale de l'Armement - DGA), which is responsible for overall project management; the French Atomic Energy Commission (CEA), responsible for the nuclear boilers; and Naval Group, which is responsible for overall project management of the submarine build, in association with TechnicAtome for the nuclear boilers.

The programme's first follow-on contract, awarded in February 2021, covers development studies up to the end of 2025, as well as long lead time procurement, production of the first hull and boiler room components for the first 3G SSBN and adaptation of Naval Group's manufacturing resources to the specific requirements of the 3G SSBNs.

Production of the main components of the nuclear boiler room and propulsion system, in particular the tank for the first SNLE 3G, has already begun at Naval Group's Nantes-Indret site.

The 3G SSBNs will feature a number of major technological advances over their predecessors, which Naval Group detailed as featuring: an extended detection capability, with sensors of the highest technological standard; enhanced stealth, including improved hydrodynamics and increased manoeuvrability; high-performance weapons and combat system, able to carry out deterrence missions until the end of the 2080s; the highest levels of nuclear safety and security; the latest standards of living conditions for sailors on board, thanks in particular to a new plant for reprocessing the ship's atmosphere.

Naval Group stated that some of these features would find their way into the French Navy's four current Triomphant-class SSBNs "to ensure the best possible performance throughout their operational life up to the 2050s".

Noting that a nuclear submarine "is one of the most complex objects ever built by man", Naval Group stated that the construction of an SNLE 3G submarine "requires the integration of almost 100,000 devices, as well as hundreds of kilometres of cables and circuits".

The programme, the company said, "benefits the entire French naval industry", adding that "almost 90% of the SNLE 3G programme's added value will be produced in France for several decades, representing some 3,000 direct, highly skilled jobs that cannot be relocated".

Naval Group described the SNLE 3G programme as "a national adventure that will involve the whole of France, mobilizing more than 400 companies and 400 skills across the country: from Alsace to Brittany, from the Paris region to Toulouse and the Provence-Alpes-Côte d'Azur region".

Pierre Éric Pommellet, CEO of Naval Group, was quoted in a company press release as saying, "We are proud to symbolically launch the production of the hull of the first third-generation SSBN today, alongside the DGA, the French Navy, the Atomic Energy Commission and TechnicAtome, as well as all our state and industrial partners. Through this major programme, Naval Group is fully committed to serving French sovereignty and nuclear deterrence, by mobilising all its skills, talents and industrial resources, and by drawing on a solid defence-industrial and technological base, spread across the country."

Sweden places order for 321 more Patria 6×6s

(pf) The Swedish Defence Procurement Agency (FMV) has ordered 321 six-wheeled armoured vehicles from Patria, the Finnish defence manufacturer announced on 20 March 2024.

Credit: Patria

The contract valued at around EUR 470 million, is one of the largest ever Swedish orders for Patria.

The 321 vehicles, which in Sweden are called Pansarterrängbil 300, will be stationed at the Livgardet Regiment in Kungsängen as well as several other units around the country.

Patria has previously delivered 20 6×6 vehicles, which were ordered in April 2023.

The Patria 6×6 type set for delivery is the armoured personnel carrier (APC) model, which according to Patria "offers the latest vehicle technology such as state-of-the-art protection for up to 12 crew members". The vehicle is modular and can be configured for a wide range of different roles. Apart from operating as troop transports, the Swedish Patria 6×6s will be used for command-and-control and ambulance duties and will "form an important cornerstone for Sweden's increasing defence capability", Patria stated.

"Sweden is an increasingly important market for us, and we are glad to be able to support the Swedish armed forces at a time of their significant expansion. We are confident that we can fill the deliveries promptly as we have done previously," Mats Warstedt, Patria's senior vice president for the Nordic market, was quoted as saying in a company press release. "The Pansarterrängbil 300 vehicle is an excellent example of Finnish-Swedish co-operation as the vehicle is designed for Nordic conditions from the start and significant value is provided by Swedish suppliers, such as the engine and the steel of its armour," Warstedt added.

The FMV previously ordered 20 Patria 6×6 vehicles in a contract announced on 17 April 2023. The vehicle was chosen as the platform for the Common Armoured Vehicle System (CAVS) collaborative programme between Finland, Latvia, Sweden and Germany.

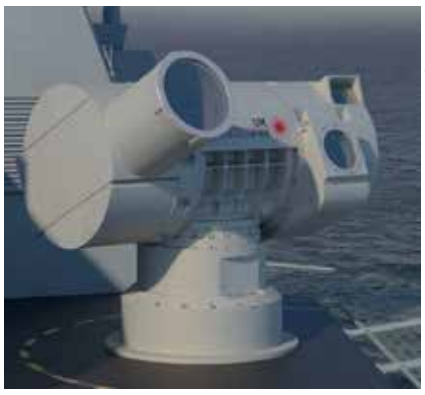
Sweden joined the 6×6 research and development programme in 2022 and is expected to have a requirement for several hundred vehicles throughout the 2020s. The Patria 6×6 has a maximum combat weight of 24 tonnes, a maximum payload of 8,500 kg and in its APC configuration can carry up to 10 soldiers in the rear plus a crew of two in the front cabin. Powered by a Scania DC 09 diesel engine developing 294 kW, the vehicle has a maximum speed of more than 100 km/h on land, up to 8 km/h in water and a range greater than 700 km.

While the vehicle has STANAG Level 2 ballistic and mine protection as standard, this can be increased to STANAG Level 4 if required.

UK MoD to press ahead with installing DragonFire LDEW on Royal Navy warships

(pf) The UK Ministry of Defence (MoD) announced on 12 April 2024 that it will install the UK DragonFire laser directed-energy weapon (LDEW) – developed by MBDA in conjunction with Leonardo UK, QinetiQ and the UK's Defence Science and Technology Laboratory (Dstl) – on Royal Navy warships.

The installation of the weapon will take place from 2027 – far quicker than previously envisaged, thanks to new defence procurement model that has just come into force. Laser weapons were originally expected to be rolled out to UK armed forces in 2032.



Credit: MBDA

"In a more dangerous world our approach to procurement is shifting with it. We need to be more urgent, more critical and more global," said UK Defence Secretary Grant Shapps in announcing the initiative. "Our widespread reforms will deliver the latest kit and weaponry for our armed forces faster and help identify export opportunities that can boost the UK economy.

"DragonFire shows the best of the UK at the forefront of military technology, and we will not delay in getting it in the hands of our military to face down the threats we're facing," Shapps added.

On 19 January 2024 the UK MoD announced that the DragonFire LDEW demonstrator had successfully conducted firing trials against aerial targets at a range in the Hebrides.

On 5 March, meanwhile, Peter Cooper, Dstl's principal LDEW advisor, told select journalists at Dstl's Porton Down facility that DragonFire represents a "step change in UK high-energy laser systems" and that the team was "now at the stage of understanding the art of the possible" regarding the system.

The next stages of DragonFire's development will include further live firings and the manufacture and installation of weapon systems onto Royal Navy platforms, the MoD stated.

The UK DragonFire programme leverages MBDA's decades of weapon system manufacturing expertise, Leonardo's position as a world-leading authority in laser technology, electro-optics and advanced targeting, and QinetiQ's experience as the only UK company to successfully develop and safely operate high-energy laser sources in the UK along with coherent beam-combining technology.

DragonFire has been developed through a GBP 100 million (EUR 117 million) joint investment by industry and the UK MoD, working with Dstl. MBDA noted that the MoD's decision to progress the programme "ensures that the companies involved can retain, maintain and grow the critical hi-tech skills, knowledge and jobs that contribute to the UK economy", adding that "future exports of DragonFire to the UK's allies will further support these benefits".

DragonFire has the potential to be a long-term, low-cost alternative to certain tasks missiles currently carry out. The system uses a 50 kW-class laser to deliver its effect, with its performance said by the development team to be 'equivalent to hitting a GBP 1 coin from kilometres away', all while the target is moving at speed –

with the platform possibly also moving – and while delivering enough dwell time on the targeted point to deliver an effect.
While the DragonFire LDEW has a number of potential applications, the decision to initially field the system on Royal Navy warships is viewed as being the most practical. Larger naval platforms place relatively few size, weight and power restrictions on the system, while the LDEW itself can be deployed against multiple kinds of target. CGI video footage of the envisaged system in action, first shown at Porton Down on 5 March, showed a warship-based DragonFire installation both shooting down an unmanned aerial vehicle and disabling the engine of a fast attack craft-type vessel.
The employment of an LDEW in a maritime environment also places fewer restrictions on its use in terms of negating any possible effects of collateral damage to anything beyond the intended target.

GDELS enters the modular AFV market with the Piranha HMC 10×10

(pf) General Dynamics European Land Systems (GDELS) announced on 15 April 2024 that it has expanded its Piranha wheeled armoured vehicle family with a new variant: the Piranha Heavy Mission Carrier (HMC).
With a gross vehicle weight (GVW) of up to 40 tons (36.3 tonnes) and a payload of 17 tonnes, the Piranha HMC features a 10×10 all-wheel-drive power driveline and a unique multi-link suspension system (MLS) with first/second- and fourth/fifth-axle steering. This arrangement, according to GDELS, facilitiates minimum axle-loads that comply with European road regulations, superior cross-country mobility and trench-crossing capabilities with a reduced turning cycle of less than 18 m.
A key aspect of the Piranha HMC design is that it is modular in nature, with the rear third of the chassis able to accommodate a variety of different mission modules.
Until now the only AFV to adopt such a modular configuration has been the Boxer 8×8 multirole armoured vehicle developed by the ARTEC consortium: a joint venture comprising Germany's Krauss-Maffei Wegmann and Rheinmetall Landsysteme and Dutch company Rheinmetall Defence Nederland. However, the GDELS HMC solution is not intended to allow mission modules to be swapped, as with the Boxer.


Credit: GDELS

"With the 10×10 Piranha Heavy Mission Carrier, the company is responding to the growing need for highly manoeuvrable wheeled armoured vehicle platforms for increasingly demanding mission profiles while accommodating essential Military Mobility requirements for NATO and international customers," GDELS stated in a company press release.
"The Piranha HMC is a direct response to our global customer base's evolving payload and space claim requirements for versatile and multi-purpose missions including direct and indirect fires, air defence and tactical bridging capabilities," Dr Thomas Kauffmann, GDELS vice president for global sales and services, was quoted as saying.
"This unique vehicle platform is a result of our continuous strive towards innovative automotive and driveline technologies combined with over 40 years of excellence and experience as a world-class vehicle OEM," added Giuseppe Chillari, GDELS vice president for wheeled vehicles and managing director of GDELS-Mowag.
Compared to the Piranha HMC's GVW of up to 36.3 tonnes and payload of 17 tonnes, the latest Boxer has a GVW 38.5 tonnes for its tactical variants, offering a payload of 13.3 tonnes, and a GVW of 41 tonnes for technical variants, giving a payload of 15.8 tonnes.
With the Boxer having been adopted by the armies of Germany, the Netherlands, Australia and Lithuania (and additionally soon to enter UK and and Ukrainian service), GDELS has clearly decided that the AFV market is ripe for an alternative modular AFV with an even heavier mission payload.

Ukrainian bomb-laden UAV attack reaches factory in Tatarstan

(pf) Ukraine has used bomb-laden unmanned aerial vehicles (UAVs) to attack a factory in Russia's Tatarstan region more than 1,200 km from unoccupied Ukrainian territory in what appears to be the Ukrainian military's deepest strike of the war so far.
The factory, located in the town of Yelabuga, is believed to be a site where Shahed UAVs supplied to Russia from Iran are assembled and was attacked around 05:45 local time on 2 April 2024.
A video of the attack posted online by Russian media outlet Ostorozhno Novosti shows a bomb-laden UAV derived from a light aircraft diving onto a factory site and causing a sizeable explosion. The location has been verified by media channels such as Reuters as being in Yelabuga.


Credit: via Ostorozhno Novosti

Ukraine's military intelligence said the strike on Yelabuga "caused significant destruction of production facilities", although this was denied by Tatarstan's regional leader, Rustam Minnikhanov.
The UAV in question appears to be based on a two-seat A-22 Foxbat ultralight aircraft made by Ukrainian aerospace company Aeroprakt. This aircraft typically has a maximum range of 1,100 km and an endurance of 10 hours, although this officially stated range is probably based on a manned flight with an emergency reserve. It is thus conceivable that, for a one-way unmanned flight, the aircraft could reach Yelabuga from Ukraine with a sizable warhead payload in place of the pilot.
Perhaps a more interesting question is how a light aircraft with a cruising speed of just 180 km/h could penetrate so far into Russian airspace without getting shot down, especially when the country is at war.
Ukraine has been using bomb-laden UAVs to strike at Russian infrastructure for several months, with the UAVs in several cases reaching their targets. In January a major gas terminal was struck in St Petersburg, which is around 900 km north of Ukraine's border.
A Ukrainian source who spoke to CNN following Ukrainian UAV attacks on oil refineries in recent months suggested that the Ukrainian UAVs used for those strikes are equipped with an artificial intelligence-enhanced terrain-following capability, meaning they do not need to communicate with any ground station and can autonomously make their way to their targets without being jammed.
It is possible that this capability, combined with a low-altitude flight plan, has allowed the Ukrainian UAVs to avoid being shot down, but Russia's air defences are clearly having their own problems, even as Russia's own UAV and missile attacks cause problems for Ukraine.
Even if the damage caused by the Yelabuga attack is not significant, it could still conceivably force the Russians to spread their air defence assets over a wider area to avert further such embarrassments.

ASC to partner BAE Systems in building future SSN-AUKUS-class submarines

(pf) The Australian government has selected Australia's ASC to join BAE Systems in building the country's new fleet of nuclear-powered attack submarines (SSNs) in the latest significant development in the AUKUS trilateral security pact agreed between the United States, the United Kingdom and Australia in September 2021.

Credit: BAE Systems

Australian Deputy Prime Minister Richard Marles and UK Defence Secretary Grant Shapps announced the news in Australia on 21 March 2024, marking the next step in the pathway for Australia to build and operate its own submarines under the SSN-AUKUS programme.

Under the AUKUS agreement Australia and the UK will operate a common future submarine, incorporating technology from all three nations, based on the UK's next-generation design, on which BAE Systems is leading.

BAE Systems and ASC Pty Ltd will now bring together their complementary skills, expertise and capabilities under a collaborative arrangement in Australia, ultimately leading to the establishment of a long-term, incorporated joint venture.

"We're extremely proud of our role in the delivery of this vitally important, tri-nation submarine programme," BAE Systems Chief Executive Charles Woodburn was quoted as saying in a company press release. "Our selection as a partner in Australia, alongside ASC, recognises our role as the UK's long-term submarine design and build partner and as a key player in Australia's maritime enterprise and wider defence landscape. Drawing on decades of experience in the UK and Australia, we look forward to working with ASC to develop an enduring, sovereign nuclear-powered submarine building capability for Australia.

"We're already making good progress on the design and development of the next-generation submarine in the UK, where we have more than 1,000 people working on the SSN-AUKUS programme and major infrastructure investment underway," Woodburn added. "This latest step will ensure an integral connection between the UK design and the build strategy development in Australia as we work together to deliver next generation military capability as well as considerable social and economic value to all three nations."

The appointment of a builder by Australia comes a year after UK Prime Minister Rishi Sunak, Australian Prime Minister Anthony Albanese and US President Joe Biden met in San Diego, where they announced that the first generation of AUKUS submarines would be based on a UK design.

"The partnership has carried out extensive engagement with the International Atomic Energy Agency, with all countries committed to developing an approach that protects classified information and strengthens the global non-proliferation regime," the UK MoD stated in a 21 March press release.

The SSN-AUKUS class will be the largest, most powerful and advanced attack submarines the Royal Navy (RN) has ever operated and will start to replace its Astute-class SSNs, which BAE Systems has been building at its site in Barrow-in-Furness in the northwest of England. Four Astute-class boats are currently operational, with another working towards operational status and the final two under construction.

The SSN-AUKUS submarines will enter RN service from the late 2030s, while Australia expects to deliver its first SSN-AUKUS boat in the early 2040s.

The UK Ministry of Defence awarded BAE Systems almost GBP 4 billion (EUR 4.66 billion) for the next phase of the SSN-AUKUS programme in October 2023. That funding covers development work through to 2028, enabling BAE Systems to progress the detailed design phase of the programme and procure long-lead items. The award is also funding significant infrastructure investment in Barrow, which will see the site's facilities double in size from 80,000 to 160,000 m2 by the late 2030s as part of a multi-billion-pound programme, and continued recruitment to support the national endeavour.

BAE Systems is also designing and building the UK's next-generation nuclear-powered ballistic missile submarines, the Dreadnought class, with construction underway on the first three of four new boats.

Rheinmetall acquires REEQ to add hybrid/electric tactical vehicles to its portfolio

(pf) Rheinmetall has expanded its vehicle portfolio to include innovative light hybrid/electric-powered vehicles by acquiring Dutch start-up REEQ, the German company announced on 18 March 2024.

A full 100% of REEQ shares were acquired by Dutch subsidiary Rheinmetall Defence Nederland at the beginning of this month. Both parties agreed not to disclose the purchase price.

REEQ, which began operating in 2018, has developed a new generation of mobility that combines tactical transport with a mobile energy source (microgrid) and is fully prepared for autonomy. The technology was developed and is produced in the Netherlands.

Credit: REEQ

Currently, REEQ's vehicle portfolio consists of an unmanned ground vehicle (UGV), a side-by-side buggy and a quad bike, all three with exactly the same modular drive train that can be hybrid powered or fully electric.

"Through the acquisition of REEQ, Rheinmetall is able to serve the Dutch and European market in the field of light tactical mobility, both manned and unmanned, in combination with a microgrid solution," Rheinmetall stated in a press release. "Rheinmetall's industrial strength and the innovative power of a start-up complement each other. Within the Rheinmetall Group, REEQ retains its status as a start-up in the field of development. The further development and series production of these vehicles will also take place in the Netherlands."

Located in the city of Ede, Rheinmetall Defence Nederland is part of Rheinmetall's Vehicle Systems Division and is a wholly owned subsidiary of Rheinmetall Landsysteme.

Collaborative Combat Aircraft: "Buy 'em cheap and stack 'em high"

Georg Mader

During the latest Air & Space Forces Association (AFA) Warfare Symposium in Aurora, Colorado on 12 February 2024, USAF Secretary Frank Kendall presented his plans for a deep restructuring of his department. Kendall and Air & Space Force leaders announced sweeping changes to the USAF's whole organisation, including its manning, readiness and weapons development. These changes are aimed at increasing overall readiness, gaining a competitive edge in warfare, and primarily seem geared toward China.

To be precise, with regards to the "re-optimisation for intensifying great power competition with China", as Kendall emphasised during a conversation with AFA President and CEO Lt Gen (ret.) Bruce 'Orville' Wright, "The goal is to strengthen overall operational readiness and ensure that we have the right capabilities to fight against US adversaries." He pointed to a theoretical, though still possible conflict – either from a Chinese military attack on Taiwan, or from mutual miscalculations that could escalate – and said such changes were long overdue. "We are running out of time," he repeated. Subsequently, operational squadrons are now set to be reorganised into 'action units', each designated a 'Deployable Combat Wing', 'In-Place Combat Wing' or 'Combat Generation Wing'. "We will ensure our deployable wings have everything they need to fight successfully as a unit," Kendall stressed.

Credit: GA-ASI

CG render of the General Atomics Aeronautical Systems, Inc. (GA-ASI) design for the 'LongShot' CCA programme.

Initially outnumbered

On the first day of a hypothetical air war with China towards the end of the 2020s, things do not look pretty for the USAF. The US' next-generation fighter jet, now in the final stages of a competitive selection process under the USAF Next Generation Air Dominance (NGAD) programme, or the US Navy's FA/XX programme, could well have made progress by then, but would likely still not be operationally available for some years. Worse, a Chinese Air Force (PLAAF) operating close to home has a fleet with advantages in numbers and perhaps quality in certain key capability areas.

To regain this advantage, US airpower strategists are turning to a new type of aerial weapon system – the so-called 'Collaborative Combat Aircraft' (CCA), often referred to as 'loyal wingmen'. By accompanying and supporting US fighters and bombers as a kind of stealthy 'vanguard', this family of low-observable unmanned combat aerial vehicles (UCAVs) with varying capabilities and costs, and featuring advanced autonomy, could help to offset China's definite advantages in initial numbers and partial advantages in quality. Thus, the second realisation is that this business is, or will be primarily focused on air-to-air combat, and therefore primarily about taking out the PLAAF's force multipliers.

These – currently a handful of each – are Il-78 MD/TD tankers, Tu-154M and Y-8- and Y-9-based electronic intelligence (ELINT) aircraft, as well as their airborne early warning and control (AEW&C) fleet, including the propeller-driven KJ-200 and KJ-500, as well as their four jet-powered KJ-2000 aircraft. Towards the end of the 2020s, a new Chinese AEW&C aircraft based on the new Y-20 transport aircraft platform is likely to be in service.

Of course, the PLAAF will presumably defend these key assets with their many J-10, J-11, J-15, J-16 and J-20 fighters, along with their naval J-35 fighters. Additionally, these

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fighters would be expected to target the equivalent US opposing force AEW&C aircraft with their J-20 fighter using its PL-17 ultra-long-range beyond visual range (BVR) missiles. As such, these would make good targets for targets for CCA UCAVS carrying AIM-120C/D AMRAAMs. CCA strikes against ground-based threats are likely in a secondary SEAD/DEAD capacity, but would probably be primarily for lower-cost CCA types, or those operating in a loitering munition capacity. However, for loyal wingmen to stay 'loyal', they will need to be secured against cyber-attacks to avoid being neutralised, turned around, or captured, as was the case when Iran successfully captured a US RQ-170 over its airspace on 5 December 2011, purportedly the result of a cyber-attack.

Credit: Anduril

Anduril's 'Fury' CCA concept

Wargaming CCA

The Mitchell Institute for Aerospace Studies recently gained some interesting findings regarding the concept of these CCAs. Under its dean, former Operation Desert Storm air campaign planner, Lt Gen (ret.) David Deptula, 60 players from the AFA, USAF, industry and scientific fields, conducted a wargame in early February 2024 named *The Need for Collaborative Combat Aircraft for Disruptive Air Warfare*. Its rules were framed around Beijing seeking to match the capabilities of the most established aerospace powers and focused on developing anti-access/area denial (A2/AD) capabilities, with an eye toward negating any possible threat to their dominance in the Western Pacific.

Before starting, the wargamers agreed that CCAs should be additive and complementary to next-generation crewed combat aircraft, but should not replace them. They also agreed that CCAs will be needed at a large scale in a peer conflict, because typically, only one-third of a deployed inventory of manned combat aircraft will be available 24/7 to execute missions. Applying those numbers to the USAF's F-22 inventory (after former Secretary of Defense Bob Gates capped their numbers in 2009) of 100 combat-coded 'Raptors', illustrates how an air warfare commander could have about 30 of these low-observable fighters ready for missions at any given time, assuming all 100 would be deployed. Of course, there would also be a larger number of F-35s available by US and allied forces, with better sensors, but a lesser focus on air-to-air combat than the 'Raptor'. These would be callud upon to face many hundreds of PLAAF fighters on the opposing side.

It is therefore no wonder that the USAF is planning to field an initial tranche of up to 1,000 CCAs, though that number could grow. Initial plans envision a thrust range of 1,361-3,629 kgf (3,000-8,000 lbs) for them to fly and fight alongside manned fighters, to augment combat operations, conduct surveillance and likely – as some are considered expendable – to draw enemy fire. Kendall said he wanted their production to start by FY 2028 and on 24 January 2024,

Credit: Boeing

MQ-28 Ghost Bat Loyal Wingman aircraft, undergoing testing at RAAF Woomera Range Complex in Australia.

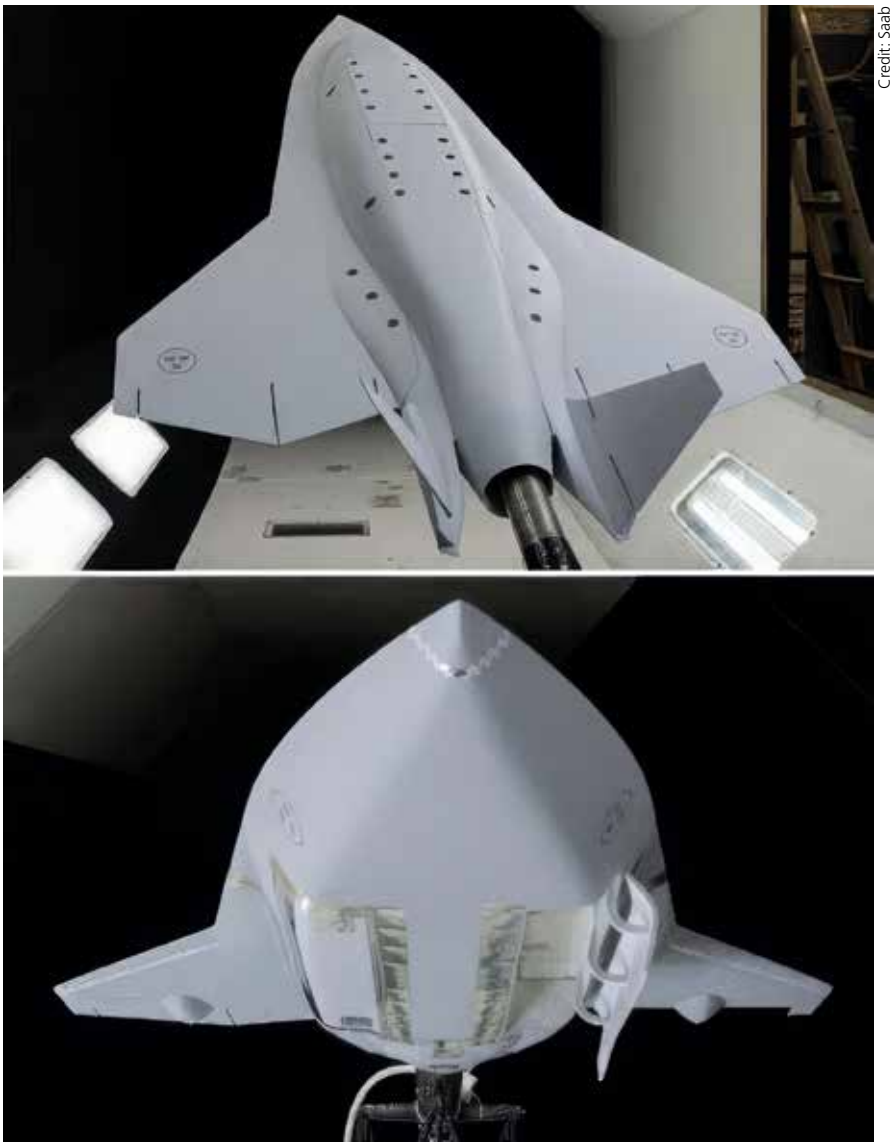
it was disclosed that five companies had been contracted to design and build CCAs: Boeing, Lockheed Martin, Northrop Grumman, General Atomics and Anduril.

The players at the Mitchell Institute were divided into five groups. Three 'blue teams' represented US forces with different detailed tasks, but the same operational goal – preventing PLA forces from securing and maintaining air superiority over the South China Sea. A 'red team', which deployed Chinese forces and responded to the attackers' moves on the first day, while a 'white team' awarded points to either side. The 'blues' were provided with a considerable CCA stockpile from 10 different classes, either air-launched in their tens from three B-52s, or later from B-21s, as well as two released from 10 F-15EXs, and a further 60 took off from ground bases on islands. All of these flew together or ahead of eight F-22s and 16 F-35s. The most surprising conclusion was: "Buy 'em cheap and stack 'em high."

Given the choice between generic CCA types and a notional budget, all three 'blue teams' in the first waves opted for 100+ lower-end CCAs that were barely larger than cruise missiles, though large enough to carry two AMRAAMs or GBU-53/B StormBreaker bombs. These had a range greater than 1,204 km (650 NM) at high subsonic speeds, and it was not expected that many of the aircraft (notionally with a price-tag of USD 2–15 million each) would return. By contrast, the most sophisticated and expensive (notionally costing USD 30–40 million) two or three CCA types in the exercise, featuring advanced active and passive targeting sensors, were not requested in the first phase at all!

In the end, the 'reds' could not establish their denial-umbrella. Overall, the wargame was therefore claimed to have substantiated recommendations for developing a CCA force that would disrupt and defeat Chinese operations to control the air. It also became clear that new concepts are required to operate CCAs alongside crewed and other uncrewed aircraft for counter-air missions. Limiting CCAs to performing only as adjuncts to crewed aircraft could constrain their combat potential. Moreover, those 'cheaper' CCAs carrying two air-to-air missiles (AAMs) should be designed with at least enough survivability and mission systems to ensure they will be able to complete their kill chains in highly contested environments. The larger and costlier systems with what is called 'affordable combat mass' – carrying up to six AAMs – can no longer be regarded as 'expendable'.

A realisation has evidently arrived, that any UCAV with sufficient performance to be a 'wingman' is too costly to be sacrificed in numbers, so the suggested approach has changed from just accepting their losses to managing procurement and operating costs. However, in general the wargame confirmed that advances in autonomy and other uncrewed technologies have created a unique opportunity to augment the lethality of 5th and 6th generation fighters with various CCAs designed to disrupt and defeat counter-air operations, such as those expected to be rolled out by China.



Credit: Saab

Front and rear views of Saab's conceptual CCA design undergoing wind tunnel testing.

A common trend

The shift towards collaborative UCAVs is of course not only happening in the US. The Franco-German-Spanish SCAF and the Italian-Japanese-UK-led Global Combat Air Programme (GCAP), have both committed to a 'system of systems' approach, with manned fighters operating alongside unmanned companions equipped with sensors and effectors, in ways that previous combat aircraft have not been capable of doing.

In this context, BAE has revealed a new version of its 'Concept 2' UCAV, and there are also the recently flown Turkish Anka-3 low-observable UCAV or Saab's wind tunnel-tested UCAV design with internal weapons bays, as well as the Chinese GJ-11 or India's 'Ghatak'. With regards to India, at the November 2023 Dubai Air Chiefs' Conference, Indian Air Force (IAF) Air Marshal R. Radhish warned attendees he would be 'lying' if he said his country's vision for a family of combat-teaming drones would be realised sooner than 10 to 20 years from now. Perhaps he was referring to India's overly-complex acquisition processes, but at the same time, this timescale might also provide a reality check for the ambitions of the USAF and others. ■

Connectivity talks

Dr Lee Willett

Navies need connectivity to enable communications (including data transfer) between maritime uncrewed systems (including uncrewed underwater vehicles). Such a communications structure itself needs capability and design standards to enable it to work.

Maritime uncrewed systems (MUS) are being developed and procured as assets intended to assist NATO navies in adding capability and capacity in the current naval operating environment, including towards the higher end of the operational spectrum. In capability terms at this end of the spectrum, MUS can offer sensing, they can offer strike, and a range of outputs in between. In capacity terms at this end of the spectrum, they can offer mass. Even with this mass, though, a navy's human operators and its uncrewed systems need communications with each other and with others to generate effect. Whatever capability or capacity a navy has, its effect will be limited if systems (crewed or uncrewed), operators, and operations are not connected. In other words, connectivity 'talks'.

The challenge for naval operators is that different navies operate different platforms, weapons, and systems, equipment that is largely designed and built differently because it is developed for different – and national – customer requirements by different – and often national – industry suppliers. While there is habitually significant overlap between such equipment in capability and output terms, the connectivity that should enable them to operate and integrate effectively can be different enough to the point that such effect connectivity, integration, and operation is a challenge.

In other words, there is a need for standardisation in connectivity to enable platforms, weapons, systems, and even people to 'talk'.

Author

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Credit: US Navy

A US Navy sailor stands watch in the combat information centre onboard the Arleigh Burke-class destroyer USS Rafael Peralta. NATO STANAGs are used to develop common standards in system technological design, capability, and integration, to enable operators to collect, fuse, process, and use data for operational advantage.

This is not a challenge that is new with the arrival and use of MUS. Capability design standards are something NATO has been developing for some time. The alliance has a long-standing process of developing what are known as standardisation agreements, or STANAGs. In terms of communications STANAGs, key examples demonstrate the importance of communications connectivity and the role of a STANAG in enabling this.

"A STANAG is a NATO document that specifies the agreement of member countries to implement a standard," according to NATO. These standards encompass "rules or guidelines that ensure mutual understanding and practical functionality", it added.

Specifically, NATO defines a standard as a document, established by consensus and approved by a recognised body, that provides, for common and repeated use, rules, guidelines, or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. Within such a document, the standard may define the development and implementation of concepts, doctrines, and procedures to achieve and maintain the required levels of compatibility, interchangeability, or commonality needed to achieve interoperability.

"Standards enable people from a wide variety of countries and backgrounds to have compatible equipment, to understand each other's methods and procedures, and to operate smoothly even if they have just started working together," according to NATO. "This is … interoperability, which is the ultimate goal of standardization."

The alliance's STANAG development is led by the NATO Standardization Office (NSO), "which initiates, co-ordinates, supports, and administers NATO standardization activities", NATO stated. As part of this process, the NSO – which, since 2014, has been an integrated NATO Headquarters staff element, reporting to NATO's Military

Committee and the Committee on Standardization – works with the Military Committee on developing the broad concept of and process for developing military operational standards.
This fits within NATO's broader Defence Planning Process, which is the alliance's primary means for identifying required capabilities and promoting their timely, coherent development and acquisition by allies; within this context, the NSO encourages STANAG implementation through defence planning. Overall, according to NATO, "These activities foster NATO standardization with the goal of enhancing the interoperability and operational effectiveness of alliance military forces."
Currently, more than 1,200 STANAGs are promulgated within NATO. STANAGs cover the full range of military capabilities, including ammunition sizes, air-to-air re-fuelling capability, rail gauges, common markings on ships or aircraft supporting the same operation, formats for information sharing, procedures for moving logistics, the words that troops use to communicate with each other, and compatibility in communications equipment.
In certain capability areas – particularly communications technology – the STANAGs are complex, relating to the technological design, capability, and integration of a communications system.

Linking capability

One of the most important NATO STANAGs developed and implemented to date is the process that underpinned the alliance-wide introduction of the Link tactical data system. The three most prominent Link networks NATO has established are Link 11, Link 16, and Link 22.
The Link tactical communications network enables data exchange across a secure radio system that connects air, surface, subsurface, and ground-based data systems. Link 22 is the latest iteration, and is designed to replace and upgrade the capability provided in Link 11 and Link 16.
In tactical operations-level terms, the Link network is a standardized communications system designed to transmit and exchange real-time tactical information between network participants.
While the Link network is a multi-domain structure, what is new today is the need to integrate MUS, and especially uncrewed underwater vehicles (UUVs) – the latter operating, of course, in the underwater domain, which still presents basic, physical communications challenges from a technology perspective. To meet this new communications requirement, a bespoke

Credit: NATO

NATO Centre for Maritime Research and Experimentation personnel operate a JANUS digital underwater communications network during NATO's 'Dynamic Monarch' submarine rescue exercise in the Mediterranean Sea in 2017. Like the JANUS STANAG (4748), NATO's STANAG 4817 is designed to provide development and integration standards for underwater communications.

STANAG is being developed – what is arguably one of NATO's most critical current and recent STANAGs.
STANAG 4817 is being designed to provide seamless, multi-domain command and control (C2) of MUS. Such C2 is the critical enabler for MUS operations, particularly in the underwater domain. Here, this C2 will enable the transportation and sharing of increasingly important data and the information that is processed from it.

Operational context

Such information harvested from the underwater domain includes habitual task areas such as intelligence, surveillance, and reconnaissance (ISR) and indicators and warnings (INW), which remain integral to building wider maritime domain awareness (MDA).
In the modern naval operational environment, some traditional underwater sensing tasks – for which UUVs are ideally suited, with the information they glean and the actions they take being operationally crucial – are increasingly important. While connecting uncrewed systems for mine counter-measures (MCM) operations is an established concept, and represented the first regular use of UUVs in order to remove crewed platforms from harm's way, MCM operations are today an area of greater focus for underwater C2 of MUS capability due to the wider use of mining for operational effect, for example to close off access points. This is being demonstrated in the Russo-Ukraine war, with both sides mining littoral waters in the Black Sea. The new mine threat that has emerged in the war – that of drifting mines, which are flowing freely across the Black Sea – underlines the blue-water MCM threat, too. In the absence of a naval force structure, following its fleet largely being destroyed during not only the current conflict but also during Russia's invasion and subsequent annexation of Crimea in 2014, Ukraine is using UUVs to conduct MCM operations.
For anti-submarine warfare (ASW), increasing Russian activity and capability across wide areas of the Euro-Atlantic theatre's underwater domain is creating the challenge for NATO of geography and mass. The alliance's relatively limited collective submarine capacity (relatively limited, in terms of boat numbers compared to areas and tasks to cover) means there is an increasing focus amongst NATO navies on developing MUS capabilities – and especially UUVs – to provide the more routine presence and sensing capability. Sustained, and sometimes forward-deployed, sensing capability is something NATO navies have often done with submarines. However, what is new today is the use of UUV capabilities to provide this routine sensing presence, especially through the establishment of ASW barriers.
What is also new in the underwater domain in terms of building connected capability is the use of MUS across all domains to deter and defend against the growing threat to critical undersea infrastructure (CUI) situated on the seabed. Recent years have seen several high-profile incidents occur, most notably the Nordstream gas pipeline explosions and the BalticConnector pipeline and cable ruptures (both incidents occurring in the Baltic Sea, in Sep-

tember 2022 and October 2023 respectively). The importance of deterring and defending against CUI threats is significant enough for NATO at national and alliance levels that member states are investing in bespoke equipment and are testing its connectivity at one of NATO's most prominent exercises – the Portuguese Navy/NATO Maritime Command (MARCOM)-hosted 'REPMUS'/'Dynamic Messenger' combined MUS exercise, which takes place off Troia, southern Portugal in September each year. At the 2023 iteration of the exercise, uncrewed air vehicles (UAVs), uncrewed surface vessels (USVs), and UUVs were employed in integrated layers to locate a seabed cable, secure it, and deter and defend against a direct threat to it.

Barriers to progress

Concepts for building barriers consisting of integrated, connected UUVs (either autonomous underwater vehicles or underwater gliders) to secure CUI or to provide ASW barriers across maritime choke points are designed to provide potential obstacles to the operational progress of adversary submarines, which might be seeking to threaten such CUI or slip through such choke points.

NATO's Smart Defence Initiative ASW Barrier is a key concept the alliance is developing to build capacity to establish sensing networks in key places at key times, for example around CUI sites or at choke points. The concept is based around delivering integrated, connected webs of UUVs, plus other crewed and uncrewed platforms. One potential obstacle to capability development progress here that NATO is tackling, in the process of delivering this capability, is establishing the standards required to enable the build and operation of this network, plus several other MUS communications architectures that enable and support this and other MUS operational constructs.

STANAG 4817 was conceived to determine the MUS connectivity and communications architecture design standards required to enable the establishment of an integrated MUS network, including its operational C2. Such networks are the glue that binds the operational capability and effect together.

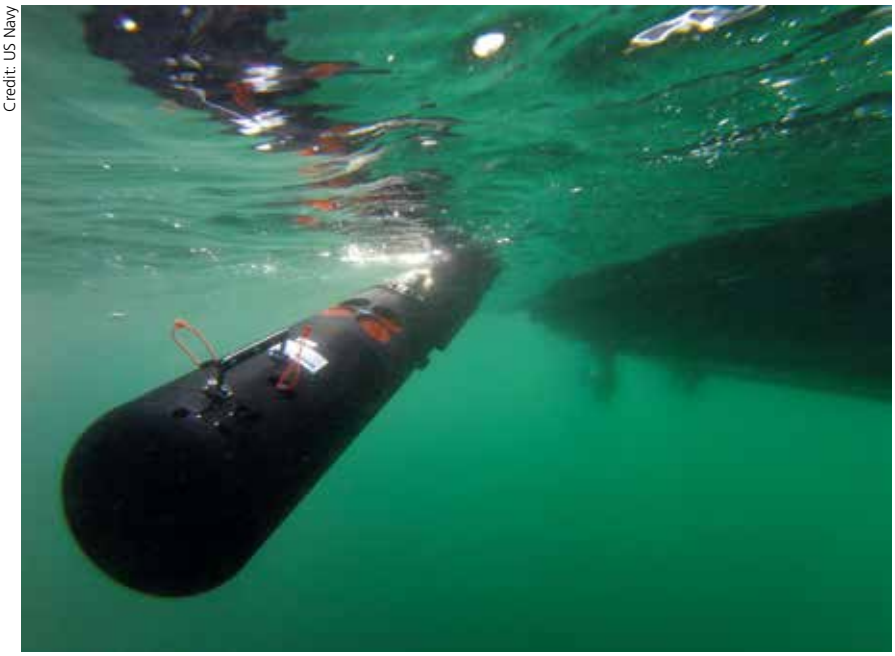
"You cannot have a UUV if you cannot operate it," Rear Admiral James Parkin – the UK Royal Navy's (RN's) Director Develop – told the Undersea Defence Technology (UDT) exposition, held at London's ExCel exhibition centre in early April.

Operators need to be able to offboard the data from the UUV, he continued. This is done using connectivity networks. Alongside offboarding data, such networks need to provide the required MUS C2, and must be underpinned by a resilient, secure, and seamless infrastructure.

The RN's StrikeNet communications architecture – the navy's digital backbone for supporting dispersed operations and distributed C2, and which evolved from its MAPLE NSN (Maritime Autonomous Platform Exploitation naval strike network) construct – is an overarching C2 framework under which STANAG 4817 has been developed. Rear Adm Parkin told the UDT conference that STANAG 4817 sits at the heart of the StrikeNet construct, and steps allied interoperability forward into interchangeability.

"We will buy nothing or use nothing unless it is compatible," said Rear Adm Parkin. "STANAG 4817 is how we will win the next war."

Credit: US Navy



A REMUS 100 autonomous underwater vehicle (AUV) is tested at a 'REPMUS' exercise. AUVs, along with underwater gliders, will be a core component of NATO ASW Barrier concepts.

REPMUS development

The 'REPMUS'/'Dynamic Messenger' exercise construct is a driving force for development in terms of building MUS capability and the requisite STANAGs, and integrating and testing them including in operational experimentation using active NATO task groups. The effectiveness of integrating MUS systems with each other and into operations, along with the underpinning C2 infrastructure and architecture, is already being demonstrated in the 'REPMUS' outputs.

For example, in an MCM serial conducted at 'REPMUS 2023', a US UUV autonomously located a mine contact and tasked two other UUVs (one British, and one Dutch) to investigate the contact and complete the rest of the mine clearance task, a senior NATO official told a media briefing at the exercise. "The UUV level of autonomy has increased probably two- or three-fold this year," the official said, adding that the collaborative autonomy demonstrated in the MCM serial was achieved with no human intervention.

"The UUVs were assuring the commander that the area of sea was clear of mines," the official continued. "To put it into metrics, if you were to use a single national system to clear the same seaspace, it would have taken about 18 hours. With three systems from three different countries working collaboratively, it took two-and-a-half hours."

In terms of delivering usable capability, this example underlined the importance of collaborative autonomy as a principal, but also the impact of a common C2 architecture, as being defined and developed under STANAG 4817.

Mines present a covert sea denial challenge to NATO navies operating in a particular seaspace, particularly as any reported mine contact will require investigation. Thus, the ability to work collaboratively to clear an area more rapidly offers distinct operational advantage.

The drifting mine challenge was also used in serials at 'REPMUS 23'. The 'REPMUS' environment provides a particularly useful construct within which to develop and test a STANAG like 4817. STANAG 4817 is the standard that NATO will be using to de-

Credit: Portuguese Navy

A UUV is pictured ashore in Troia, Portugal at the 'REPMUS' exercise in September 2023. 'REPMUS' in a major NATO activity for testing MUS capability and connectivity.

velop the capacity required to tackle the threats that MUS capability is applicable to. The exercise brings the operational experimentation and military operator communities together with the scientific operational research community – with key research stakeholders like the NATO Science and Technology Organization's La Spezia, Italy-based Centre for Maritime Research and Experimentation (CMRE) playing a central role in planning and conducting the exercise. This enables the two communities to combine the expertise they bring and the data they generate in order to develop an operational construct such as STANAG 4817. Combining the range of expertise and data developed across the exercise's operational experimentation, and then feeding lessons learned into NATO operational tactics, techniques, and procedures (TTPs), was a central aim of STANAG 4817's ongoing development process in 'REPMUS 23'.

In this context, STANAG 4817 is a key step in developing the alliance's capability to use MUS to deliver a common operational picture. Simply put, STANAG 4817 will pre-define what NATO needs in terms of compatibility from MUS systems developed to support NATO exercises and operations, with a particular emphasis on being able to contribute to the development and sharing of that picture. STANAG 4817's role in how NATO maritime systems, including MUS, develop and distribute data is crucial.

"We are in an operating environment where we are using data like never before. We're going in the direction of data-centric warfare," Commander Antonio Mourinha – a Portuguese Navy officer posted as Director of the navy's Troia-based centre for operational experimentation (CEOM), and 'deployed' on 'REPMUS' as Chief of Staff – told the exercise media briefing.

Credit: NATO

Multinational personnel conduct mine counter-measures (MCM) activities at 'REPMUS 2022'. NATO STANAGs are designed to enable MUS from different countries to integrate and collaborate when conducting crucial tasks like MCM.

"The use of MUS and their payloads, and the ability to connect all of them together and to use this data extensively is key to the success of operations. This is real here [in 'REPMUS'], is real in Ukraine, and is real in any place."

"An uncrewed system doesn't have value unless it can carry something that is useful," said Cdr Mourinha. Such things of use that add value, he explained, are payloads that provide a sensor, an effector, or data-gathering/data-using capacity in some way. "It is really important that we have the ability to assess, [in the location] where we are, the data that is being collected by the MUS. This is what is useful for the commander in the operation."

For 'REPMUS 23', testing and experimentation with MUS (especially UUVs) using multi-domain C2, integrated through STANAG 4817, was one of the major objectives, said Cdr Mourinha. "This is going to become a NATO standard, under STANAG 4817," he continued. "STANAG 4817 is going to be a NATO standard for high-level, multi-domain C2 of unmanned systems. This will allow you to have a system that communicates with other systems, and that can give orders to other systems. It is a 'system of systems'."

In sum, the use of STANAG 4817 to build a 'system of systems' is intended to allow data to flow between assets and C2 nodes to build the common operational picture. "We are really shaping the future of these data flows," said Cdr Mourinha. "We look to use not only MUS but [other] systems to collect data, to fuse data, and to process data, and to provide the operators with the best advice in terms of how to proceed."

While STANAG 4817 continues to develop, 'REPMUS 23' used two main C2 networks: the CMRE-developed Collaborative Autonomy Tasking Layer (CATL) protocol, which focuses on passing information – including commands – between different MUS; and the UK/US-developed I2I (Interoperability to Interchangeability) network, which focuses on connecting up different C2 nodes as well as different national networks (for example, the UK's MAPLE NSN).

CATL and I2I send different messages using different 'languages'. STANAG 4817 will provide a common set of technical and operational standards within a common C2 architecture standard in the longer term, including capacity to blend different communications 'languages', Cdr Mourinha explained. A standard is like using a common language, he added.

The importance of STANAG 4817 is such that NATO navies are continuing to prepare to send platforms and systems to 'REPMUS 2024' for C2 evaluation and integration. For example, at the SAE Media Group's Maritime Reconnaissance and Surveillance Technology conference in London in January, the discussions noted that the Italian Navy is planning to send a frigate to the exercise in 2024 with a combat management system that is STANAG 4817-compliant.

Back at the 'REPMUS 23' media brief, Cdr Mourinha reinforced the simple importance of constructs like STANAG 4817 for NATO. "The war of the future will rely very much on connectivity," he said. ■

Credit: NATO

NATO operational task groups are the end-user beneficiaries of the information MUS and other maritime platforms will generate through the use of greater compatibility in capability and operations through developing STANAG 4817.

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Central European armoured vehicle programmes

Martin Smisek

The Visegrád Group countries, comprising the Czech Republic, Hungary, Poland, and Slovakia, have all undertaken noteworthy armoured vehicle procurement or modernisation programmes in recent years. This article provides a general overview of the Visegrád Group's most significant land vehicle programmes to date.

Czech Republic

After numerous delays, the contract for the delivery of 246 CV90 tracked combat vehicles for CZK 59.7 billion (including VAT) was signed by the Czech Ministry of Defence (MoD) on 24 May 2023. The contract also includes 29 mobile workshops, training support, spare parts and other accessories. The Swedish manufacturer BAE Systems Hägglunds signed contracts with the following main Czech subcontractors: VOP CZ, EXCALIBUR ARMY, VR Group, Meopta and Ray Service. The leading role of the Czech industry will be played by the state-owned VOP CZ, which will serve as a vehicle integrator performing final assembly and subsequent functional tests of five of the seven variants on order.

The CV90 will be delivered to the Czech Army in these variants: infantry fighting vehicle (IFV; 141), command vehicle (31), reconnaissance vehicle (18), artillery observation vehicle (12), engineer vehicle (13), recovery vehicle (15) and medical evacuation vehicle (16). Of the total, 36 will be designated as wartime reserves. Most of the vehicles will be used by the units of the 7th Mechanised Brigade, with the first 10 vehicles due to be delivered in 2026. The first battalion should be reequipped with the vehicle in 2027, while the last CV90 is planned to be delivered in 2030.

At present, VOP CZ is performing a basic upgrade of the Czech Republic's T-72M4 CZ tanks, which has been delayed due to technical problems with the new components of the TURMS-T fire control system supplied by Leonardo. Although 14 upgraded vehicles were due to be delivered to the 73rd Tank Battalion by the end of 2023, the unit did not receive any tanks. According to the updated schedule, 11 modernised tanks are due to be delivered in 2024, followed by a further 22 in 2025.

During 2022 and 2023, Germany donated 14 Leopard 2A4 tanks to the 73rd Tank Battalion, and one Büffel armoured recovery vehicle will be delivered during 2024. In late February 2024, the MoD announced that negotiations with Germany were underway on a further donation of the same batch of vehicles as compensation for Czech aid to Ukraine. At the same time, Prague has received an offer from German defence industry to buy 14 more Leopard 2A4 tanks and a Büffel 3 vehicle in a joint purchase on similar terms as the German MoD.

A significant increase in the combat capability of the 73rd Tank Battalion is to be achieved with the introduction of a new main battle tank (MBT), scheduled for 2027–2030. In 2023, the Czech MoD began negotiations with German officials on the joint purchase of Leopard 2A8 tanks. The Czech Army would like to buy at least 77 tanks, including derivative combat support vehicles. The Czech Republic is also interested in participating in the production and servicing of the tanks, with the MoD wishing to conclude a contract for these in 2024.

In 2023 and 2024, deliveries of series production TITUS 6×6 wheeled vehicles were made. In 2019, 62 units were ordered, with 20 of the MKPP (fire support coordination variant), 36 of the KOVS (communication variant) and six of the KOVVŠ (command and staff variant) for units of the 4th Brigade Task Force and the 13th Artillery Regiment. The integration of electronics into all vehicles was performed by RETIA at Pardubice, while Tatra Defence Vehicle at Kopřivnice carried out the final assem-

Credit: Tatra Defence Vehicle

Two MKPP TITUS fire support coordination vehicles for the 13th Artillery Regiment of the Czech Army at the Tatra Trucks testing area in Kopřivnice.

Author

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

Credit: Hungarian Defence Forces

The 1st Armoured Brigade received its initial Leopard 2A7HU MBT in December 2023.

bly of 52 vehicles and manufactured the last 20 hulls. Between 2025 and 2027, the second phase of the acquisition of MKPP, KOVS and KOVVŠ TITUS vehicles for the 4th and 7th Brigade Task Force is due to take place.

The Czech Army plans to modernise its current fleet of Pandur II CZ 8×8 wheeled IFVs between 2027 and 2029. The modifications will include increased ballistic protection, firepower, manoeuvre capability and modernisation of communication systems. The most noticeable change will be the installation of new remote turrets. At the same time, the acquisition of new wheeled IFVs for the last battalion of the 4th Rapid Deployment Brigade – the 44th Light Motorised Battalion, currently equipped with Iveco Defence Vehicles (IDV) LMVs – is to take place. With this change, the 44th Light Motorised Battalion will be converted into a mechanised battalion.

The last major planned acquisition is the universal armoured wheeled engineer vehicle of the UKP-ŽV programme. According to a feasibility study conducted in 2021, the Thales Bushmaster 4×4 protected patrol vehicle was selected as the most suitable platform, and VOP CZ signed a Memorandum of Cooperation with Thales Group in May 2023. Despite this, the MoD carried out an update of the market survey at the end of the same year without publicly identifying a specific type of preferred platform. The Czech Army is requesting up to 82 UKP-ŽV vehicles to be delivered between 2025 and 2031.

Hungary

In December 2018, Hungary placed an order for 44 Leopard 2A7HUs (also referred to as the Leopard 2A7+ standard) and 12 refurbished Leopard 2A4s. The latter arrived in 2020 and allowed tank crews of the 11th Tank Battalion, the sole Hungarian tank unit, to familiarise themselves with the German platform. The handover ceremony of the first Leopard 2A7HU tanks took place in the garrison of the 1st Armoured Brigade (former 25th Rifle Brigade) at Tata

Credit: Hungarian Defence Forces

Hungarian Lynx KF41 of the 5th Rifle Brigade (in January 2023 reorganised into the 30th Armoured Infantry Brigade) during a driving exercise at Táborfalva in December 2022.

on 14 December 2023. Three more vehicles followed on 10 January 2024, bringing the total number of tanks to eight. According to the current timetable, 44 Leopard 2A7HUs, five Wisent 2HU armoured recovery and engineer vehicles, as well as three Leguan 2HU bridge layers, are to be delivered to Hungary by 2028.

On 15 December 2023, representatives of the Hungarian state defence company N7 Holding Nemzeti Védelmi Ipari Innovációs, Rheinmetall Hungary and Rheinmetall Landsysteme signed a EUR 288 million contract for the joint development of the Panther KF51 EVO tank. This is the latest variant of the Panther KF51, which will be equipped with the L55A1 120 mm smoothbore gun, an autoloader and Rheinmetall's StrikeShield active protection system (APS). The turret architecture will enable subsequent retrofitting of Rheinmetall's 130 mm gun if required.

In September 2020, the Hungarian MoD awarded Rheinmetall a contract to supply 218 Lynx KF41 tracked combat vehicles and associated support equipment for a total value of more than EUR 2 billion. The delivery package included ammunition, spare parts, maintenance support and simulators, as well as nine Büffel armoured recovery vehicles, nine armoured vehicle launched bridges and 38 RMMV (Rheinmetall MAN Military Vehicles) trucks. In the initial phase, Hungary took delivery of 46 Lynx IFVs produced in Germany. The first KF41 was transferred to the Hungarian military on 15 October 2022. The remaining vehicles will be produced in Hungary by Rheinmetall Hungary, a joint venture co-owned by Rheinmetall (51%) and the Hungarian state (49%) established at Zalaegerszeg. The 30th Armoured Infantry Brigade carried out an inaugural live-firing exercise with the Lynx KF41s in mid-September 2023.

The first Lynx to be built in Hungary rolled off the assembly line in December 2023; following functionality and performance inspections, the first Hungarian-built Lynx will be transferred to the Hungarian Ground Forces in mid-2024, and Rheinmetall Hungary is also due to deliver nine combat support vehicles. The contract originally envisaged the delivery of the Lynx KF41 in seven variants: IFV, command vehicle, reconnaissance vehicle, artillery observation vehicle, mortar carrier, ambulance and driver training vehicle. However, an eighth is in development, under a EUR 30 million contract signed on 15 December 2023, covering the conceptual development of a mobile air defence variant armed with a Skyranger 30 remote turret.

The last major Hungarian armoured vehicle programme is Gidrán, which is the Hungarian Army's service designation for the Ejder Yalçın wheeled vehicle, manufactured by Turkish company Nurol Makina. The first 10 Gidráns, ordered in 2019 and equipped with Aselsan SARP remote weapon stations (RWSs), were handed over to the 36th Anti-Tank Missile Battalion of the 25th Rifle Brigade at Tata on 11 February 2021. An additional 40 vehicles for the 25th Rifle Brigade were ordered in December 2020. These Gidráns were completed at the Kaposvár plant, which was established jointly by Rheinmetall Hungary and HT Division. However, this facility served only for the equipping of the Turkish base vehicles with military equipment according to the requirements of the Hungarian Army.

Thus, on 31 October 2023, representatives of Rába Autóipari Holding, Nurol Makina and N7 Holding Nemzeti Védelmi Ipari Innovációs signed a Memorandum of Understanding on the establishment of a joint venture – Gidrán Páncélozott Járművek – for the production of the Gidráns at Rába truck manufacturing facility in Győr. According to the plans, 400–500 vehicles will be produced for domestic use over the next five to six years, but the Turkish–Hungarian joint venture is also aiming to manufacture 2,000 vehicles for export customers over the next 10 years.

Poland

On 27 July 2022, the Polish Armaments Agency concluded a framework agreement with Hyundai Rotem for the purchase of as many as 1,000 new K2/K2PL Black Panther tanks. In the first phase, on 26 August 2022, 180 K2 tanks worth USD 3.37 billion were purchased to equip three tank battalions, with deliveries planned in 2022–2025. The contract included training, logistics support, explosive reactive armour (ERA) packages, 500,000 rounds of 120 mm ammunition, as well as 4.3 million

Credit: Polish General Command of the Armed Forces

Polish Leopard 2A4 tanks are being upgraded to Leopard 2PL/M1 standard locally with the assistance of Rheinmetall Landsysteme.

rounds of 7.62 mm and 12.7 mm machine gun ammunition. By mid-June 2023, Hyundai Rotem had delivered 28 tanks with the company scheduled to supply a total of 56 tanks in 2024 and 96 tanks in 2025.

The Black Panthers will be successively deployed in the brigades of the 16th Mechanised Division: 20th Mechanised Brigade, 15th Mechanised Brigade and 9th Armoured Cavalry Brigade. The deliveries of the remaining 820 vehicles for around 14 tank battalions in the Polish variant K2PL are expected to begin in 2026 and due to last until 2030. According to the framework agreement, 500 K2PL tanks will be produced at Wojskowe Zakłady Motoryzacyjne in Poznań and 320 in the Republic of Korea.

Credit: Polish Army/Daniel Wójcik

The live firing exercise of the K2 Black Panther tanks from the 20th Mechanised Brigade at Orzysz military training ground in March 2023.

In July 2021, Poland announced the purchase of the latest M1A2 SEPv3 Abrams tanks for USD 4.75 billion in a deal that the Polish Government made clear was intended to be a deterrent against possible Russian aggression. The actual contract was signed on 5 April 2022 and included the purchase of 250 M1A2 SEPv3s, along with 26 M88A2 Hercules armoured recovery vehicles (ARVs) and 17 M1074 Joint Assault Bridge (JAB) support vehicles, as well as a training and logistics with associated ammunition – including the KE-W A1 armour-piercing fin-stabilised, discarding sabot, tracer (APFSDS-T) round and M830A1 high-explosive anti-tank multi-purpose tracer (HEAT-MP-T) round. According to the plans, the first Abrams M1A2 SEPv3s are expected to be available by the end of 2024, with deliveries completed by late 2026. The tanks are to be introduced into the inventory of the 18th Mechanised Division deployed in eastern Poland.

On 4 January 2023, after the donation of over 200 Polish T-72 tanks to Ukraine, an agreement was signed between Poland and the United States for the supply of 116 ex-US M1A1SA/FEP Abrams tanks, logistic support equipment, and ammunition for the Polish Land Forces. The value of the contract was approximately USD 1.4 billion, with part of the cost (almost USD 200 million) covered by the United States through the Foreign Military Financing programme. Along with the 116 M1A1 Abrams for two

tank battalions, Poland will also receive 12 M88A2 Hercules recovery vehicles, eight M1074 joint assault bridges, six M577 command post carriers, and 26 next generation shop equipment maintenance contact (SECM) shelters. The first company of 14 tanks was delivered to Poland on 28 June 2023 and subsequently transferred to the 1st Armoured Brigade. The second user of the M1A1SA/FEPs will be the 19th Mechanised Brigade; both brigades are part of the 18th Mechanised Division.

In the meantime, the Polish defence industry has been engaged in modernising Leopard 2A4 tanks. Under a contract signed in December 2015, and a separate addendum signed in June 2018 between the Armament Inspectorate of the MoD (now the Armaments Agency), and the consortium of Polska Grupa Zbrojeniowa and Zakłady Mechaniczne Bumar Łabędy, a total of 142 tanks were to undergo overhaul and modernisation to the Leopard 2PL variant. The upgrade was to be completed between 2019 and 2022. However, due to limited modernisation capacity, work on the remaining tanks will take until 2027, and in the process, these are due to be upgraded to the newer 'Leopard 2PL/M1' standard unveiled in 2021.

By the end of 2023, a total of 62 tanks in the Leopard 2PL or Leopard 2PL/M1 standards were in service with the Polish Land Forces. The upgraded tanks are operated by the 10th Armoured Cavalry Brigade and the 1st Armoured Brigade. Additionally, the total number of Polish Leopard 2A4s to be upgraded is expected to be dropped from 142 to 128, given that Poland donated 14 Leopard 2A4s to Ukraine in early 2023.

In October 2014, the New Infantry Amphibious Fighting Vehicle Borsuk development programme was launched. Following the production and extensive trials of five prototypes, on 28 February 2023 the Polish Armaments Agency signed a framework agreement with Huta Stalowa Wola for the manufacture of 1,000 Borsuk IFVs and 400 derived combat support vehicles in 10 variants, thus making Borsuk the future standard tracked fighting platform of the Polish Land Forces. The first IFVs equipped with indigenous ZSSW-30 turrets are expected to be delivered to the 16th Mechanised Division in 2024, with the support versions following in 2026. The whole programme is scheduled to be completed by 2035.

The Rosomak armoured personnel carrier (APC) programme, a Polish-licensed version of the Patria AMV 8×8, is ongoing. The licence agreement for the production of the vehicles was due to end in 2023 but was extended by an annex from late September 2022 until the end of 2028. The Polish Land Forces are awaiting the delivery of 18 Rosomak-WPT technical support vehicles between 2023 and 2025 and an additional 11 Rosomak-WRT technical reconnaissance vehicles in 2024–2025, and 29 Rosomak-WEM medical evacuation vehicles will be produced during the same timeframe.

In September 2021, a contract was signed for the development and production of 11 Rosomak-RSK reconnaissance vehicles which were due to be delivered between 2028 and 2029. Moreover, eight Rosomak-WD divisional command posts, 60 Rosomak-S anti-tank guided missile (ATGM) carriers armed with Spike-LR missiles, and three Rosomak M3 patrol vehicles with OSS-D manned open-top turrets were delivered recently. In July 2022, the Armaments Agency ordered the first batch of 70 ZSSW-30 weapon stations for the retrofit to existing Rosomak IFVs equipped with HITFIST 30P turrets. The production and integration of the ZSSW-30s into the vehicles was scheduled to be carried out between 2024 and 2027, with a total of 341 turrets planned to be built for Rosomak IFVs.

One of the latest additions to the Polish defence industry is the Waran wheeled armoured vehicle, a version of the Czech

Credit: US ANG/Staff Sgt Matthew A. Foster

In November 2022, a Polish Borsuk infantry fighting vehicle with a ZSSW-30 turret underwent qualification tests within the 15th Mechanised Brigade.

Credit: WB Group

A Waran wheeled armoured vehicle (Polish version of the Czech PATRIOT II) serves, among others, as the launcher of the Gladius reconnaissance and attack UAV.

PATRIOT II developed by Excalibur Army and manufactured under licence by Huta Stalowa Wola. Waran will be used in the Gladius and Ottokar-Brzoza programmes, and as a command vehicle in the Rocket and Artillery Forces. On 6 May 2022, a contract was signed for the supply of four battery sets of the Gladius reconnaissance and strike unmanned aerial vehicles (UAVs), along with training and logistics for PLN 2 billion. Deliveries to the 18th Artillery Regiment started in December 2022 and continued into 2023.

The PGZ-Ottokar consortium concluded a framework agreement for the supply of an unspecified quantity of Ottokar-Brzoza tank destroyer battery sets on 20 July 2022. In 2023, the contractor delivered the initial prototype vehicles. The Waran launch vehicle variant is equipped with an elevating launcher, notionally housing six MBDA Brimstone ATGMs – however Po-

Credit: Slovakian MoD

The very first AMV XP for the Slovak Armed Forces was delivered in the BOV 8×8 AMBS ambulance variant.

land has not yet confirmed selection of the missile, and Rafael's Spike NLOS is still being offered as an alternative. An Ottokar-Brzoza battery set has been reported to comprise eight launch vehicles, a battery command vehicle, two platoon command vehicles, two reconnaissance vehicles, two transporter vehicles, two medical evacuation (MEDEVAC) vehicles, and a mobile workshop. The first user of these systems will be the 14th Anti-Tank Artillery Regiment, with initial operational capability (IOC) of the first battery set expected to be achieved by 2025.

Slovakia

On 26 September 2023, the Slovakian MoD publicly presented the first AMV XP 8×8 vehicle in the ambulance variant, which will be introduced into the armament of the Armed Forces of Slovakia in 2024. In August 2022, a contract for EUR 447 million (including VAT) was concluded for the delivery of 76 AMV XP vehicles in three variants – 60 IFVs, six command vehicles and 10 ambulances, as well as related logistics, spare parts and ammunition. The first 12 vehicles will be manufactured in Finland. The final work on all AMV XPs will be carried out in Slovakia, with the Slovak defence industrial involvement in the project expected to achieve at least 40% of the contract value. The main Slovak subcontractors are state-owned KONŠTRUKTA-Defence with its facility at Moldava nad Bodvou and CSM Industry at Tisovec. While the former will assemble the chassis, the latter will produce the hull and perform the final assembly of the remaining 64 vehicles by 2027. Moreover, the Slovakian MoD plans to buy an additional 424 AMV XPs over four phases.

The contract for the purchase of 152 CV90 MK IV tracked combat vehicles for EUR 1.32 billion (excluding VAT) was signed by representatives of Slovakia and Sweden on 12 December 2022. The deal also included training equipment, including tactical simulators. The main Slovak industrial partner is state-owned enterprise ZTS-ŠPECIÁL, which will carry out the final assembly of 131 vehicles. Koval Systems will perform the complete production of 116 D-series turrets. Other key Slovak industrial partners include EVPÚ (mechatronics), Aliter Technologies (ICT), Ray Service and Neways (electronics), as well as Virtual Reality Media (simulators). The contract covers the delivery of CV90s in seven variants: 110 IFVs, 15 command vehicles, nine reconnaissance vehicles, three APCs for anti-materiel rifle squads, nine APCs for grenade launcher squads, three armoured recovery vehicles and three armoured repair vehicles. The first 10 IFVs are due to be delivered during 2026 with deliveries of the last CV90s scheduled to conclude in 2029. During the second phase of the acquisition, the Slovak MoD would like to order an additional 71 vehicles.

During 2022 and 2023, the 14th Tank Battalion received a donation of 14 Leopard 2A4 tanks from Germany to equip one of its four tank companies. The remaining units of the sole Slovak tank battalion use legacy T-72M1s. The Slovak MoD has not yet announced how and when it intends to acquire new MBTs. However, the MoD of the Czech Republic are trying to convince their Slovak counterparts to join the multinational purchase of Leopard 2A8s.

Within the framework of the Foreign Military Financing programme, the Slovak Army is set to obtain 160 JLTV 4×4 protected patrol vehicles from the United States. The corresponding Letter of Offer and Acceptance, valued at USD 189.94 million, was signed on 20 July 2023. Delivery of the vehicles is scheduled for 2025, with 110 M1278A1 Heavy Guns Carriers configured with remotely controlled M153 CROWS weapon stations and the remaining 50 M1278A1s equipped with manned machine gun weapon stations. The deal also includes the shipments of spare parts, maintenance tools, as well as provision of training and warranty service. The JLTVs are to be introduced into the inventory of the Slovak special forces, various combat support and service support units, as well as the Defence and Protection Battalion of the 81st Wing at Sliač air base. ■

Romanian acquisition programmes: a steady path to reindustrialisation

Manuela Tudosia

Bordering Ukraine and with direct access to the Black Sea, the tempo of defence planning and defence-related acquisitions has never been more dynamic in Romania. With an estimated defence expenditure of 2.44% of GDP in 2023, of which 35.2% was dedicated to the acquisition of major equipment (including related R&D), Romania attracts the attention of defence suppliers as much as Poland does in the same region.

Romania is generally perceived as a European country that emphasises the opportunities for EU–NATO cooperation, while shying away from the discourse of EU strategic autonomy in defence. Romania is also known for its strong defence partnership with the US and for a relative preference for off-the-shelf military procurement from external sources, often government-to-government. The US' designation of Romania in 2021 as a "Dependable Undertaking" only serves to reinforce this perception.

Aside from the US as its most prominent strategic partner, Romania has been procuring military equipment from a variety of other external sources, notably Israel, France, Switzerland, Italy and Türkiye. With the acquisition of 17 F-16AM/BM Block 15 combat aircraft from Portugal and 32 from Norway, these two countries can be added to the top defence equipment supplier countries.

The local defence industrial base is often described as lagging behind after 30 years of limited financing and a progressive loss of skills – largely due to the aging and retirement of the workforce –as well as being relatively decoupled from major defence modernisation efforts. However, the Romanian Defence Ministry's Directorate General for Armaments (DGA) is transparent about the past, just as it is with current and upcoming major acquisition programmes, and provides some information about the participation of the local defence industry. However, obtaining a comprehensive picture requires researching and compiling information from multiple sources.

Credit: US Army/Pfc Jason Klaer

Pyrotechnics ignite on the range as a Romanian Piranha V infantry fighting vehicle conducts firing during the Anakonda 23 training exercise at Nowa Deba Training Area, Poland, on 15 May 2023.

The emergence of structured approaches to reindustrialisation

Although the pace has dramatically increased lately, many of the major acquisition programmes are following a defence planning schedule that precedes the ongoing conflict in Ukraine.

A strong modernisation trend started in 2017 with the adoption of the Armed Forces' Acquisition Plan for 2017–2026. Long forgotten by now, this Plan had been initially withdrawn from the meeting agenda of the Supreme Council of National Defence (CSAT) – Romania's defence decision-making body – because it had not met the political agreement to allocate 2% of GDP for defence. The revised Plan respected the political agreement, and also allowed the initiation of procedures for eight acquisition programmes with a total value of around EUR 9.8 billion, approved by the Romanian Parliament a few months earlier. According to Romanian law, the contracting au-

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thority has the obligation to request prior parliamentary approval for the initiation of award procedures with an estimated value of contract equal to or higher than the equivalent in Romanian RON of EUR 100 million (excluding VAT).

Greater Romanian defence industry involvement was planned as part of this series of acquisitions. At the time, it was hinted that all defence-related acquisitions – with the exception of government-to-government ones (G2G) – would have to involve cooperation with local industry. Whereas in defence speak this is generally known as 'offsets', readers should be reminded that, for many years, the principle of 'offsets' has been a difficult topic in the EU context. Though never actually banned, because it was understood that "any unilateral intra-European decision to abolish offsets would severely hinder the competitiveness of the European defence industry in the global market", "since 2005, the EDA Member States have sought consistently to act together to develop a more open and competitive European defence market", as noted in the European Defence Agency's (EDA's) Industry & Market Directorate In-House Study 'Abatements: a pragmatic offset tool to facilitate the development of the European Defence Equipment Market'. As an enabler, a Code of Conduct on Offsets was adopted in 2009 with the participation of 25 EDA Member States and Norway.

The actual consequences of this approach to offsets on the EU defence industrial base as a whole – both positive and negative – can only be analysed with hindsight in a separate article; nevertheless, this issue highlights the sensitivity and difficulty of decision-making processes that have to consider numerous variables.

Several prominent acquisitions initiated in 2017, many of which are now being implemented, involve cooperation with local defence industry partners. The acquisition of up to 227 Piranha 5 wheeled armoured vehicles in six different configurations and initial logistic support from General Dynamics European Land Systems (GDELS) is one of them. Still in the implementation phase, this acquisition programme involves the production of the vehicles in Romania under a strategic cooperation and technology transfer agreement between GDELS-Mowag and Romanian company Uzina Mecanică București (UMB), part of the Romanian National Company ROMARM. In this context, the UMB facilities were renovated and UMB employees were trained in Switzerland for series production of the Piranha 5.

The acquisition of seven PATRIOT long-range surface-to-air missile (SAM) systems was approved by the US State Department in 2017 and implemented a few months later through a contract worth USD 3.9 billion awarded to Raytheon and Lockheed Martin. This acquisition did not include industrial cooperation, but it is likely that the conflict in Ukraine triggered an expansion compared to the initial planning. In May 2022, a Memorandum of Understanding (MoU) was signed with Raytheon Missiles & Defense for the co-manufacturing of SkyCeptor intercepting missiles in Romania by Electromecanica Ploiesti, a subsidiary of ROMARM. In August 2023, this was confirmed through the signature of a Letter of Intent between Electromecanica Ploiesti and Raytheon Missiles & Defense for the effective start of the production collaboration.

The first two PATRIOT batteries were delivered to Romania in 2022, and two in 2023. Romania also participates in the recent joint procurement of up to 1,000 PATRIOT PAC-2 GEM-T missiles under the European Sky Shield Initiative (ESSI) coordinated by the NATO Support and Procurement Agency (NSPA). The contract, worth up to USD 5.6 billion, was awarded in January this year to COMLOG – a joint venture between Raytheon and MBDA Germany founded in 1987. In this context, Romania is expected to acquire 200 PAC-2 GEM-T missiles for its PATRIOT systems.

Another high-visibility programme initiated as part of the 2017 plans, now in implementation, is the acquisition of High Mobility Artillery Rocket Systems (HIMARS) and related support and equipment, approved by the US State Department for Foreign Military Sales (FMS) for an estimated cost of USD 1.25 billion. However, this contract does not include the significant involvement of Romanian industry.

Some programmes initiated in 2017 were also delayed, with naval capabilities being the most affected. For this reason, acquisitions in this sector are expected to be prioritised in the future. One example of a delayed programme, eventually solved relatively rapidly, is the Mobile Anti-Ship Missile Launch System (SIML) programme intended to arm the two modernised Type 22 frigates and the four multirole corvettes, which were also planned for acquisition since the last decade. Four companies were initially admitted for negotiations during the initial procurement procedure: Boeing (US), Kongsberg Defense & Aerospace (Norway), Saab Dynamics (Sweden) and MBDA (France), but only MBDA submitted an offer in the second phase of the procedure. According to the Romanian MoD's news page, *Inforadar*, the negotiation failed because the contractor imposed non-negotiable conditions, unacceptable for the MoD at the time, since they fell outside the scope of the initial plan.

Credit: RTX

The SkyCeptor is a long-range SAM for cruise and ballistic missile defence, compatible with US and NATO standards, which can be used with the PATRIOT system. The SkyCeptor is considered a relatively affordable solution, which could facilitate procurement and stockpiling.

The acquisition of SIML eventually moved forward thanks to the signature of an FMS agreement in 2021 with the US to acquire the Naval Strike Missile (NSM) Coastal Defense System (CDM), which should be completed in 2024. Raytheon, in collaboration with Kongsberg, are providing the systems, estimated to be worth up to USD 217 million, if all options are implemented. The deal is said to involve technological and industrial cooperation, namely a production and maintenance capacity established at the level of a Romanian economic operator. However, it is unclear if and what company or entity was selected to fulfil this task.

Similar to the cooperation model established with GDELS for the Piranha 5, the Romanian government expressed the intent in 2017 to acquire four corvettes and to renovate the existing T22R frigates for the navy. Nonetheless, in August 2023, the Romanian MoD cancelled the competition procedure, won in 2019 by the French Naval Group to build four *Gowind* corvettes and to renovate two existing T22R frigates in partnership with Santierul Naval Constanta. The reasons for this cancellation have been widely reported as: initial legal challenges raised by competitors, followed by the refusal of Naval Group to sign the framework agreement.

Credit: US Navy/Spc Josiah J. Kunkle

Independence-variant littoral combat ship USS Gabrielle Giffords (LCS 10) launches a Naval Strike Missile (NSM) during exercise Pacific Griffin, on 1 October 2019.

Now deemed to be an essential procurement, several future acquisition scenarios are speculated. The organisation of a similar competition is considered a low probability whereas a G2G procedure, either with France or with the US, a high probability. Since Romania acquired NSM, and because the Damen corvette *Sigma* 10514 (main competitor) can be armed with US solutions, and also since Damen already has two shipyards in Romania, some speculate the high probability of a G2G agreement with the US Government where the building is subcontracted to Damen and the corvette armed with US equipment. However, this is not the only scenario of a potential G2G agreement with the US. On the other hand, procurement from France is still not excluded, especially in a context where relations between the two countries are assumed to have strengthened after France decided to become the Framework Nation for the multinational battlegroup hosted by Romania, as part of NATO's forward presence. If not with the corvettes, French cooperation with Romania in some areas seems likely to happen in the coming years. Very promising negotiations were held before 2020 on the acquisition of AH-1Z Viper and UH-1Y Venom helicopters from Bell Helicopter (US) for Romania's land forces. The helicopters were supposed to be produced in a second phase at the Romanian company IAR Brasov. In view of this, in 2016, Bell Helicopter signed an MoU with IAR-Ghimbav Brasov Group. However, the acquisition did not materialise, and other actors subsequently expressed interest in providing helicopters, such as Airbus and Lockheed Martin/Sikorsky.

Credit: US Navy/Spc Josiah J. Kunkle

A Bulgarian Air Force H215M Cougar helicopter on exercise Strike Back 19, at the Novo Selo Training Area, Bulgaria, on 17 June 2019. Romania's Navy is due to receive two such helicopters configured for ASuW.

While nothing concrete has happened on this front since then, in 2022, on the margins of the visit of French President Macron to Constanța (to meet French soldiers deployed on 'Mission AIGLE'), the French and the Romanian Defence Ministers – Sébastien Lecornu and Vasile Dincu, respectively – signed a Letter of Intent (LoI) aimed at "developing the capabilities of Romanian Naval Forces" though the French MoD did not disclose much about the scope of the cooperation. However, the Romanian Minister of Defence was quoted by the Bulgarian publication Actualno, announcing the signature of the LoI and hinting that this also concerned the acquisition of helicopters and of Scorpene submarines. In October 2022, the Romanian MoD officially asked the Parliament to approve the acquisition of Airbus H215M helicopters equipped for anti-surface vessel warfare (ASuW) for the Romanian Navy, at an estimated cost of EUR 150 million. The delivery of the first helicopter is expected in 2026. This acquisition does not remove the unknowns concerning procurement of helicopters for the land forces, but the likelihood of acquisition from a European provider is not excluded.

Airbus has a production unit in Romania – Airbus Helicopters Romania – a joint venture between Airbus Helicopters (60%) and IAR (40%) established in 2002. According to the Airbus website, "Airbus' commitment to Romania deepened in 2016 with the creation of a new plant, whose primary goal is to produce the H215M helicopter." However, due to a lack of orders, on 17 October 2019 the company suspended the construction of the factory. The H215M are expected to continue to be produced outside the country.

Local defence industrial capacity confirmed among priorities

Romania's Military Strategy issued in 2021 provides continuity to the modernisation efforts previously initiated and guides the implementation of its two multiannual modernisation programmes, 'Armata 2026' and 'Armata 2040'. The strategy highlights that inconsistencies between the national defence industry's capacity to produce weapon systems (…) and the needs of the Romanian Armed Forces could be a potential vulnerability, and prioritises support ac-

Credit: US Army/Paolo Bovo

Croatian Army soldiers, launch a Mistral VSHORAD missile during the exercise Shield 24, near Medulin, Croatia, on 12 April 2024. In June 2023, France, Belgium, Cyprus, Estonia and Hungary signed a Letter of Intent for the joint acquisition of the Mistral 3 ground-based air defence system.

tions aimed at strengthening the economic-industrial base and the defence industry. In April 2021, the Parliament also approved the start of 10 new acquisition programmes, many of which are currently in the "implementation" or "preparation" phase, as identified on the MoD's DGA website.

Triggered by the Russian war of aggression against Ukraine, the original 'Armata 2040' programme was updated by CSAT in October 2022 to include the reconfiguration of acquisition programmes and efforts to restore stocks and the modernisation of defence industry. This was followed, in October 2023, by the approval of the Romanian Armed Forces' Acquisition Plan for 2024–2033, that equally considers the change in the regional security situation and, apparently, restates the importance of retaining a functional sovereign defence industrial capacity. While the plan is not available to the public, and little has been unveiled so far regarding its content, some of the acquisition priorities can be guessed from the history of uncompleted past procurements and from recent high-visibility announcements, such as the acquisition of the F-35 Lightning II Joint Strike Fighter, or of two Scorpene submarines. In addition, the MoD's DGA website lists the most important programmes under preparation in the short term. Some of them are currently in the awarding or competitive bidding process.

The competition for 1,059 light armoured tactical vehicles (L-ATV) was completed recently, with Turkish company Otokar the sole bidder. Purportedly, other companies decided not to bid due to contractual conditions requiring that more than half of the vehicles be assembled in Romania, as well as maintenance to be carried out by local defence industry partners.

An award procedure is underway for 298 tracked IFVs. According to analysts, a choice will be made between Rheinmetall's Lynx, GDELS' Ascod, BAE Systems Hägglunds' CV90, and Hanwha Aerospace's Redback. If technology transfer and industrial collaboration is part of the contractual obligations, the companies that already have a presence in Romania might have an advantage.

The competition for the acquisition of 27 short-range air defence and very short-range air defence systems (SHORAD/VSHORAD) is also underway. Whereas the winner will be chosen based on the best price-performance ratio, as well as proposed delivery terms (weighing 20%), this procurement also seems to involve some political sensitivities. Based on statements by anonymous MoD sources, scenarios circulated that this acquisition could take two directions: a bidding process effectively launched at the end of 2023, and acquisition of MBDA's Mistral 3 as part of the multinational joint procurement programme led by France.

Several names were also circulated to have entered the competition but without being confirmed by official sources; for example MBDA with the VL Mica and Mistral 3, Rheinmetall Air Defence with Skyranger 30 and Skyranger 35, Kongsberg with NASAMS, Diehl Defence with IRIS-T SLS and IRIS-T SLM, and Rafael with SPYDER. Some analysts have suggested that the cooperation agreement signed in 2017 between MBDA and Electromecanica Ploiești, a ROMARM subsidiary, could be an advantage for the company.

A multitude of programmes require high absorption capacity

While the number of ongoing and planned defence acquisitions by Romania is impressive, they cannot all be covered in this article. The multitude of programmes that will have to be managed firmly sets the Romanian defence industry on the path to modernisation, but it also increases pressure to establish effective processes to be able to quickly absorb such a large quantity of technology and knowledge.

In this respect, it is worth noting that in December 2023, a Government Emergency Order (No. 124/2023) was adopted, which streamlines the operationalisation and implementation of development, technological and industrial cooperation in security and defence. It also establishes and defines the operation of a *Romanian Agency for Technological and Industrial Cooperation for Security and Defence*. The new agency will build on the foundations of the existing *Office for the Compensation of Acquisitions of Special Technologies*, and will receive new responsibilities.

Complex acquisition programmes will have to be implemented in the coming years; these will require highly effective logistic and maintenance operations, if not more complex development and production.

The acquisition of F-16 Fighting Falcons from Portugal and Norway is one of these acquisition programmes since both the maintenance and modernisation infrastructure is developed in Romania, with Romanian company Aerostar Bacau designated as maintenance centre. It is still unclear how the preparation for the transition to the F-35 Lightning II Joint Strike Fighter will be made, though this is doubtless a high priority on the MoD's agenda. The acquisition of 48 F-35s was confirmed in October 2023 following parliamentary approval and will be implemented in two tranches: two squadrons of 32 jets in Phase 1 for a total of USD 6.5 billion initiated in 2023, and one squadron of 16 jets in Phase 2, the value of which is to be determined at a later stage.

The supply of Watchkeeper X tactical unmanned aerial vehicles (UAVs) from Elbit Systems, for an approximate value of USD 410 million started in 2023,

with the first purchase order made for the initial three out of the seven units. Aerostar Bacau will also be involved in the implementation of this programme. A collaboration agreement was signed in 2021 with the UK joint venture U-TacS for the potential production of the Watchkeeper in Romania. The collaboration is also likely to include Thales Systems Romania, Romaero S.A. and the National Institute for Aerospace Research (INCAS).

It is unclear how much logistic and maintenance support will be needed for the announced acquisition of 54 Abrams M1A2 SEPv3 tanks or the operation of Bayraktar TB2 UAVs, but additional needs for logistics and maintenance capacity can be expected.

Credit: Lockheed Martin

On 17 November 2023, Derco, a Lockheed Martin group company, signed an agreement with Aerostar S.A. for the repair of landing gear, wheels and brakes to ensure the maintenance of the Romanian Air Force F-16 fleet.

What next for the Romanian industrial base?

In a context where the revitalisation of defence industries across Europe is essential, the Romanian defence industry clearly has something to offer. To varying degrees, partnerships with local defence industry partners were and still are covered by many major acquisition programmes, but they have never been strongly enough emphasised. As such, public awareness about industry's potential is relatively low. At the same time, the core of the Romanian defence industry is still state-owned, which makes it subject to specific constraints. However, this is not only a characteristic of Romania, but of other countries in the region as well.

If the gaps in the defence industry start to be filled, more political determination and vision is needed to adopt holistic policies and industrial strategies that connect the rest of the industrial base – civilian and private industries – with the defence planning process, thereby increasing overall industrial capacity, security of supply, and resilience in the long term. In the wake of four elections scheduled for 2024 – local and Euro-parliamentary, presidential, and parliamentary – thinking of defence in holistic terms, across the spectrum of all policies may be welcome. ■

Bulgarian acquisition programmes

Chris Mulvihill

In the wake of the war in Ukraine, Bulgaria finds itself poised to revamp its antiquated and legacy forces. Following over two decades of underinvestment in defence, the challenges confronting the Bulgarian armed forces have reached a critical juncture. There is a looming risk that basic capabilities might soon fall beyond domestic fulfilment, casting a spotlight on the pressing necessity for an all-encompassing modernisation strategy.

Navigating through a maze of economic, social, and political constraints, the question emerges: How will Bulgaria manage to dedicate the next decade to rebuilding critical capabilities of its armed forces through procurement of new equipment? This article aims to dissect several key domains where Bulgaria has acquired, is in the process of acquiring, or plans to procure new or second-hand equipment to replenish or enhance capabilities across its land, air, and naval forces. Additionally, it will scrutinise potential areas requiring attention in the forthcoming years as maintaining legacy equipment becomes increasingly difficult.

Challenges to Bulgarian procurement

Bulgarian national security is dependent on continued cooperation with its NATO and EU allies. This includes military cooperation with the US, which already has a permanent presence in Bulgaria, but also expanding defence ties with Greece, Romania, and even Turkey. These benefits of NATO membership understandably require Sofia to contribute at least 2% of its gross domestic product (GDP) to its own defence. To realise this goal, Sofia has outlined how and where it will be investing into the armed forces in the 2021 development plan for the Bulgarian armed forces.

One of the main issues that necessitates the procurement of new equipment is the large percentage of equipment in all domains that is still reliant on Soviet-era technology. In many cases, the maintenance of such equipment continues to rely on licenses given by Russian companies to local maintenance firms, or even outsourcing maintenance directly to Russian companies altogether. This is despite Russia having been named a strategic threat to Bulgarian national security in recent years.

The 2021 plan also aims to resolve the shortfall and gaps in capabilities in the air, land, and sea domains, identifying 188 minimum requirements which the Bulgarian armed forces do not satisfy. This would require the procurement of numerous systems to restore or provide new capabilities, with an added necessity being that these solutions originate from EU or NATO countries. It was estimated at that time that the total cost of achieving these requirements would necessitate around USD 22 billion in spending over an 11-year period. Due to the cost of achieving these 188 requirements, only 38 such requirements are budgeted to be achieved by 2032.

Despite the Russian invasion of Ukraine, the plan has not seen any revisions to date. It has been argued that this is due to the economic limitations of investing large funds into defence at the expense of other areas – a common concern throughout Europe. However, there is also a more unique political and social backlash against the development of the armed forces when it is Russia that is now openly-stated to be the greatest threat to Bulgaria. This not a conclusion that has gone unchallenged in what is arguably the most Russophilic society in NATO. As such, a revised development plan for the armed forces would undergo a level of scrutiny that goes beyond concern over cost and will face pushbacks from Russophilic political elements who do not wish to see a Bulgarian armed forces rebuilt to potentially enter a conflict against Russia.

Credit: US Army/Staff Sgt Steven M. Colvin

Bulgarian Soldiers of 1-61st Mechanized Battalion follow a BMP-1 during Exercise Peace Sentinel at Novo Selo Training Center, Bulgaria, on 24 November 2015.

The Land Forces

The Bulgarian Land Forces (SV) and the Joint Special Operations Command (JSOCOM) are set to receive a substantial capital boost, aimed at rejuvenating and enhancing

their capabilities through the procurement of new systems. This section explores the pivotal areas targeted for modernisation, including armoured fighting vehicles, mobile air defence, artillery, and multiple launch rocket (MRL) systems. For reference, the table below lists recent, ongoing, and planned procurements in these areas.

Programme	Branch	Year of First Delivery	Units	Cost (USD)
T-72 Modernisation	SV	2022	44	48 million
Stryker Procurement	SV	2025 (est.)	183	1.3 billion
Protected Patrol Vehicle Procurement	JSOCOM	2022	98	31 million
Mobile Air defence Replacement For 9K33 Osa	SV	Unknown	Unknown	Unknown
Multiple Launch Rocket System Procurement	SV	Unknown	Unknown	Unknown
155 mm Artillery System Procurement	SV	Unknown	Unknown	280 million (est.)

Central to Bulgaria's modernisation agenda is the overhaul of its legacy main battle tank (MBT) fleet. Preferring modernisation over outright replacement for cost-effectiveness reasons, the focus is on upgrading the T-72 tanks, which remain the backbone of the army's armoured capability. This upgrade, concentrated on a battalion within the 61st Stryamska Mechanised Infantry Brigade, incorporates subsystems from Elbit Systems. These enhancements significantly boost the T-72's operational range, situational awareness, and lethality, enabling engagement with targets up to 3,000 m away while moving at speeds up to 25 km/h.

A noteworthy development in September 2023 was the approval of a foreign military sale (FMS) facilitating Bulgaria's acquisition of various Stryker 8×8 vehicle variants from General Dynamics Land Systems (GDLS). This move, aimed at replacing aging BTR-60 8×8 and BMP-1 models among other specialised vehicles, marks a significant shift in Bulgaria's mechanised infantry capabilities. Although the deal precludes local production opportunities akin to the Croatian or Polish models with the Patria Armoured Modular Vehicle (AMV) 8×8, Bulgaria aims to establish a Stryker maintenance hub. This facility would not only serve Bulgaria but also provide maintenance and spare parts production for European Stryker fleets, mitigating the loss of industrial cooperation opportunities.

The modernisation drive extends to air defence and fire support systems, with plans to adapt the utilise the Stryker and created a Bulgarian 'M-SHORAD' variant. This adaptation involves integrating additional subsystems like the RS6 LW30 remote weapon station, Ranger R20SS radars, and TACFLIR 280 HDEP optoelectronic sensors, enhancing Bulgaria's short-range air defence capabilities beyond the outdated ZIL-131-mounted ZU-23-2 cannons.

Credit: USMC

The modernised T-72 comes with an auxiliary power unit, four laser-warning receivers, a new fire-control system, thermal gunner's sight, a battle management system, driver's thermal camera, a new thermal sleeve for the main gun, and an upgraded intercommunication system for the crew.

Credit: Bulgarian MoD

Despite being a wheeled platform, it is thought that the 90 M1296 Stryker Dragoon platforms will also replace the BMP-1 in Bulgarian service.

Variant	Quantity
M1296 Infantry Carrier Vehicle	90
M1126 Infantry Carrier Vehicle	17
M1132 Engineer Squad Vehicle	9
M1130 Command Vehicle	33
M1133 Medical Evacuation Vehicle	24
M1135 NBC Reconnaissance Vehicle	10

With the 9K33 Osa system facing obsolescence and missile stockpile limitations, Bulgaria's involvement in the European Sky Shield Initiative (ESSI) could facilitate the procurement of a modern replacement, ensuring alignment with broader continental defence frameworks. Something like an IRIS-T SLS comes to mind as a broadly equivalent system.

Artillery modernisation is also critical, given the obsolescence of current platforms like the 122 mm 2S1 Gvozdika. With the retirement of the 2S3 Akatsiya, Bulgaria's heavy artillery is limited to the towed 152 mm D-20 howitzer, highlighting the need for a modern 155 mm system to maintain its large-calibre artillery capabilities.

Lastly, the replacement of the BM-21 Grad and potentially the OTR-21 Tochka could be done with a single modern multiple launch rocket system capable of launching multiple calibres of rockets, such as the Korean K239 Chunmoo, which is able to launch both smaller 130/239 mm rockets as well as larger 400/600 mm missiles. Such a move could allow Bulgaria to consolidate its rocket artillery capabilities into a smaller number of formations with mixed range capabilities, saving manpower when compared to the current arrangement of fielding rocket artillery formations dedicated to specific range bands.

The Air Force

The Bulgarian Air Force (VVS) has encountered significant challenges in fulfilling even the most basic requirements for safeguarding Bulgaria's domestic airspace. The VVS' inventory includes both fixed-wing and rotary aircraft, in addition to overseeing the majority of the armed forces' air defence systems, such as the S-300P. Unfortunately, the air force's systems have largely remained unchanged since 1990, with minimal progression away from Soviet-era systems. As these ageing systems become increasingly difficult to maintain and approach the end of their service life, Bulgaria has grown more dependent on NATO air-policing missions to protect its skies. The air force has set modest goals within its development plan: by 2026, it aims to make its tactical transport fleet available for use by NATO partners, and by 2032, it hopes to have a combat fleet free to participate in NATO air-policing missions. A likely development here is that Bulgaria will incorporate neighbouring North Macedonia into its zone of air-policing, relieving the Hellenic Air Force, which currently performs this task.

This sorry situation stems from the belated effort to replace the ageing MiG-29 fleet with modern multirole combat aircraft, ultimately deciding on the new-build F-16 C/D Block 70s in 2019. However, production delays post-COVID pose a significant risk that the VVS will struggle to keep even a small number of MiG-29s operational for domestic air-policing until the F-16s arrive in 2025-2026. Delays in necessary new infrastructure at Graf Ignatievo Air Base, where the F-16 fleet will be stationed, may further postpone their introduction. It is understood that the Ministry of Defence is collaborating with Lockheed Martin and local construction firms to expedite the airbase's redevelopment in time for the initial deliveries.

The acquisition of F-16s also signals the much-needed overhaul of Bulgaria's surveillance radar network, which has not advanced beyond locally-upgraded Soviet-origin radar systems, including the P-37, P-14, and P-18 radar sets. In a contract valued at up to USD 220 million, the air force hopes to procure up to half a dozen radar sets. Competitors for the tender include Elta, Indra, Leonardo, Lockheed Martin, and Thales. Thales has long been the favourite as Paris and Sofia have recently pledged to increase defence cooperation. If so, it is likely Bulgaria will opt for the GM400 from the Ground Master range, recently purchased by neighbouring Serbia. This acquisition would enable an interoperable aerial surveillance capability that could also integrate with NATO's Combined Air Operations Centres in Germany and Spain.

This development could also indicate progress in addressing one of Bulgaria's looming crises with its ground-based air

Credit: Bulgarian MoD

The MiG-29 was the last combat aircraft procured by the VVS until the recent purchase of the F-16 C/D Block 70s. According to satellite imagery of Plovdiv airport, only four of these aircraft are operational – including two MiG-29UB variants which are not equipped with a radar

defence (GBAD) network. The VVS controls most of the country's air defence systems, including the 2K12E Kvadrat, S-125 Neva-M, S-200VE Vega-E, and S-300PMU systems. Recent years have seen the S-300PMU systems facing readiness issues, and they were notably absent from the annual air defence exercises at Shabla on the Black Sea. Until at least August 2022, negotiations were known to be ongoing with Russia's Almaz-Antei concerning the refurbishment of several components of the S-300PMU system, particularly the vehicles.

Bulgaria's limited capacity to maintain both the systems and missiles domestically has resulted in a reliance on support from Russia, with Ukraine being another potential provider. Given the ongoing conflict, neither option is currently viable, a reality acknowledged by the Bulgarian MoD, which is expected to commence procuring new GBAD equipment in the short to medium term to prevent a total collapse in Bulgaria's GBAD capabilities.

With Bulgaria's accession to the European Sky Shield Initiative (ESSI), there is optimism for benefiting from joint procurement of air defence systems from a variety of European and international manufacturers. The Diehl Defence IRIS-T family of surface-to-air missile (SAM) systems could offer a compelling solution for supplementing short- and medium-range air defence, while the company's IRIS-T SLX also provides a valid option for a long-range SAM system, if the country decides to opt for a single European supplier to meet its requirements. Alternatively, Bulgaria may explore options from Israel or the US, contingent on cost and delivery timescales.

Credit: Bulgarian Air Force

Bulgaria inherited a large and very capable air defence network from the Soviet era. However, a lack of investment and planning has led to a stagnation in their air defence capabilities, leading to an impending crisis.

The Navy

The Bulgarian Navy (VMS) has witnessed considerable investments yielding tangible results since the nation's integration into NATO. Historically considered the least prioritised branch, its significance has been on an uptrend, especially in light of escalating conflicts within the Black Sea region. The recent heightened use of naval mines in the ongoing conflict in Ukraine has underscored the Navy's critical role in ensuring the security of international shipping lanes. In collaboration with the Romanian and Turkish navies, the Bulgarian Navy has actively deployed minehunters to clear naval mines from key waterways. Its modest naval aviation fleet, comprising two Eurocopter AS565 Panthers and one AS365 Dauphin helicopter, also plays a pivotal role in search and rescue operations. According to the 2021 development plan, the Navy aims to maintain at least one of its two patrol vessels in a state of constant readiness for international peacekeeping missions, capable of enduring for up to six months at sea.

In contrast to the Army and Air Force, efforts were made in the 2000s to enhance the naval fleet with the acquisition of three Wielingen-class frigates from Belgium and three Tripartite-class minehunters from both Belgium and the Netherlands. These acquisitions were not mere replacements but served to increase the Navy's overall tonnage. Additionally, the Navy has placed orders for two new-build MMPV 90 corvettes from Lürssen Werft, outfitted with an TOT 76/62 SR 76 mm gun, RBS-15 Mk3 anti-ship cruise missiles (ASCMs), along with eight cells of VL MICA SAMs for air defence, and a Rheinmetall Oerlikon Millennium 35 mm automatic cannon for close-in protection.

The Navy has prioritised funding requests for two main areas: the restoration of the submarine service and the procurement of new mobile anti-ship missile systems. Regarding the former, the Bulgarian Navy had long ago retired its Romeo class submarines. Although attempts to negotiate for second-hand Ula class submarines from Norway appear to have been unsuccessful, Sofia has indicated that procuring a submarine remains a high priority for the Navy.

Officially, Bulgaria maintains two coastal rocket-artillery brigades, equipped with P-15 Termit anti-ship missiles. Their usage in exercises in recent years has been limited, with the last test launches occurring in 2020. Nonetheless, retaining this capability is a stated goal of the Navy. In line with equipping the new MMPV 90 ships with RBS-15 Mk3 ASCMs, Sofia has a choice to negotiate with SAAB AB for the purchase of RBS-15 for usage from mobile launchers on the coast or start a separate procurement process, which will take longer.

Credit: Bulgarian MoD

The MMPV 90 corvettes are also not intended to replace any vessels but will relieve the duty on the Navy's frigates from Bulgaria's obligation to have vessels ready for international deployment on EU and NATO missions.

Back of the queue?

A pressing concern that looms large over Bulgaria's ambitious defence procurement plans is the dilemma of being both financially constrained and potentially too delayed to realise these objectives promptly. Amid a widespread drive across Europe for rapid rearmament, many defence manufacturers are contending with substantial order backlogs, which could extend delivery timelines by up to a decade. This situation risks leaving Bulgaria in a precarious position, potentially underprepared in critical areas of defence.

The burgeoning question is whether Bulgaria will be compelled to reassess its "Made in EU or NATO" procurement stipulations and consider sourcing from beyond its traditional allies. In navigating these turbulent waters, Bulgaria finds itself at a crossroads, weighing the imperatives of timely modernisation against the principles of alliance solidarity and regional procurement. This delicate balance underscores the strategic conundrums faced by smaller NATO members striving to bolster their defence capabilities in an increasingly uncertain global security landscape.

As Bulgaria charts its course through these complexities, its decisions will not only shape its military readiness but also reflect broader trends in defence procurement strategies within the alliance. In this era of heightened security challenges, Bulgaria's journey underscores the intricate dance of maintaining defence readiness, adhering to alliance commitments, and navigating the global arms market. ■

Credit: Bulgarian MoD

The Bulgarian navy has seen in a spike in activity since 2022 with a trilateral effort between Bulgaria, Romania, and Turkey in demining international waters in the Black Sea.

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KVAČR 2035: Major procurements for the Czech Republic

Martin Smisek

On 20 December 2023, the Czech Government approved the Concept of the Development of the Army of the Czech Republic 2035 (Koncepce výstavby Armády ČR 2035; KVAČR 2035). The document defines the main directions of its development until 2035, including the key arms purchases.

The first part of the concept deals with the period until 2030 when a significant increase in investment in the modernisation of the Czech Armed Forces is envisaged. Instead of the current 20%, the Czech Republic plans to invest up to 60% of its military spending into new armaments. The document also foresees investments in new technologies, increasing stockpiles and developing infrastructure. Between 2031 and 2035, investments will be stabilised at 35% of the Ministry of Defence (MoD) budget. In these years, the armed forces will focus on the system integration of newly acquired armaments, as well as life cycle management. Additionally, KVAČR 2035 sets out six strategic objectives. One of the main priorities is personnel – the ambition is to have 30,000 professional soldiers and up to 10,000 active reserve troops by 2030.

Credit: Czech MoD

The F-35A Lightning II will be introduced into the inventory of the 211th and 212th Tactical Squadrons at Čáslav Air Base in the early 2030s.

Air Force

The most significant and expensive acquisition programme is the purchase of 24 F-35A Lightning II aircraft with associated air-launched weapons, spare parts, logistics and training. The deal, valued at USD 4.99 billion, was finalised on 29 January 2024 with the signing of the Letter of Offer and Acceptance and the Memorandum of Understanding between the Governments of the Czech Republic and the USA.

The first Czech F-35As will leave the Lockheed Martin production line at Fort Worth in 2029 and then remain in the US, where they will be used to train an initial group of Czech pilots and ground crews. Half of the fleet, or one tactical squadron, will be produced by 2031, when the first Lightning IIs are also expected to arrive at the 21st Tactical Air Force Base at Čáslav. The initial operational capability (IOC) of the first squadron is expected to be achieved by the end of 2031. The other half of the fleet will be produced between 2032 and 2034 at the Cameri FACO facility in Italy. The complete fleet should be available to the Czech Air Force in 2034, and a year later the full operational capability (FOC) of both tactical squadrons is due to be achieved.

The acquisition of the F-35 means the phasing out of all Saab JAS-39C/D Gripens and L-159A ALCAs, which should end their career in the Czech Air Force in 2035. At the same time, the Gripen is due to undergo one major upgrade, while the purchase of a range of new air-launched weaponry for this type is still envisaged.

The Czech MoD plans to award a contract for the purchase of two C-390 Millennium transport aircraft in 2024, with delivery dates for the 24th Transport Air Force Base at Prague-Kbely scheduled for 2025 and 2026. Moreover, an acquisition of two business jets for the same unit in the category of Embraer Legacy and Praetor 500/600 is under consideration.

Meanwhile, deliveries of H-1 series helicopters for the 22nd Helicopter Air Force Base at Náměšť nad Oslavou will continue. In August 2022, it was announced that the US Government would donate six AH-1Z Viper helicopters and two UH-1Y Venom helicopters to the Czech Republic. These helicopters will be retired from US Marine Corps (USMC) service and upgraded to the standard of the newly-purchased aircraft (eight UH-1Y and four AH-1Z) ordered in December 2019. After undergoing upgrades, the donated helicopters are due to be delivered in 2026.

In addition, the Czech MoD plans to acquire six heavy transport helicopters after 2030, which will be operated from Náměšť nad Oslavou Air Base. Among the candidates under consideration is the CH-47F Chinook. Additionally, all Czech W-3A Sokol helicopters are due to be retired without replacement by the end of 2028.

Author

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Over the long term, the purchase of one squadron of unmanned combat aerial vehicles for the Czech Air Force is also envisaged.

Air defence

The crucial programme for the forthcoming years is the acquisition of four batteries of the Israeli SPYDER air defence system for the 25th Anti-Aircraft Missile Regiment at Strakonice. The deliveries are planned to take place in 2025 and 2026. One battery is composed of nine vehicles, including four launchers, all based on Tatra 815-7 8×8 trucks. The delivery will include an initial stock of I-Derby and Python 5 missiles in short- and medium-range configurations.

In October 2023, the Ministry of Defence signed a contract for the shipment of 48 I-Derby LR missiles (the I-Derby ER variant fitted with a booster) capable of engaging targets at a maximum range of some 80 km, and maximum altitude of around 20 km, which should be delivered by October 2027. The deal also includes an option for the acquisition of hundreds of additional missiles in six versions.

Among the pressing needs is the purchase of an armoured platform for the transport of the RBS-70 and RBS-70 NG man-portable air defence system (MANPADS). One possible solution is the purchase of the MARS S-330 4×4 protected patrol vehicle, produced locally by SVOS, and fitted with a remote weapon station armed with three RBS-70 Mk2 or BOLIDE missiles. The Czech Air Force currently plans to order 16 vehicles for the same number of RBS-70 NG systems which were delivered in 2020 and 2021. However, the acquisition project has not yet started.

Credit: Rafael Advanced Defense Systems

The 251st Anti-Aircraft Missile Battalion will receive four batteries of the SPYDER air defence missile system in 2025 and 2026.

Marketing Report: EVPÚ

Outstanding sight capabilities for modern warfare

Today's armoured fighting vehicles are designed to outmatch the enemy while keeping crew members as safe as possible. With this purpose in mind, combat vehicles are equipped with high quality electro-optical sights that provide excellent surveillance and target acquisition capabilities and increase the effectiveness of firing while the vehicle is moving. A diverse range of customisable and easy-to-integrate commander and gunner sights is produced in the Czech Republic by EVPÚ Defence a.s.

The CMS-1 commander sight, one of the company's flagship products, is a stabilised panoramic sight suitable not only for direct mounting on armoured vehicles or vessels but also for integration into gun turrets. It is equipped with a day observation channel, a night observation channel and an eye-safe laser rangefinder. The day channel consists of a sensitive zoom camera operating in the NIR spectrum, which ensures very good visibility even in poor light conditions. The night channel consists of a cooled thermal imaging camera which provides a clear and detailed image at long distances and allows the operator to observe and aim at ground or low-flying air targets in total darkness. All sensors are mounted on a gyrostabilised pan-tilt sensor head with a 360° range of movement in azimuth, which gives the commander complete overview and awareness of the situation on the battlefield.

The battlefield conditions may be severe, but CMS-1 is built to withstand them. The sensors are placed in a heavily ruggedised housing, which is resistant to all weather conditions, shocks and vibrations. CMS-1 is able to operate in an impressive range of temperatures and climates, from -32°C in polar regions to +55°C in dry, hot deserts. The whole system is protected by an Armox ballistic steel plate to prevent damage from indirect hits and offers ballistic protection in compliance with AEP-55 STANAG 4569 Level II. Operators can control the system via a user-friendly ruggedised unit with a display and a joystick.

EVPÚ Defence will be exhibiting selected products from its defence portfolio at EUROSATORY 2024. Visitors are warmly welcome at booth 520A in Hall 5A, Paris Nord Villepinte Exhibition Centre, from 17–21 June 2024.

Credit: EVPÚ Defence

The Czech Republic entered the European Sky Shield Initiative (ESSI) as a founding member on 11 October 2022. The project involves joint procurement of air defence systems, and the Czech Air Force could participate in the purchase of a counter-uncrewed aerial vehicle (C-UAV) or an anti-ballistic missile (ABM) system. Although the previous KVAČR 2030 concept envisaged the acquisition of a counter-rocket, artillery, and mortar (C-RAM) system between 2022 and 2026, a funding shortfall has led to a delay of this capacity until after 2031.

Mechanised infantry and tank troops

The highest priority project for the ground forces is the rearmament of the only heavy brigade – the 7th Mechanised Brigade – with new infantry fighting vehicles (IFVs) and main battle tanks (MBTs). The Ministry of Defence ordered 246 CV90 vehicles, which will be delivered between 2026 and 2030. Most of them will replace BVP-2s of the 71st, 72nd and 74th Mechanised Battalions, as well as the Mechanised Company of the 73rd Tank Battalion.

In addition, a small number of CV90s – in specialist variants – will go to the 13th Artillery Regiment and the 15th Engineer Regiment. The sole tank unit – the 73rd Tank Battalion – currently operates T-72M4 CZ, T-72M1 and Leopard 2A4 tanks, all of which are set to be replaced by the latest Leopard 2A8 standard. At the time of writing, negotiations were underway to conclude the related contract. [Note: further information on both projects can be found in the article on Central European armoured vehicle programmes elsewhere in this issue].

Credit: Tatra Defence Vehicle

A possible candidate for the rearmament of the 44th Light Motorised Battalion of the 4th Rapid Deployment Brigade is the recently developed Pandur II 8×8 EVO.

Significant changes are also due to take place in the Czech Army's second mechanised infantry brigade – the 4th Rapid Deployment Brigade. Pandur II CZ IFVs operated by the 41st and 42nd Mechanised Battalions are to go through a mid-life upgrade from 2027 to 2029. Simultaneously, the third mechanised battalion should get new wheeled IFVs. One of the possible solutions is the purchase of Pandur II 8×8 EVO, the development of which has been started recently at Tatra Defence Vehicle in cooperation with General Dynamics European Land Systems (GDELS). The entire Pandur II 8×8 EVO project was conceived so that many of its design elements could be used in the planned modernisation of the existing fleet of Pandur II CZ vehicles.

Another long-delayed modernisation project concerns the acquisition of new self-propelled mortars. According to KVAČR 2030, their purchase should have taken place between 2023 and 2025. The new KVAČR 2035 states that the acquisition of 74 systems will not take place until between 2031 and 2035. The Czech Army prefers a solution with a rotating turret armed with a breech-loaded mortar.

Although KVAČR 2035 envisages the purchase of additional MKPP (fire support coordination variant), KOVS (communications variant) and KOVVŠ (command and staff variant) vehicles based on the TITUS 6×6 wheeled platform as early as 2025 and 2026, no contract has been concluded at the time of writing.

Credit: Czech MoD

Most of the 246 CV90 armoured vehicles being procured will be inducted into the inventory of the 7th Mechanised Brigade. The final assembly of most of the vehicles will take place at the VOP CZ state enterprise in Šenov u Nového Jičína.

Airborne and special forces

The Czech airborne forces are represented today by the 43rd Airborne Regiment in Chrudim. Within its ranks, the Land Rover Defender 130 Kajman manufactured by SVOS was due to be replaced by a new type of light assault vehicle. According to KVAČR 2030, this was supposed to happen between 2021 and 2024. The tender for 159 vehicles was announced in October 2022 but was cancelled in September 2023. The main reason was the significant increase in price compared to the planned funding and

changes in the operational requirements of the Army due to the Russo-Ukrainian war. KVAČR 2035 therefore envisages the purchase of new light assault vehicles only between 2031 and 2035.
The 43rd Airborne Regiment will also need a new anti-tank guided missile system to replace the obsolete 9K113 Konkurs (AT-5 Spandrel). The preferred solution is the Rafael Spike-LR2. The unit may also acquire a new capability in the form of loitering munitions.
The Czech special forces, namely the 601st Special Forces Group, will acquire new special operations vehicles as a replacement for Land Rover Defender 110 SOV IIs produced by SVOS some 18 years ago. This year, the first 12 Supacat HMT400 Jackals should be purchased with the total requirement expected to be 24 vehicles.

Credit: IAI

In May 2023, the Ministry of Defence cancelled the planned acquisition of three Heron I UAVs for the 533rd Unmanned Systems Battalion. Instead, 200 smaller tactical drones will be purchased.

Artillery

Czech artillery capabilities are currently centred around the 13th Artillery Regiment at Jince. By the end of 2030, this unit should be comprehensively re-equipped with new hardware, including the introduction of the ADLER III CZ automated fire control system, the adoption of which started in 2023 and will be completed by 2027.
The regiment obtained the last of 20 TITUS MKPP fire support coordination vehicles in 2023. By the end of 2024, two PODTEO meteorological support systems should arrive in Jince. The latter are based on the Iveco Defence Vehicles (IDV) LMV 4×4 platform, equipped with the CL ARM 35 single-axle trailer carrying the Vaisala RT20 radiotheodolite radiosonde sensor system, which is used for measuring wind and meteorological data at typical artillery projectile altitudes.
The first eight Nexter CAESAR 8×8 CZ self-propelled guns, assembled by Excalibur Army, will be handed over to the 13th Artillery Regiment in February 2026. The last of the 62 CAESARs on order should be delivered in 2027. New ammunition transport vehicles and mobile artillery workshops based on the Tatra 815-7 trucks will be purchased, as well as LOV-VČ platoon commander vehicles based on the LMV platform. The same platform will be used as the basis for the LOV-REKO topographic survey vehicle which is currently under development at Vojenský technický ústav. Three Saab ARTHUR weapon-locating radars are set to be upgraded and integrated into the ADLER III CZ fire control system.

CBRN defence and engineer troops

Vojenský výzkumný ústav completed deliveries of 40 S-LOV-CBRN and 40 LOV-CBRN II armoured chemical, biological, radiological and nuclear reconnaissance vehicles in 2023. The vehicles, based on the LMV platform, were mostly introduced into the inventory of the 31st Radiological, Chemical and Biological Defence Regiment at Liberec as a replacement for the obsolete BRDM-2rch (for more details see related article in ESD 1/2022). A process has been initiated to procure the equipment for the decontamination of large aircraft as well as the CBRN-COLPRO collective protection tent system. In addition, the development of a new sampling and transport vehicle for sampling and identi-

Credit: Australian Army

The preferred solution for the UKP-ŽV programme is the Bushmaster Protected Mobility Vehicle manufactured by Thales Australia.

fication of biological, chemical and radiological agents (SIBCRA) teams based on the IDV MUV 4×4 platform was initiated. New CBRN command and control (C2) vehicles (replacing the VAP-1 and VAP-1M) and successor generation of decontamination vehicles (replacing the ACHR-90M) will be bought in during 2027 and 2028–2030 respectively.

One of the priority projects for the Czech engineer forces is the UKP-ŽV universal armoured wheeled engineer vehicle programme (for more details see ESD 3/2023). Although this project began with market analysis back in 2018, due to funding issues, the purchase was postponed. Thanks to an increase in the defence budget in recent years, the necessary funds are now available, so the MoD has decided to proceed with the tender. The current preferred solution is based on the Thales Group Bushmaster 4×4 wheeled platform. The Czech Army is requesting up to 82 UKP-ŽV vehicles to be delivered between 2025 and 2031. At the time of writing, no contract has been concluded.

Another key programme for the 15th Engineer Regiment is the procurement of bridging vehicles in the military load classification (MLC) 70 category and pontoon bridges in the MLC 80 class. While deliveries of the former are due to take place between 2025 and 2027, the latter are scheduled for delivery between 2025 and 2028. While both projects have been postponed for some time due to lack of funding, Excalibur Army, which several years ago, introduced the AM-70 EX bridge-laying vehicle and the GDELS Improved Ribbon Bridge (IRB) pontoon bridge on the Tatra 815-7 8×8 truck platform, is trying to win contracts for both bridge systems.

In addition to these major programmes, a contract for 60 Volvo VTN3R 6×6 tipper trucks has recently been awarded. Smaller contracts for the supply of other construction machinery, such as wheeled loaders, will follow.

Logistics

Following Russian aggression against Ukraine, as an urgent operational requirement, the Ministry of Defence ordered 209 Tatra 815-7 6×6 cargo bed trucks (deliveries are due 2022–2023) and 80 Tatra 815-7 Multilift MSH-165-SCA container carriers (deliveries due 2023–2024). Deliveries of Tatra 815-7 logistics vehicles will continue into the future, since the Czech Army needs to replace at least 600 legacy T-815 VVN 6×6 and 8×8 cargo bed trucks.

There is also a need to acquire new heavy equipment transporters (HETs) in larger numbers. The Czech Army obtained only five Scania R660 A 6×4 tractors with Goldhofer MPA 5 low-loading trailers in 2023. An additional five, as well as four Scania R660 A 8×4/4s with Goldhofer STZ-VP/MPA-V 6 trailers, will be delivered during 2024.

The MoD recently launched tenders for framework contracts for the supply of CITRA water tankers based on the Tatra 158 6×6 (deliveries are due 2025–2029), as well as Tatra 158 8×8 and Tatra 815-7 6×6 fuel trucks (deliveries expected in 2025–2031).

Meanwhile, smaller contracts for the supply of various logistics equipment, such as field workshops, various ISO 1C containers, cargo trailers or mobile cranes, have already been concluded. Deliveries are due to materialise in the coming years. ■

Credit: Excalibur Army

The AM-70 EX, based on the T-815-7 8×8 chassis, could be the future replacement of the legacy AM-50 bridge-laying vehicles operated by the 15th Engineer Regiment.

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BADAR EXPO SOLUTIONS

Heavyweight of choice?

Shaun Connors

The tank transporter, or perhaps more accurately, the heavy equipment transporter (HET) will not be the most numerous 'truck' in the inventory of any armed force, it's number seldom exceeding a third of the to-be-transported heavy armour fleet. However, despite those relatively small numbers, it will most definitely be one of the most important 'trucks' in any fleet, and is also very likely to be the most expensive.

Like any *'truck'* used for almost any role within the military, type/configuration options for a HET are numerous. These can start with what is essentially a commercial tractor unit painted green or tan, with a rack for the drivers' rifle, and progress right through to a purpose-designed fully tactical option. That same variety of choice applies to the all-important, but so often overlooked, semi-trailer.

User choices for a HET are driven my many factors, not least budget, with a basic 'green/tan painted' commercial option coming in at less than half the purchase price of a fully tactical, designed-for-purpose alternative. That fully tactical, designed-for-purpose alternative, albeit a more expensive alternative to acquire will of course have greater longevity, will probably have refurbishment/rebuild factored into its design, and will of course be better suited to deployed and/or combat operations.

Pressure to comply with various aspects of commercial transport legislation can also impact quite heavily on type choices, particularly for a NATO-grade armed force, and even more so for those within the EU. Clearly the more tactical and military-specific any design is, the less likely it is to fully comply with current/pending commercial transport legislation.

Acknowledging that when compared to a 'fully tactical' counterpart, a legislatively-compliant design will almost certainly be more user-friendly on a day-to-day peacetime basis. However in a deployed and/or conflict situation, the fully tactical counterpart will be the better-suited of the two options.

Author

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Credit: Carl Schulze

This Scania-fronted combination is clearly for non-tactical tank and heavy equipment transport applications, and while doubtless useful and cost-effective during peacetime, would be of lower utility during an actual conflict.

Legislative compliance issues can begin with what appear to be the simpler things such as vehicle lighting, or the location and type of recovery/towing points, and include factors such as overall height or even turning radius. Using the latter as an example, even a four-axle tractor unit with 'normal sized' commercial tyres can meet these requirements with relative ease, but for a unit of comparable dimensions (including overall width and wheel track) fitted with the much larger 16.00 R 20 single off-road tyres, the issues can be very real.

At the most significant end of the scale, emissions compliance is regularly a topic of heated debate. No matter what claims are made, it remains fact that no engine which is current EU/EPA emissions compliant will run continuously on jet, low-grade/high-sulphur or even 'dirty' fuel, for extended periods without limitations of some sort. A far simpler, albeit still EURO 3-compliant unit, is without doubt a far more practical option for such usage.

Similar compliance issues arise with the semi-trailer. Once little more than a wooden-floored flatbed on an I-beam frame with leaf-sprung walking beam suspension, the modern HET semi-trailer is now a highly complex piece of kit, and something that can cost almost as much as the tractor unit it is coupled to. The specification differences between a fully commercially-compliant semi-trailer that can transport an MBT and the ideal tactical option, are even wider than those of the towing tractor. The laws of physics dictate that for all-terrain stability, an ideal HET semi-trailer will have a load bed and track comparable to the width of its primary MBT payload. As an example case the Leopard 2A6 comes in at 3.75 m. Axle numbers should be the minimum required to meet desired ground pressure (usually five, occasionally six), and tyres should be something akin to 24 R 21 wide footprint singles.

If there are HET procurement trends to be identified, then any trend with semi-trailers is far clearer than that for tractor units. To allow for relatively trouble-free peacetime usage, almost without excep-

Credit: Boevaya mashina, via Wikimedia commons

The German Army's FAUN SLT 50-2/Kässbohrer combination are currently being replaced, but are a perfect example of a no-compromise, designed-for-purpose HET, the likes of which Europe is unlikely to see again.

tion NATO/EU users are opting for a legislation-compliant option, albeit one that is as all-terrain capable and high-performing on deployment as technically possible. Trailer (without extending 'greedy' boards) width and/or wheel track is usually 3 m, and while some do occasionally bite the bullet and go wider, in order to comply with height limitations, axle loadings and turning requirements, most now opt for up to 8 pendular suspended axle rows (many of which steer), fitted with up to 64 road-biased tyres (up to eight per axle row), that are around two-thirds the diameter of an off-road option such as the 24 R 21.

With tractor units, as previously mentioned, it remains possible to procure a capable tactical option that is for the most part legislatively compliant. Large 1600 R 20 off-road single tyres, military-specific cabs, deep fording, winterisation, full EMC compliance and other military demands, for the most part can be engineered in and within current legislation. However, this is becoming more difficult year-on-year as commercial legislation is requiring ever more driver aids and safety systems to be fitted as standard. Quite frankly, if left to their own devices on deployed operations, these can be a life-threatening tactical liability.

With tractor units, there is less agreement over procurement direction than there appears to be with trailers, and while in most instances within Europe, EU standards compliance is an ever-present procurement bane, users still vary widely in their choices. A typical example given later in this piece is that of neighbours Norway and Sweden.

The perfect scenario for HETs would of course see an armed force having two fleets, a peacetime fleet that complies fully with all legislation, and that can run on roads and possibly even prepared tracks, and a tactical fleet that puts capability ahead of all else, including compliance with legislation. Regrettably, that perfect scenario is simply not affordable in the modern world, and in truth it probably never was, even in the Cold War world which tended to lean towards a capability ahead of compliance policy with most military procurements. As previously outlined, leanings these days do tend to be the other way, with legislative compliance over full tactical capability being the direction taken. A genuine designed-for-purpose HET is now something of a rarity.

The user conundrum

Using Europe/NATO as a sizeable test subject, a glance through inventories will show that no two users currently operate the same HET, and while there is inevitably some commonality in brand of tractor truck if not exact model, there is even greater variety in the semi-trailer department. The HET trailer has traditionally been seen as the local production 'carrot' by the tractor unit manufacturer, the usual prime contractor for a HET contract award. However, with the size and weight of payloads ever increasing, the ability to design and manufacture a trailer that complies to any degree with legislation while remaining a viable load carrier on anything on than level metalled roads is becoming ever more difficult to do. Such a capability is now considered beyond that of many legacy suppliers of HET semi-trailers. Additionally, with semi-trailers generally outlasting their original tractor units by means of design simplicity in general, the increasing size and weight of payloads is also becoming an issue for those that wish to retain, refurbish and reuse existing trailers with a new tractor unit.

Based on age, within Europe/NATO a number of armed forces either are currently, or in the near-term will be looking to replace their current HET fleets. A most definite front-runner for those that have yet to decide on a replacement HET has to be the Rheinmetall MAN Military Vehicles (RMMV) HX81 tractor truck, and for those that require a degree of legislative

Credit: Shaun C. Connors

This Norwegian Army Scania 3 series tractor is a mildly militarised commercial model, and while the semi-trailer is full-width, it and the tractor were clearly specced to be legislatively compliant at the cost of true off-road mobility.

Credit: Vitaly Kuzmin, via Wikimedia commons

Interestingly the Russian military are replacing fully tactical MAZ/MZKT HETs with a more commercially orientated KAMAZ-fronted combination. The trailer remains full-width. Not that it would worry the Russians, but the combination would be far from complaint with EU road regulations.

compliance combined with a tactical capability, potentially with a Doll-produced semi-trailer.

Before taking a closer look at the HX81, its recent successes, and potential future opportunities, a quick run through of the opposition is in order. This run will not cover semi-trailers, just tractor trucks, and will be a non-technical, range-specific overview.

Europe's 'big seven' commercial truck manufacturers all offer commercial heavy haulage options that can haul payloads equal to those of even the heaviest MBTs with ease. However, not all of these manufacturers directly offer a true military HET option.

Daimler, Scania and Volvo offer commercial models with varying degrees of militarisation, these options including armoured cabs. Daimler has the added option of two distinct and different models, the cab-over-engine (COE) Arocs, or the bonneted Zetros. Renault could offer a mildly militarised commercial model directly, although for higher levels of militarisation this would likely be offered via or in conjunction with Arquus, which is essentially the former Renault Trucks Defence. IVECO's defence division IVECO Defence Vehicles (IDV) can offer variants of the new Modular Military Range (MMR) that has options including commercial or military-specific cabs. Technically, should any requirement call for a 'green panted' truck, IDV could offer an appropriately-specced IVECO commercial model. For completeness, Renault is owned by Volvo, while Scania and MAN (along with Volkswagen) are part of TRATON Group.

DAF (owned by US company Paccar) does not technically offer an all-wheel drive and/or military product. However, it should be noted that Belgian armed forces are currently receiving a batch of TATRA Phoenix (including a small number of HETs) that are badged and promoted as DAF. TATRA's Phoenix is a heavy/severe-duty design that uses a DAF cab and Paccar engine (Paccar is DAF's parent company), and the Belgian deal involves local content by DAF. TATRA also has the option to offer users the military-focused T815-7; this and the Phoenix range are based on TATRA's unique tubular backbone-type chassis and swinging half-axle suspension arrangement.

Realistically, the above are the most likely competitors for the HX81, and most certainly within Europe. As far as the 'big seven' commercial truck manufacturers are concerned, MAN's TGS heavy commercial range has technically not been overlooked. RMMV is a 51/49% joint venture between Rheinmetall and MAN Truck & Bus AG, and this entity is responsible for global military sales of MAN trucks. So, as part of the TG MIL range, the TGS series could be offered by RMMV should any user require a more commercially-based solution than the HX81.

Not to be overlooked as a potential European competitor for RMMV in limited markets is Sisu, Finland's specialist producer. Sisu offers the Polar range, these are purpose-designed chassis, but with Daimler (Mercedes-Benz) aggregates and cab. While the range currently does not include a HET, it would not be beyond the capabilities of specialist manufacturer Sisu to design and produce one. Finally, BMC of Turkey offers a HET derivative of its latest Tugra commercial range.

Beyond Europe, there are a variety of heavy truck manufacturers, but not all have any real interest in the military marketplace, and in particular more specialist variants such as HETs, while others such as those based in countries such as Belarus, China, Iran or Russia, are of little or no real relevance to the European military truck market.

For completeness though, Belarus is of course home to MZKT and MAZ. MZKT was the former supplier of multi-axle transporter, erector, launchers (TELs), HETs and similar vehicles to Russia and many Warsaw Pact armed forces. China is awash with heavy truck manufacturers, most capable of producing a HET of sorts. For now the PLA appears to be procuring two broadly similar military-specific HETs from Taian Aerospace Special Vehicle Co., Ltd. (TASV) – the Taian TA4360 and TA4410. Iran appears to be receiving HETs that are based on Volvo designs/models, although details regarding the actual sourcing/production of these are sketchy at best.

Russia, following the effective loss of MZKT with the independence of Belarus turned primarily to BAZ and Kamaz to fill a very large specialist vehicle void. For the last decade, the HET of choice for Russia has been the Kamaz-65225, a HET derivative of the commercial Kamaz-6522. For reasons unknown (which could vary from Russian industry's inability to develop a viable replacement for the older MAZ-537, through to pure economics), the Kamaz-65225 while all-wheel drive is 6×6, not 8×8, and is fitted with twin

rear wheels/tyres, rather than the larger single configuration of the MAZ-537. The standard semi-trailer for the Kamaz, and indeed all HETs mentioned in this paragraph, while not fitted with wide footprint all-terrain tyres, do have significantly larger diameter wheels and tyres than their western counterparts. Perhaps most interestingly, all their load platforms are full-width (the width of their payload), and not reliant on the stability-limiting 'greedy boards' that are required for full road usage compliance within the EU.

Returning to worldwide competitive possibilities for the HX81, the most obvious of these would be the US Army's current HET of choice, the military-specific Oshkosh M1070A1. For compliance with European roads, the M1070A1 has been modified and is designated the M1300, and this operates with a European legislation compliant M1302 semi-trailer supplied by Broshuis. The ongoing US Common Tactical Truck (CTT) program could evolve to offer the US Army options in the HET segment, but it is considered likely that procurement of the M1070A1/M1300 will continue in the near- to mid-term. Since its introduction in A0 configuration, Oshkosh has actively marketed the M1070 worldwide, and while the UK is the only European operator of a derivative of the type, it is known to have performed well.

Also from the US, Mack and Navistar both potentially have options. Mack, owned by Volvo, is again active in the defence arena and a military HET based on the Granite commercial platform should be relatively easy to develop. Navistar Defense also has options. Navistar Defense is now a standalone company, 70% owned by Cerberus

Credit: US Army

Arguably a bit of a mismatch – the US Army's Oshkosh M1070 tractor and M1000 semi-trailer, the latter having well-publicised mobility issues and not really suited for being dragged to where the tractor was capable of pulling it.

Capital Management, the remaining 30% retained by Navistar, Navistar itself part of TRATON. Navistar has previously delivered HETs, the most recent known customer being Israel, for which the company extensively revised a commercial model, adding a selection on non-standard heavier duty/capacity COTS components to the specifications.

Front runner

Returning to the HX81, with seven known current customers or users, the type is pretty close to being market leader within Europe and European-accessible markets. Additionally, as previously noted, it looks likely to be a serious contender for a selection of current/pending HET requirements within those regions.

Current users or customers of the HX81 are Australia, Austria, Germany, Norway, Saudi Arabia, Ukraine, and the UAE. Australia, in July 2013 and as part of the wider Project Land 121 (Overlander) Phase 3B ordered an estimated 110 HX81s, 21 of which are fitted with a Rheinmetall armoured cab, the remainder with the standard HX range military-specific flat-panelled cab. Trailers as local content are supplied by Haulmark Trailers, these are a very specific design configuration to comply with Australia's stringent axle weight laws.

Austria ordered an initial four HX81s, and as part of a frame contract awarded to RMMV in 2023 for up to 1375 trucks has ordered a further 15, with an armoured cab and an eight-axle Doll semi-trailer.

When deliveries conclude this year, Germany will have received a total of 158 HX81 HETs. The original 21, which included two qualification vehicles, are fitted with a KMW armoured cab, while the remaining 137 examples are fitted with the standard HX range unprotected cab. There are some other limited configuration differences between these and the original 21 delivered.

Norway's HX81s are, as of early 2024, in production. Norway and Sweden are both procuring RMMV trucks under a joint procurement project fronted by Norway's Defence Logistics Organisation (NDLO). Highlighting an earlier comment regarding a lack of commonality in HET procurement across armed forces, this fact is further reinforced when it is noted that even under a joint procurement project, Norway may be procuring HX81 for a HET role, but Sweden has opted for a far less tactical TG MIL-based solution.

In 2016 an undisclosed international customer, now known to have been Saudi Arabia, awarded Rheinmetall a contract for 110 HX81s with semi-trailers. Due to export licence issues it is believed that only 20 tractor units and all trailers would be delivered. Following a potential sale to Jordan and then Romania, in 2023 it was revealed that the 90 remaining HX81s, together with full-width three-axle Doll, tactical semi-trailers would be supplied to Ukraine by Germany. The original semi-trailers are understood to have been Nicolas-suppled five-axle full-width examples with 24 R 21 wide footprint tyres, and an APU-driven axle for additional traction off-road

The first export user of the HX81 is understood to have been the United Arab Emirates (UAE). Between 2011-2014 it is understood that 32 (4 + 28) HX81s with 28 Crossmobil five-axle full-width semi-trailers were delivered. Most HX81s have an extended version of the standard RMMV modular military cab, and the rear two drive axles have the standard 16.00 R 20 tyres replaced with wider 24 R 21 tyres, as fitted to the semi-trailer.

Looking ahead, there are three pending requirements within Europe that immediately spring to mind, these in France, the UK and the Netherlands. France has a definite need to replace a near 30-year old fleet of purpose-designed Renault TRM 700-100 HETs, and while in more recent times these have been supplemented by less capable Sisu E-Tech 480, the need for replacement remains. Recent truck winners in France have been Renault/Arquus (perhaps understandably) and Scania, with the latter also having a truck manufacturing plant in France. If France desires a true tactical option, neither Scania nor Renault have anything in their respective portfolios that can match the HX81 in this area.

With regard to the UK, the current Oshkosh 1070F HETs were procured under a private finance initiative (PFI), and a decision on whether or not to extend this is imminent. The UK has definitely reaped the benefit of a tactical HET on global deployments in recent years, and even supplemented the originally procured road-biased semi-trailers with a more robust off-road solution for use on deployed operations. Should the UK opt to replace its current Oshkosh HETs, given the standard British Army truck fleet consists of RMMV HX models, the HX81 would have to be a serious competitor, even against the latest M1070/M1300 which has been selected by the US for operating in Europe.

Credit: Carl Schulze

A current German Army RMMV HX81 tractor and Doll seven-axle semi-trailer.

The HX; oily bits and beyond

RMMV (then MAN), confirmed development of the HX tactical range of trucks in 2003, and the launch customer for the HX range was the UK MoD. The revised HX2 range entered production in 2015, with the final original HX models (HX77 for Australia) delivered in 2023. In technical terms, the HX81 combines elements of both HX and HX2 ranges. With the HX range RMMV has strived for maximum commonality with the TG commercial product, the aim being to reduce procurement and through-life costs. Given the very specific nature of a tactical military HET design, the number of model-specific components or modifications is greater than with a standard HX range truck.

The HX81 is entirely conventional in design and based on a single-piece C-section ladder-frame chassis. Early HX81 designs

featured a chassis that was essentially a shortened version of the chassis of the HX77 8×8, with later HX81 designs incorporating the front section of the HX2 range 44M 8×8. HX chassis are derived from the commercial TGS chassis, the primary differences being the cross members, which are HX-specific to enable the higher degree of torsional twist required for an off-road design. The wheelbase of the HX81 is 1.8 m + 3.2 m + 1.5 m, although options are stated to be available. The original two HX81s delivered had a slightly shorter tandem to tandem wheelbase of 2.95 m. Maximum permissible gross combination weight (GCW) is 130,000 kg. Gross vehicle weight (GWV) rating (unladen plus imposed fifth wheel load) can vary by configuration, but maximum permissible is now 45,000 kg, up from its original figure of 44,000 kg.

Credit: Rheinmetall

Three-quarter view of the HX81 fitted with an optional cab armour protection.

The HX81 can be fitted with a selection of cabs, options including two swap-cab armouring solutions that are known as the Integrated Armour Cabin (IAC). The IAC was originally developed in conjunction with Krauss-Maffei Wegmann (KMW) for the SX range of trucks. A Rheinmetall-developed IAC option is now available. The first 19 HX81s ordered by the German Bundeswehr are fitted with the KMW IAC. Australia and Norway have both opted for the Rheinmetall option for their HX81s fitted with an IAC. The unarmoured cab fitted to the HX81 is the latest version of RMMV's modular military-specific cab, this tracing back to the Category 1 trucks that entered service in 1976. The HX range evolution of the modular military-specific cab is 290 mm deeper than its immediate predecessor, and has more than 600 litres of gross stowage space in the rear. This is sufficient for radio equipment and the full kit of three soldiers. In its extended configuration, this cab can seat up to six if required. The bulk of the instrumentation package has been taken from MAN's TG WorldWide commercial range, as this is deemed more practical and cost-effective than the purpose-designed instrumentation of earlier cabs.

The detachable hard-top roof accommodates the optional air-conditioning equipment, plus a nuclear, biological, chemical (NBC) filtration system for the over-pressured cab if required. The roof is reinforced to take the weight of two soldiers and withstand the recoil forces of a 12.7 mm heavy machine gun in a ring-mount. A blast-proof vertical split-windscreen is fitted as standard, and a riot protection kit is available for the cab. Appliqué protection kits, for which vehicles are prepared to accept at the production stage, have also been developed for this cab, in conjunction with Ressenig of Austria and Rheinmetall of Germany. Known as the Modular Armour Cabin (MAC), in basic specification the weight of these kits is about 1,500 kg, and it would be technically possible to fit the ballistic protection elements from these to the HX81 should it be required.

The 132 HX81s ordered by the Bundeswehr in 2018 are being fitted with the unarmoured cab. In configuration the cab will be very similar to the cab fitted to the Ungeschützte Transport Fahrzeuge (UTF; ENG: Unprotected Transport Vehicle) HX42M (6x6) and HX44M (8x8) family of vehicles, the contract for which was awarded to RMMV in July 2018. The unprotected cab of the HX81 can be exchanged for the protected IAC version if required.

Immediately behind the cab, the engine cooling system and air intake/intercooler/exhaust unit is located, in a hydraulically tiltable carrier that also houses some ancillaries and up to two spare wheels/tyres and hoist. Immediately behind this carrier, a double drum power take-off (PTO)-driven winch system capable of handling the weight of a main battle tank (MBT) can be fitted. German Army HX81s are fitted with twin 20,000 kg rated winches, with an additional self-recovery winch fitted to those with an armoured cab.

Being a tactical-role truck, NATO tow and recovery fittings are fitted front and rear, including an optional standard towing pintle on the rear cross member. A steel front bumper is standard, as are various chassis-mounted brackets for sealed-for-wading stowage options. Tactical (including blackout) lighting is part of the standard electrical specification, with further modifications to enable the installation of additional military-specific electronics and communications or command equipment an option.

The Jost fifth wheel is located over the rear tandem, and has a rated load of 19,000 kg when 16.00 R 20 tyres, as well as the IAC, double winch system, and a spare wheel are fitted. This rating increases to 21,000 kg with 24 R 21 tyres. The 840 litre aluminium fuel tank is located on the left-hand side between the front and rear axle pairs, giving a >800 km range. The chassis together with cab and all ancillaries (including all driveline components) is capable of fording to a depth of up to 750 mm without additional preparation. All external compartments are watertight as the HX range are designed for an optional 1.5 m fording depth.

The HX81 drivetrain, while consisting of commercially-available components, is specific to the HX81 and components are extensively revised for the military HET role. Motive power is provided by a MAN D2868LF04 V8, 16.16 litre diesel engine rated at EURO 5 emissions compliance. The engine is conventionally located, longitudinally between the chassis frame and under the cab. The LF04 variant of the D2868 is military-specific and is supplied without a front-mounted cooling fan, no plastic covers, military software, and the 'anti-wear package' to enable long-term use on low and military-grade fuels. Maximum power output is 500 kW (680 hp) at 1,900 rpm, and peak torque is 2,700 Nm at 1,000 to 1,700 rpm. The torque delivery curve is optimised to match the TC-Tronic automated gearbox and HET application. The cooling package is HX81-specific, and includes a

Credit: Carl Schulze

From the rear, a current German Army HX81/Doll semi-trailer combination. To enable escort-free movement when unladen, to accommodate an MBT (or similar) payload the trailer requires the use of extending 'greedy boards'.

pair of HX77 radiators mounted in parallel. The original HX81 prototype was fitted with a variant of the D2868 engine rated at EURO 3 emissions compliance and developing 660 hp (492 kW).

The ZF TC-Tronic automated constant mesh gearbox (branded TipMatic in MAN's commercial product line) has 12 forward and two reverse gears, and is coupled to a ZF WSK 440 torque converter and (with the exception of Australia), a MAN G253 two-speed transfer case with full-time all-wheel drive. The ratio spread of the gearbox allows for the use of full engine torque at almost any speed, additionally, retardation provides 500 kW of wear-free braking for downhill descents.

The driveline of the HX81 range is completed by MAN's single tyre specific hub-reduction axles, originally VP/VPD-09 units rated at a technically permissible 9,000 kg (each) for the front, and HPD-1372-E/HP-1342-E units rated at a technically permissible 13,000 kg (each) for the rear. Later HX81s have 11,000 kg rated front axles taken from the HX44M, and 16,000 kg rated rear axles are an option. With 16.00 R 20 tyres fitted, technical maximum rear axle loads are reduced. All axles are fitted with driver-controlled cross-axle differential locks; there are longitudinal differential locks in the rear axle combinations, and the transfer case.

Brakes are dual-circuit air-actuated drums on all axles. MAN's Electronic Brake System (EBS) with ABS with off-road logic is standard, these supplemented by an air-actuated exhaust brake with additional Exhaust Valve Brake system. The gearbox retarder, engine braking and service brakes are automatically blended by the vehicle electronics, with a heat exchanger dissipating the waste heat into the cooling system.

The HX81 range is fitted with leaf springs on all axles. Front steer-drive axles are sprung by a combination of parabolic leaf springs with progressively acting rubber assistors and shock-absorbers, suspension rated at 10,000 kg per axle in standard configuration. Rear axles are sprung by inverted multi-leaf trapezoidal springs with radius rods and anti-roll bars, and the suspension is rated at 14,500 kg per axle in standard configuration.

Early HX81s were fitted with 395/85 R 20 tyres, although these have since been replaced by 16.00 R 20 tyres. Other options include 14.00 R 20 and 24 R 21. Tyre chains for all tyre sizes up to 16.00 R 20 are permitted. A semi-automatic or central tyre inflation system (CTIS) and run-flat inserts are optionally available.

Steering is ZF 8099 hydraulically actuated, and on trucks with 11,000 kg steer-drive axles this is uprated with each steer-drive axle featuring steering actuation on both sides. Steering lock is 36° on the front axle, and 18° on the second axle.

The HX81 is transportable by the A400M transport aircraft. Approach and departure angles of the tractor (without trailer) are 41° and 44° respectively. Gradeability of the tractor (without trailer) is in excess of 60%, and it is capable of climbing a 600 mm vertical step and crossing a 2.3 m wide ditch. The fording depth is 750 mm without additional preparation. ■

Credit: Shaun C. Connors

The seven-axle semi-trailer coupled to this Austrian Army HX81 tractor may well allow for complaint road transport of all Austrian Army loads on road in peacetime, but it is an inescapable fact that in environments such as those currently found in the Ukraine, that trailer would not be capable of being dragged undamaged where the tractor unit could drag it.

Azerbaijan ponders the purchase of JF-17 from Pakistan

Ilya Roubanis

The sale of Pakistani fighter aircraft to Azerbaijan has been the subject of recurring speculation since 2007. However, the story has resurfaced in February 2024, and now the long-rumoured acquisition appears to have become credible.

The information initially circulated on social media and was soon picked up by mainstream outlets. This author was able to independently confirm the credibility of the story with sources in both Baku and Islamabad. For the first time, and after years of speculation, the stars seem to have aligned for this deal: Azerbaijan urgently needs a jet fighter and Pakistan's offer is convincing, with the value of the deal widely shared as being USD 1.6 billion.

The Russian vacuum and the Pakistani offer

According to the Centre for European Policy Analysis (CEPA), Azerbaijan's largest supplier of arms has historically been Russia. That can no longer be the case. The war in Ukraine means that every country around the world with a fleet of vintage Soviet era and Russian jet fighter frames is looking for replacements. Azerbaijan has repeatedly upgraded its fleet of MiG-21s, MiG-29s, SU-24s, and SU-25s. The median airframe age of this fleet is well above 30 years old, and Russian can no longer be relied upon for either spare parts or ammunition. In this context, investing in Russia's fifth generation of Su-57 or Su-75 aircraft is highly unlikely.

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Credit: PAC

Pakistan Air Force JF-17 Thunder.

The JF-17 Block III (Thunder) is a joint venture between China Aviation Industry Corporation (AVIC) and the Pakistan Aeronautical Complex (PAC). Chinese systems make the aircraft a system with a claim to 4.5 generation credentials. Pakistan's offer appears to be a qualitative leap forward compared to Azerbaijan's current fleet and will transform the nature of aerial combat in the Caucasus.

The latest Block III version of the 'Thunder' entered service in 2023; Pakistan claims improved capabilities, not least due to a wide-angle holographic head-up display system. Furthermore, there are several features contributing to beyond-vision capability. The fighter is equipped with a KLJ-7A X-band 3D active electronically scanned array (AESA) radar. The second version of this radar allows the pilot to lock on to multiple targets at over 150 km in range. Finally, the Thunder is able to carry long-range (220–300 km) guided missiles such as the PL-15, which change the profile of the platform. In the words of former Vice Chief of the Pakistani Air Force Saeed Khan, "close aerial combat is no more a matter of comparison any more between fighters; today it is not Fox 1 [semi-active radar guided] or 2 [infrared homing] that are important, but Fox 3 [active radar homing] that is going to decide the fate of the battle", referring to the beyond-visual range capability of the platform.

Another important detail is that the Thunder also features an Aselpod targeting pod on its centreline hardpoint made by Turkey's Aselsan. According to Professor of International Relations at Kadir Has University (Istanbul), Serhat Guvenc, Turkey may be the future supplier of the jet fighter's engine.

The Thunder has already been sold to Nigeria and Myanmar and there are apparently advanced negotiations with Iraq. The Arab state has been offered 12 jet fighters for USD 664 million, which

means that for USD 1.6 billion, Azerbaijan would be able to renew its whole fleet and establish the infrastructure required and train a new generation of pilots.
It is clear that buying a fighter platform is all about a relationship, and not just a one-off sale. Pakistan is offering an aircraft that is competitive in a range of fighting environments, at a good price, with guarantees of supply chain resilience against the threat of possible sanctions.

The Three Brothers and the JF-17 stopgap solution

The sale of Pakistani fighters to Azerbaijan has been at the heart of recurring speculation for over a decade. The relationship is diplomatically strategic. Pakistan was the second country (after Turkey) to recognise Azerbaijan's independence in 1991. The three states have since been referred to as "The Three Brothers." Characteristically, Armenia blocked Pakistan's association with the Russia-led Collective Security Treaty Organization (CSTO) in 2017 due to Baku's close ties to Islamabad.
Pakistan has also been a fervent supporter of Azerbaijan vis-à-vis Armenia, particularly over the question of Nagorno-Karabakh. Islamabad dispatched military advisors to Azerbaijan during the 44-day Second Karabakh War of 2020 that changed the territorial status quo. Pakistan's Army Chief General Syed Asim Munir visited Baku in November 2023, where he met President Aliyev. According to the former Royal United Services Institute Southeast Asia analyst, Umer Karim, this 'out-of-protocol' meeting was a tell-tell sign that a major deal was brewing.
Azerbaijan is of course committed to Turkey's TAI Kaan 5th generation fighter. Launched in 2010, the programme is currently Ankara's indigenous jet fighter programme and its sole option. Following its removal from the US F-35 programme in 2019, Turkey has been unable to secure a 4.5 to 5th generation jet fighter. Neither Turkey nor Azerbaijan can turn to France for a fighter; Sweden is also an unlikely choice and Germany has blocked the sale of the Eurofighter to Ankara. Consequently, Turkey and Azerbaijan will need a stopgap solution to cover the period from approximately 2024 to 2033, by which time the first lot of Block-1 Kaan aircraft are due to have been delivered.
That solution may not be the same for both states. The Pakistani JF-17 Block III (Thunder) is often referred to as an evolution of the J-7 Chinese platform (MiG-21) and is heavily reliant on Chinese systems, while Turkey is dependent on NATO compatible platforms. As noted by the military analyst and war correspondent in Baku, Heydar Mirza, the reliance of the JF-17 Block III on Chinese systems is not politically problematic for Azerbaijan.

The Three Brothers and the Kaan Platform

As noted by Professor Guvenc, the Three Brothers have a different "path dependency." Pakistan can look to China more so than Turkey. In significant ways, the baseline expectations of Turkish and Pakistani pilots are laid on the foundation of their common workhorse, the US-made F-16. For different reasons, neither Pakistan nor Turkey have been able to upgrade their F-16 platforms, although in the beginning of 2024 Turkey formally penned a deal with Washington for the upgrade of 70 F-16s to Block-70, as well as the acquisition of 40 new units. Still, this stopgap measure could be problematic as delivery may yet be delayed for years.
Pakistan is taking a different path, creating a platform that has more scope for customisation, allowing states that buy into the JF-17 Block III programme to make use of missile systems they have in stock. In line with Pakistan's non-aligned defence culture, Azerbaijan is making a bigger break with tradition, acquiring a non-Russian platform for the first time. Baku is gaining a cheaper platform appropriate for the theatre where it will be deployed. However, the added value of the JF-17 deal is that it deepens the multi-layered relationship of the military-industrial complex emerging between Pakistan, Turkey, and Azerbaijan.
Discussing the Azerbaijan deal with former Vice Chief Saeed Khan, one understands that the JF-17 Block III platform has been informed by the experience of fighting the Indian Air Force. Pakistani pilots have primarily been facing Indian, and to a lesser extent, Iranian adversaries, acquiring experience vis-à-vis a fleet of French and Russian jet fighters, but also dealing with an array of indigenous and Russian legacy surface-to-air missile (SAM) systems. This experience is part of Pakistan's sales pitch.
Pakistani pilots have both flown and engaged many fighter platforms that Azerbaijani pilots are likely to come up against. Pakistani pilots have also encountered many of the SAMs that Armenian or Iranian pilots would be likely to use against Azerbaijani pilots. Finally, the training of Azerbaijani pilots will be more cost-effective, as the Pakistani platforms are not only cheaper to acquire, but also to fly, allowing operators to build up more flight hours.
The contribution of Pakistani developers in the Kaan project has been widely publicised. Turkey's Deputy Minister of Defence Celal Sami Tüfekci stated in an announcement on 2 August 2023 that as many as 200 Pakistani officials and engineers were already involved in the Kaan programme. Another implicit advantage of this specific procurement is that the 'Three Brothers' have been integrating

Credit: SSB

TAI Kaan (also known as the Milli Muharip Uçak; MMU) prototype taking off for its maiden flight on 21 February 2024.

Credit: PAC

A Pakistan Air Force F-16A of No. 9 multi-role squadron 'Griffins'. The F-16 platform has been the workhorse of the Pakistani and Turkish Air Forces.

their tactical and strategic practice with the use of Turkish drone systems. Turkey's Kaan programme is now experimenting with the idea of a 'loyal wingman' drone. This can now be tested in a range of different terrains and against a range of technologies, acquiring data to improve performance.

The strategic significance of the sale

Buying into a fighter platform is buying into a relationship. Although Baku has always recognised Russia's claim to regional power status, Azerbaijan is not a member of CSTO and remains fervently non-aligned. The country prefers the plurinational "3+3" diplomatic framework. Azerbaijan is not alone in this approach and in this context the acquisition of the JF-17 may be seen as a test case. As Russia's procurement infrastructure withers, Uzbekistan and other members of the Organisation of Turkic States are seen as possible next-in-line clients.

The JF-17 platform is designed to provide significant beyond-vision capability and a first-target edge in theatres that do not have the resources to acquire state-of-the art Western systems. Pakistan is looking to fill a widening Russian vacuum and is providing a sanctions-resilient value chain that can be customised to accommodate a wide range of ammunition. The JF-17 platform has generally been offered to states that are politically non-aligned, have moderate or limited economic means, and see the possibility of Western sanctions as a real possibility. Myanmar and Nigeria were the first two clients, Iraq looks to be next, and according to two Pakistani sources, Argentina was also a possible client until the recent change of government.

Like all modern platforms, the JF-17 platform is modular, with potential for ever-increasing Turkish input. The Turkish modules are tested and evolve within the platform without compromising the integrity of NATO's data ecosystem, as noted by Professor Guvenc. Furthermore, the Pakistani deal contributes to the deepening of the emerging military-industrial complex emerging between the three states. The platform may indeed be a stopgap solution in anticipation of the Kaan 5th generation fighter. For the moment though, it is a timely stopgap filling the ever-widening Russian vacuum in an increasingly multipolar world, where plurinational cooperation without multilateral strings attached may become the new norm. ■

Credit: PAC

Rear view of a JF-17 of the Pakistan Air Force's No. 16 squadron 'Black Panthers'.

Brazil awaits its Centauro II mobile gun system

Victor M. S. Barreira

An ambitious plan by the Brazilian Army to modernise its armoured cavalry brigades is soon scheduled to reach a significant milestone with the arrival of the first two Centauro II 8×8 wheeled fire support armoured vehicles.

The Brazilian Army (Exército Brasileiro) counts 2,244 armoured vehicles in its six independent mechanised cavalry regiments, two armoured brigades, four mechanised cavalry brigades, and three mechanised infantry brigades according to the the Commander of the Brazilian Army, General Tomás Miguel Miné Ribeiro Paiva.

The initial two Centauro II for Brazil were produced in 2023, with the turret produced by Leonardo Electronics in La Spezia, and the wheeled platform manufactured by Iveco Defence Vehicles (IDV), in Bolzano. These are scheduled to be shipped to Brazil between June and July 2024, the Brazilian branch of IDV told ESD. Shortly after the first two vehicles arrive in Brazil, they will undergo a final technical and operational evaluation by personnel of the Armoured Instruction Center (CI Bld) at the Army Evaluations Center (CAEx). Formal delivery of these vehicles to the Exército Brasileiro is scheduled to take place in 2025. If the two vehicles are approved, a second tranche of seven Centauro II vehicles for doctrinal experimentation will be purchased, a Brazilian Army spokesperson told ESD. An additional 89 serial production vehicles are planned to be gradually procured out to 2037, bringing the total to 96 vehicles over this timeframe, at a cost of BRL 3.3 billion.

The Centauro IIs are intended to gradually replace part of the EE-9 Cascavel 6×6 armoured reconnaissance vehicle fleet. According to the delivery plan for the first 96 Centauro IIs, 18 vehicles are earmarked for the 2nd Mechanised Cavalry Brigade, 36 for the 4th Mechanised Cavalry Brigade, 36 for the 1st Mechanised Cavalry Brigade and six for the 1st Jungle Infantry Brigade by 2037. Up to an additional 113 Centauro IIs could be later acquired depending on the available budget, the Brazilian Army spokesperson said.

Several Brazilian Army personnel are currently finalising initial operational and maintenance training on the Centauro II in Italy. A firing course also took place at the Italian Army ranges in Montelibretti and Nettuno to evaluate the main gun. CIO informed ESD that it will deliver a complete integrated logistics support (ILS) and training package.

The Centauro II was formally selected on 25 November 2022 by the Brazilian Army's Logistics Command (COLOG) to meet its Viatura Blindada de Combate de Cavalaria Média Sobre Rodas 8×8 (VBC Cav-MSR 8×8; ENG: 8×8 Wheeled Medium Armoured Combat Cavalry Vehicle project) requirement, which is part of Brazil's Army Armoured Forces Strategic Programme (Prg EE F Bld). The Centauro II was selected over the General Dynamics Land Systems-Canada (GDLS-C) LAV 700 AG and NORINCO ST1-BR vehicles. This announcement followed a request for proposal (RFP) issued by COLOG for two vehicles issued on 20 July 2022. Soon after the selection, on 15 December 2022, Iveco Oto Melara Società Consortile (CIO), a joint venture between Iveco Defence Vehicles (IDV) and Leonardo, was awarded a contract by COLOG for an undisclosed amount for two Centauro II vehicles.

Modernising the cavalry brigades will contribute to further developing the local defence technological and industrial base. However, the incorporation of the Centauro II into the Exército Brasileiro's armoured vehicle inventory represents a challenging innovation, since this is the first time the service will field an armoured vehicle with a 120 mm gun and comprehensive intelligence, reconnaissance, surveillance (ISR) and target acquisition capabilities.

The commander and gunner's sights, the electric stabilisation servo system, and the fire control system, are all produced by Leon-

Credit: CIO

The image shows a Centauro II photoshopped into Brazilian camouflage pattern, and with the Brazilian flag added to the toe plate. The first two actual vehicles for the Exército Brasileiro will look slightly different, most notably featuring a pintle mount instead of a remote weapon station. They are scheduled to arrive in Brazil during summer 2024 for further trials.

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ardo Electronics, CIO told ESD. The LOTHAR SD two-axis gyro-stabilised sight provides the gunner with day and night identification, recognition and targeting capabilities. The Attila-D multi-spectral optronic sensor suite provides the commander with panoramic observation, as well as target detection, identification and designation capabilities.

The Centauro II's platform consists of a high hardness monocoque steel hull with mine and ballistic armour protection suite capable of handling threats such as mines, improvised explosive devices and kinetic munitions, in addition to a driveline featuring a single-differential twin-shaft design and the HITFACT MkII modular protected manned turret with a digital architecture.

The Brazilian configuration of the HITFACT MkII manned turret comes with a stabilised 120 mm L45 low-recoil smoothbore high-pressure gun with integrated muzzle brake, a coaxial 7.62 × 51 mm FN Herstal MAG58 machine gun, a pintle weapon mount armed with an MAG58 7.62 mm machine gun, eight 76 mm smoke grenade dischargers, meteorological sensor and wire cutters. The main gun is capable of firing most NATO-standard 120 mm ammunition natures.

As a potential replacement to the pintle weapon mount, discussions are already underway to explore the possibility of adding the REMAX 4 remote weapon station (RWS) produced by Brazilian company Ares Aeroespacial e Defesa to the next tranches of the Brazilian Centauro II, the company told ESD. This would allow use of either a 7.62 mm or 12.7 mm machine gun. However, the first two vehicles will only feature the pintle weapon mount.

The Centauro II for Brazil has a crew of four, comprising the driver, commander, gunner and loader. While the vehicle is optionally available with an autoloader, Brazil has opted for the manually-loaded configuration. The driver is provided with a situational awareness suite which is understood to include day and thermal cameras. The command and control (C2) package will be delivered as government-furnished equipment (GFE) and will consist of the L3Harris Falcon III VHF radio set, Thales SOTAS M3 intercom and the SGB battle management system (BMS). However, the radio could be replaced later on by a software-defined multi-band radio being developed by the Army Technological Center (CTEx) and AEL Sistemas as part of the RDS-Defesa project. Other locally-developed solutions could also be integrated on Brazil's Centauro II.

The Centauro II is powered by an Iveco Vector V8 EURO III-compliant engine developing 537 kW (720 hp), coupled to a 7+1 speed ZF Ecomat 7HP902 automatic transmission that drives eight wheels, with steering on the 1st, 2nd, and 4th axles. The wheels are fitted with run-flat inserts and use 14.00 R20 Michelin ZXL or XML tyres. The wheel stations are each equipped with independent hydro-pneumatic suspension, and connected to a central tyre inflation system (CTIS). A travel lock system for the main gun, a CBRN protection system, fire-fighting equipment and air conditioning unit also are available.

The Centauro II has a gross vehicle weight (GVW) of 30 tonnes, in terms of dimensions has a length of 8.26 m, width of 3.12 m and height of 3.65 m. In terms of mobility, it is capable of attaining maximum speeds of 105 km/h on paved roads, and has a maximum cruising range of 800 km. The vehicle can negotiate gradients up to 60%, and side slopes of 30%; additionally, it has a turn radius of 9 m, and can ford water up to a depth of 1.5 m without preparation.

Serial production vehicles for Brazil are scheduled to include a comprehensive package of offsets to be directed to the national defence technological and industrial base. The local content, which is still being discussed, could initially include the production by Indústria de Material Bélico do Brasil (IMBEL) of 120 mm TP-T training ammunition, and other round types at a later date. The development of a driving simulator and turret crew simulator by AEL Sistemas and Ares Aeroespacial e Defesa is also being discussed.

The contracts for the production vehicles could eventually lead to the assembly of the Centauro II at IDV's Brazilian plant, located in Sete Lagoas, in Minas Gerais state. The plant manufactures the VBTP-MSR Guarani 6×6 vehicle for Brazil and also for export, and is due to assemble the 4×4 VBMT-LSR Guaicurus 4×4 wheeled multi-role armoured vehicle, also for Brazil.

Credit: CIO

The Centauro II is also being fielded by the Italian Army, with 122 ordered so far, and a total requirement of some 150 vehicles.

The ambitious Prg EE F Bld strategic programme is aimed at mechanising Brazil's infantry and cavalry brigades by 2040, and includes the provision of the requisite simulators, logistics support and infrastructure. It consists of two subprogrammes: the S Prg Vtr Rodas subprogramme for the acquisition of VBTP-MSR Guarani and VBMT-LSR Guaicurus armoured vehicles, 155 mm wheeled howitzers, MaxxPro MRV-P armoured recovery vehicles, and the modernisation of EE-9 Cascavel fire support vehicles; and the S Prg Vtr Lagartas subprogramme for the acquisition of a main battle tank (MBT) armed with a 120 mm gun and a tracked infantry fighting vehicle (IFV) fleet with a medium-calibre cannon, as well as the modernisation of Leopard 1A5BR and M113BR armoured vehicles. ■

Credit: Victor Barreira

The Brazilian Army is gradually receiving more than 1,400 VBTP-MSR Guarani 6×6 vehicles in several variants

Cost-benefit analysis

Thomas Withington

Artificial intelligence (AI) and machine learning (ML) technologies are making their presence felt in the signals intelligence world, but as much as these approaches herald benefits, they may also carry inherent risks.

Computing giant IBM defines AI as "technology that enables computers and machines to simulate human intelligence and problem solving." In short, computers and machines which behave in a similar way to the human brain. AI and the term ML are often used interchangeably, but this can be erroneous. IBM defines ML as a branch of AI that uses "data and algorithms to enable AI to imitate the way that humans learn, gradually improving its accuracy."

To return to the brain analogy, your mind can be considered a blank canvas when you are born. You arrive in this world hard-wired with some knowledge such as how to eat and breathe, but not how to speak classical Arabic. Skills and behaviours like the latter must be learned. The learning process involves collecting data. We do this all the time without even realising it. Returning to the classical Arabic analogy, if you are learning the language, your teacher is sharing data with you in the form of information that will enable this. The prolonged organisation of this data will enable you to learn the language. ML is the process of collecting and organising the data, while AI is the way your brain then uses this information to know and use classical Arabic.

The human brain is ideally designed for the crazily complicated world in which we live. Every day we make thousands of decisions all based on our life experience and the knowledge we have acquired to date. We even make predictions based on our experiences in the past. We know not to cross a busy road as we have learned that fast traffic can kill and injure, and that there is a high probability this could happen to us if we cross the road now. We avoid taking the bus during rush hour if we can because the past has taught us that it is likely to be fully packed. It therefore makes sense that we are increasingly using AI and ML in computing to help make sense of complexity.

Radio soup

Increasing complexity is a hallmark of the radio spectrum, the part of the electromagnetic spectrum stretching from 3 kHz up to 300 GHz. Within this waveband radars, radios and satellite navigation systems do their work, with militaries depending extensively on all three capabilities. The problem with the radio spectrum is that militaries are not the only users. Civilian cellphone networks depend on radio frequencies, as do radio and television broadcasting. Likewise civilian marine, coastal, aircraft and air traffic control radars all rely on the radio spectrum. This is just a small selection of global radio spectrum users. There are many more which can be as diverse as medical imaging and radio astronomy. Existing and growing radio spectrum congestion is illustrated by the ever-growing number of wireless device users globally.

Ericsson produces highly respected analysis of global wireless device use. In late 2023 the company's mobile subscriber outlook said that 1.4 billion subscribers globally were using fifth-generation (5G) cellular protocols. These new cellphone and wireless device protocols promise a step change in to the quantities of data, and the number of subscribers, that can be hosted on individual networks. An analysis drafted by Thales stated that 5G networks could offer data rates exceeding 10 Gbps, which according to the company is up to 100 times faster than the data rates achievable with fourth generation (4G) protocols. More 5G

Credit: I'MTech

The rollout of 5G cellular communications protocols will contribute significantly to the increasing congestion of the radio spectrum. Will AI and ML provide mechanisms by which signals of interest can be extracted from this electromagnetic morass?

Author

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devices can be hosted on a single network node than is possible with 4G, Thales continued. A node could include an individual cellphone tower potentially connecting one million devices per square kilometre (0.4 square miles).

Help is at hand

The rolling out of 5G is good news for the cellphone user but worrisome for militaries, particularly for Signals Intelligence (SIGINT) professionals. As the spectrum gets increasingly congested, how will SIGINT cadres detect, locate and identify a signal of interest in this electromagnetic swamp? Military radars and radios are purposefully designed to transmit discreet signals which may change frequencies thousands of times per second. The point of such behaviours is precisely to frustrate attempts to detect these signals in the first place. Detect, locate and identify a radar and you probably detect, locate and identify the aircraft, ship or missile battery it equips. The same is true for any radio. It is even possible for SIGINT cadres to detect and locate individual troops based on their radio signals, along with vehicles and bases. Nonetheless, the challenge remains finding the signal in the first place. This could get harder than ever thanks to innovations in signal discretion. An increasingly congested spectrum will not help.

To exacerbate matters, signal detection can be time sensitive. For example, perhaps an enemy warship is illuminating your own, or an allied, vessel to get ready to launch an anti-ship missile. Alternatively, has the missile activated its radar for a brief period to check the ship's radar cross section (RCS) with the RCS the radar has stored in its memory? Processes like these are used by radars to confirm their target. In short, how can a signal be detected, located, identified and, if necessary, tracked in a timely manner in a congested environment? Do AI and ML have roles to play in helping to address these vexing challenges?

The first step is to detect the signal. An electronic support measure (ESM) continually monitors a segment of the radio spectrum to spot signals of interest. Returning to our above warship analogy, perhaps the ESM is monitoring the ship's locale for X-band (8.5 GHz to 10.68 GHz) radar signals. X-band is a popular choice for naval fire control radars, as these frequencies can render a target in impressive detail. If the ESM is monitoring the entire 8.5 GHz to 10.68 GHz waveband it may capture many X-band signals that are not of interest. For example, the ESM might detect friendly X-band fire control radar signals, or X-band signals being used for satellite communications. A skilled

Credit: BAE Systems

Equipping electronic support measures with AI- and ML-enabled techniques could assist these systems in finding and identifying signals of interest, and detecting anomalies in the radio spectrum that could indicate certain behaviours.

electronic intelligence (ELINT) operative can recognise the signals of interest found by the ESM. Nonetheless, as the spectrum gets more congested, this process could get more challenging. This is not to suggest that we should be taking the human out of the loop, but AI and ML have an important supporting role to play.

A written statement provided to this author by ELT Group said that "AI and ML algorithms can be trained to autonomously detect signals within the raw data (coming into the ESM). This can help in identifying relevant communications signals amidst large volumes of noise." Performing this identification will see the use of ML algorithms that "can classify signals based on various parameters such as frequency modulation and waveform characteristics." In essence, it is not just a case of detecting the signals, but also understanding their composition. This can be challenging.

Detecting unusual behaviour is something else that AI and ML could assist with. Perhaps an unusual signal has appeared within the raw ELINT data the ESM is collecting. It may not be immediately obvious that the signal is unusual, but AI techniques could help "identify unusual patterns or behaviours in the signal data, which may indicate potential threats or interesting events", according to ELT Group's statement. From a communications intelligence perspective, these techniques could help to identify radio networks connecting a battalion or brigade.

With such techniques, not only is the ESM using ML and AI to tease out signals from the noise, but the system is recognising several similar signals across a defined area. Has the electronic support measure in fact detected several tactical communications nets and the radios that are hosting these? ML algorithms and the AI they serve are continually collecting data. As in our above example showing how our own brain learns and teaches us not to cross a busy road of fast traffic, so AI learns from past experiences. Detecting that an enemy X-band radar uses a certain frequency can be used by the ESM to alert us to every time this is detected. Although this is a simplistic example, AI offers the potential to provide highly complex predictions concerning potential future events by observing the radio spectrum.

Beware of panaceas

It may seem from this article that the adoption of AI and ML as part of the SIGINT practitioner's toolbox is some years in the future, but this is not the case. The technologies are being adopted to this end: "AI and ML approaches are already being used in various capacities within the field of SIGINT," said ELT Group's statement, adding "although the extent of their implementation may vary across different agencies and organisations." The biggest uptake may be in the civilian SIGINT gathering domain, where investment is flowing. AI and ML is helping to enhance processing, analysis and data management. Domestic intelligence and law enforcement agencies may have to sift through millions of cellphone records to monitor known or suspected spies, criminals and insurgents. Furthermore, this must be done day in, day out. As such, it makes sense to adopt any technologies which can help ease this burden.

Nonetheless, embracing such technologies must always be balanced with privacy concerns: "There could be a risk that sensitive information may be improperly accessed or used, infringing on individuals' privacy

Credit: US Army

AI and ML techniques may be able to help communications intelligence practitioners make sense of complex battlefield tactical communications networks.

rights," warned ELT Group. Concerns over privacy dovetail with other ethical worries: "(T)ransparency, accountability, and adherence to international laws and conventions governing surveillance activities," are all valid concerns, the statement noted.

As this discussion regarding privacy concerns shows, it may seem that AI and ML offer untold gifts to the SIGINT practitioner, but the adoption of both is not without challenges and potential pitfalls. First and foremost, any AI is only as good as the data the ML algorithms collect and process. Signals of interest in the military domain may be few and far between. After all, the very signals that are being targeted are optimised to be hard to find. As much as AI is tackling the vexing task of SIGINT collection, interpretation and management in a contested and congested spectrum, so these approaches will no doubt be exploited to improve signal discretion.

It is imperative to avoid introducing bias into AI and ML algorithms which could negatively affect how data is interpreted. If for instance you were to only load the computer of an insurance company with details of red cars that are stolen, the algorithms may deduce that blue and yellow cars are safe from criminals. In the SIGINT context "biased algorithms may result in incorrect classifications or interpretations of intercepted communications, leading to erroneous conclusions or actions," according to ELT Group's statement. Bias could be exacerbated because of incomplete data.

Dr. Sue Robertson, an EW expert and director of EW Defence, warns that ELINT data can often be incomplete: "You never collect enough of a signal with an ESM to make a proper characterisation," she warns. "You may be trying to detect and identify one signal in an environment where you have a myriad of signals with overlapping characteristics." If you are collecting ELINT from a busy stretch of water, your ESM maybe capturing millions of individual maritime and naval radar pulses. 99.9% of these may be irrelevant. That still leaves 1,000 pulses that may be relevant and perhaps only a handful of these relate to the vessel which interests you.

As Robertson cautioned, AI software will only ever be as good as the data it is programmed with, and this can create problems if that data is unreliable. These realities raise the question of how AI and ML approaches are to interpret the ELINT they receive if that data is often incomplete. Another concern is fallibility. Humans can learn from their errors if they choose to. Is this the case for the AI and ML algorithms? "Machine learning has to be able to learn from its mistakes," Roberston emphasised.

The adoption of these technologies will not see the human removed from the collection, interpretation and dissemination process intrinsic to all forms of intelligence gathering. The goal of AI and ML is to make the human's life easier, not to replace them. There are ethical questions surrounding the removal of the person from this process, assuming that this is desirable or even possible. As ELT Group's statement noted, "the need for human oversight to ensure the accuracy and reliability of analysis" must remain paramount. Equally important is the need to protect AI and ML enabled systems from cyberattack. "Storing and processing large volumes of sensitive SIGINT data using AI and ML systems could present cybersecurity risks," the company warned, adding, "Data breaches, unauthorised access and insider threats" must all be considered, and noting, "Protecting classified intelligence data from exploitation or compromise is crucial to maintaining national security."

Ignoring or downplaying concerns risks disaster, according to ELT Group: *"Misinterpretation or the misapplication of intelligence derived from AI and ML could potentially escalate conflicts or lead to unintended consequences. Inaccurate assessments of threats or hostile activities may prompt disproportionate responses, exacerbating tensions or triggering military actions."* Wars have started because of the dubious interpretation of dubious intelligence, as with the US-led war in Iraq which began in 2003. The adoption of AI and ML techniques in signals intelligence work should be done to lower such risks, not increase them.

How can these dangers be reduced? A multilayered approach shows promise: "Addressing these risks requires careful consideration of ethical, legal, and technical frameworks governing the use of AI and ML in SIGINT operations," ELT Group emphasises. "Robust oversight mechanisms, transparency in algorithmic decision-making, and adherence to privacy and civil liberties protections are essential to mitigate potential harms and ensure responsible use of these technologies in intelligence activities." Ultimately, as Dr. Robertson observed, "when you boil it all down, AI may be able to do something much faster than a human can work, but not necessarily more accurately." ■

Credit: US DoD

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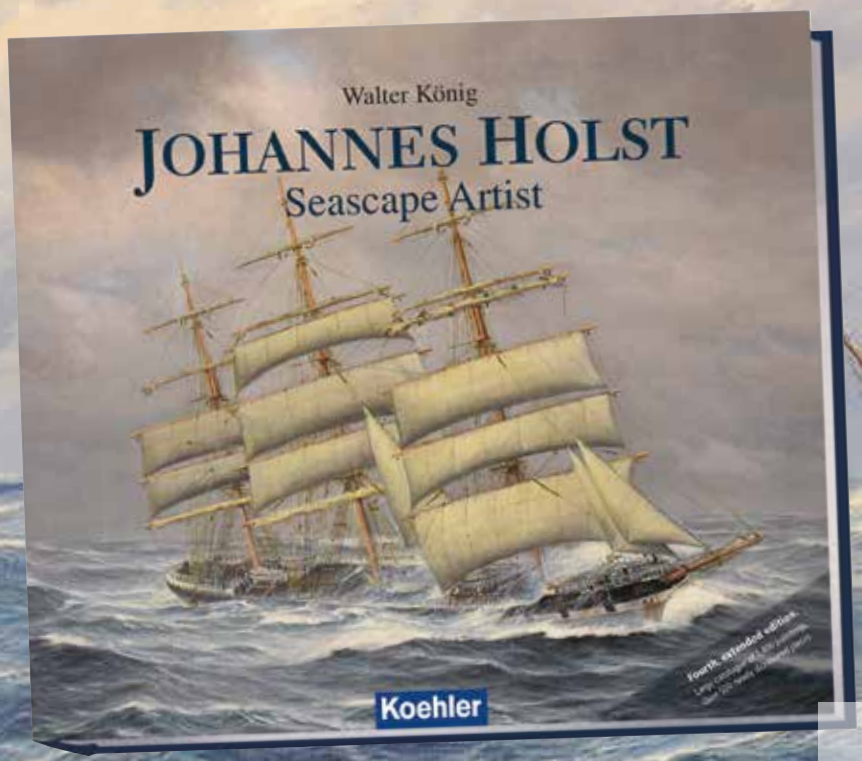

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Increasing coverage: overcoming Arctic challenges

Tim Fish

The sheer size, geography and conditions of the Arctic region present a significant challenge for surveillance and communications. Providing enough coverage of such a vast area is extremely difficult with the ability of forces to respond to events using airborne, seaborne or land platforms considerably constrained. Current communications and satellite coverage of the Arctic is also limited, making it harder to reliably move and integrate data safely and cheaply.

Due to its remoteness and the difficulty in conducting intelligence, surveillance and reconnaissance (ISR) operations in the Arctic, a number of illegal activities occur there regularly. This includes illegal fishing, drug trafficking, and arms shipments that often become 'dark' targets (vessels with their automatic identification system (AIS) transponder switched off) that need detecting. Legal operations include search and rescue (SAR) services, the work of environmental and scientific research institutions, maritime shipping of all kinds, and iceberg tracking systems. These activities, which are all increasing in number, make the need for a common operating picture even more acute.

The main shortfall in ISR is twofold: first, a lack of persistent coverage, and second, that the provided image resolutions are insufficient for activity monitoring. Most monitoring from space is performed by geostationary Earth orbit (GEO) satellites, which are situated above the equator, though the curvature of the Earth means they are unable to cover the higher altitudes near the poles from about 75° onwards. Meanwhile, non-geostationary Earth orbit (NGEO) satellites that traverse over the Arctic in a highly elliptical orbit (HEO) can provide coverage over many thousands of square kilometres, but only at resolutions of around 100 m.

Author

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Credit: Northrop Grumman

The ASBM-1 satellite enters thermal vacuum environmental testing at Northrop Grumman's satellite manufacturing facility in Dulles, Virginia.

Although there are a growing number of organisations and agencies with assets and capabilities in the Arctic, they are not sufficiently interconnected, and therefore providing a single more complete joint operating picture of activities in the region has so far not been achieved. The small population of the Arctic and its ice-blocked terrain means there little demand for large-scale communications and surveillance services. However, greater interest in the region due to its natural resources, climate change, the opening of new maritime trade routes, and strategic considerations mean there is now a growing demand for more communications capacity.

Growing satellite capability

Due to concerns about the lack of satellite coverage and limits of surveillance and communications, a number of efforts are underway to introduce new solutions. The US Air Force (USAF) released its Arctic Strategy in 2020 and devoted USD 50 million towards testing low Earth orbit (LEO) satellites around the polar region.

The Arctic Satellite Broadband Mission (ABSM) is a joint venture between Inmarsat, the Norwegian Ministry of Defence (MoD) and the US Space Force (USSF). Under ABSM, Northrop Grumman has built two NGSO satellites with combined military and commercial payloads. The company announced on 7 November 2023 that with thermal vacuum testing on ASBM-1, the first of the two space vehicles was completed. ASBM-2 will complete the same process early in 2024 with a prospective launch date later in the year.

These systems will operate in HEO over the Arctic, providing X-band satellite communication (SATCOM) connectivity for the Norwegian Government, with Viasat's Ka-band

Credit: Nanoavionics

The Huygens and Birkeland satellites, each measuring approximately 30x20x10 cm, are named after Norwegian physicist Kristian Olaf Birkeland and Dutch astronomer Christiaan Huygens.

SATCOM payload to be used by Inmarsat, and the Enhanced Polar System-Recapitalisation (EPS-R) extremely high frequency (EHF) payload by the USSF. The latter will extend EPS capability into the 2030s. Considering that the US Navy is starting a buildup in the Arctic and High North, and expanding its Joint Pacific Alaskan Range Complex (JPARC) training area, more communications and surveillance capacity will be needed to support a higher operational tempo.

The US Coast Guard (USCG) is also due to procure new Polar Security Cutters (PSCs) as part of its plan to increase the number of icebreaking-capable ships The USCG also launched its own Arctic Strategic Outlook Implementation Plan in October 2023, which includes projects to introduce modified MH-60 helicopters suitable for Arctic operations and set down requirements for a new pole-to-pole SATCOM system with GEO and NGEO satellites to support communications, as well as a terrestrial communications system.

In Europe, a partnership between the Swedish and Danish defence procurement authorities signed in July 2023 will see the joint development of a new satellite called Bifrost, which will be used to support the Danish Joint Arctic Command. Denmark is also planning to install new radar on the Faroe Islands as part of an Arctic Capability Package to improve air defence, with a contract for the radar expected in 2024.

In January 2023, two Dutch–Norwegian military nanosatellites named Huygens and Birkeland were launched into polar LEO orbit on a SpaceX Falcon 9 rocket. The pair will provide testing data and detection of radar signals for both countries. Researchers at the Norwegian FFI, Dutch TNO and Royal NLR developed the nanosatellites, together with NanoAvionics under the bilateral MilSpace 2 cooperation project.

Meanwhile, Russia and China are set to develop their own HEO satellite capability following a meeting in November between President Putin and General Zhang Youxia, the Vice Chair of China's Central Military Commission. China is expected to leverage past Russian experience and there could be cooperation on Russia's Arktika HEO project with a constellation of up to 10 satellites expected, nine of which will be focussed on the Arctic. The first pair were launched in 2021 and 2023, but China could join the development of the four Ekspress-RV satellites as these are for military use. The first of the Ekspress-RV series is scheduled to be launched in October 2025, and all four are planned to be deployed during 2026.

Meanwhile in August 2023, a joint Sino-Russian surface action group completed a transit of the Aleutian Islands near Alaska which included 10 ships. In February 2023, Russia changed its Arctic policy to remove cooperation with other members of the Arctic Council, which had suspended Russia following their invasion of Ukraine in February 2022.

Elsewhere, private operators including OneWeb and Starlink want to meet the demand for ISR and communications services by sending more LEO satellites to conduct orbits of the polar region, while SES is establishing a medium Earth orbit satellite network called O3b mPower to cover the Arctic.

Adding uncrewed assets

However, satellites alone will not provide the kind of detailed surveillance needed about events or operations taking place in a specific area. Additional assets in the air, surface and under the water are required alongside satellites to offer a more comprehensive and joined-up ISR picture.

A new Integrated Remote Sensing for the Arctic (IRSA) service is being developed as a way of filling this capability gap. The IRSA Development Group (IDG) consortium building IRSA capabilities includes Andøya Space Center, Boeing, C-CORE, Karl Osen, MDSI, Scott Polar Research Institute, Viasat, and VTT. Together, these companies and institutions are jointly funding the development of a system that integrates specially-configured and optimised commercial platforms in the sea-air-space domains for the Arctic, providing layered coverage to defence and commercial customers.

Paul Curlett, senior business development lead for Boeing Phantom Works, one of the leaders of the IDG Consortium told ESD that the IRSA was the most cost-effective way of providing surveillance of the Arctic. The IRSA is made up of long-endurance ISR platforms (both crewed and uncrewed aircraft) supported by access to several communications networks.

Credit: Andøya Space

IRSA uses land-based sensors, UAVs and space-based assets to build a more comprehensive picture of the Arctic environment by integrating data from a wider variety of sources.

"The explosive growth of remote sensing satellites, and their more tactical capabilities, allow for larger areas to survey for anomalies and then cueing high resolution satellites for detailed looks at the activity," Curlett explained. "This can only be done with the integration of space agency wide-area satellites that provide freely available data with advanced commercial systems that can distinguish threats on almost an hourly basis when done properly," he added.

The IDG can integrate these growing constellations of publicly available data and commercial satellite missions to support a range of surveillance objectives. In this way, it can respond to urgent requirements as well as provide the stability to address long-term ISR needs. Curlett explained, *"this involves tactical tasking of satellites, various ground stations for downlinking acquired data, rapid analytics to condense massive data sets into specific alerts, and dissemination through common operating picture systems… that are readily integrated into clients' own situational awareness systems".*

The IRSA project started in February 2019 with the signing of a memorandum of understanding (MoU) between the members of the IDG Consortium, initiating an early study period. This defined the required capabilities and the gaps in existing satellite and communications coverage. The IRSA was created with a full understanding of the defence and security requirements of the Arctic countries in particular, however there has been no government funding for IRSA development.

Providing IRSA

A distributed mission network architecture has been designed with mission centres located at the C-CORE facilities in St John's, Newfoundland in Canada, the Andøya Space Center in Norway and at Boeing. C-CORE manages satellite surveillance whilst the Andøya Space Center handles command and control (C2). Boeing Phantom Works is responsible for the creation of the joint operational picture through its Common Open Mission Management Command and Control – Global Edition (COMC2-GE) product.

The IDG also has its own deployable Mission Centre capable of exercising C2 of satellite detection, as well as ISR missions with crewed and uncrewed aerial vehicles (UAVs), in addition to surface and sub-surface assets. This is an extension of the capabilities provided by the Andøya Space Center. The IRSA's medium-altitude long-endurance (MALE) UAV and small UAV (SUAV) capability is provided by the Integrator and ScanEagle, both supplied by Boeing's Insitu. Meanwhile, the Centaur system from Aurora Flight Sciences provides the MALE optionally piloted vehicle (OPV) capability.

Credit: Boeing

The Integrator UAV deployed during the Arctic X22 exercise. UAVs will be an important component in surveillance of the region, able to conduct more persistent low-level observation of targets.

Boeing Commercial Satellite Services and the satellite constellations of Boeing's commercial partners are used to support the IRSA network across the land, sea and air domains, with two satellite systems providing coverage of the Arctic region. IRSA also uses OneWeb and Starlink, which are both LEO constellations operating in the Ku-band.

Other satellite missions are utilised that provide freely available data and different access protocols, while others are entirely commercial with their own operating concepts. For the future, there are other satellite systems in the development or planning stages that will offer additional coverage of the Arctic.

With an increasing number of platforms and volume surveillance data gathered, Boeing can use COMC2-GE to create a joint operational picture. "COMC2-GE has the capability to fuse data from many different data sources and satellite feeds and visually display prioritised information to decision-makers in a command centre," Boeing Phantom Works' Curlett said. "IDG has the technical capability to integrate sensor data from maritime and air surveillance radars if a customer had such a requirement and funding was available," he added.

X-trials demonstrations

Over the past three years, the IDG has been developing the IRSA network. These satellite and aircraft systems have been tested most recently during the Arctic X21 and Arctic X22 exercises.

During Arctic X21, an IRSA 'Lite' capability was demonstrated for very remote or hostile maritime scenarios and helped develop standard operating procedures. This was followed by a full demonstration in Denmark that included use of all its space, aircraft and UAV assets, during which the IRSA detected dark targets, enabled detection and response of illegal maritime activities, and search and rescue operational planning.

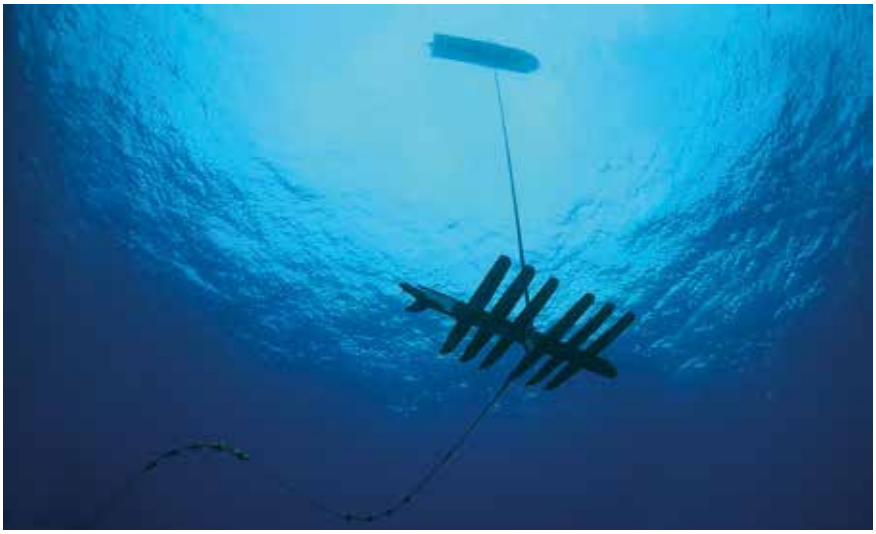
Arctic X22 was held in Norway and Denmark and was focussed on using UAV sensors and long-endurance platforms with a distributed mission management centre used to coordinate assets and data from five different organisations. More than 60 satellites from 11 different constellations were employed at various stages with C-CORE conducting the integration of the space-based information.

The integration of this satellite information with data from the crewed ISR and UAV platforms was a joint effort by the IDG partners and completed through the mission control centre: Andøya supported the crewed ISR assets, Insitu managed the UAVs and MDSI was responsible for scenario planning assets and national coordination.

In both the X21 and X22 exercises, the IRSA also detected a non-reporting warship operating close to Danish waters and was able to report it to the authorities. Curlett said the demonstrations led to contracting opportunities "that are still ongoing".

Going below

Future plans for Arctic X24 "include expansion of available assets into sea surface and sub-surface UUVs [uncrewed underwater vehicles] platforms (Wave



Credit: Boeing

View of the Wave glider USV from below. Expanding underwater surveillance is vital for the protection of key underwater critical infrastructure. Expanding into this domain will be the next step for IRSA development.

Glider and XLUUV), based on availability, to demonstrate IRSA applicability to monitor critical asset infrastructure", according to Curlett, and build on the remote sensing capabilities and SAR scenarios.

For sub-surface surveillance, the IDG plans to use the Wave Glider uncrewed surface vehicle (USV) from Liquid Robotics (a Boeing subsidiary) and Boeing's extra large uncrewed undersea vehicle (XLUUV; known as 'Orca' in US Navy service) that will be tested during Arctic X24. This exercise will take place from 17-20 June at Andøya Space Center and C-CORE at St John's in Canada, and will focus on the protection of sub-sea critical infrastructure. *"The planned demonstrations will provide a framework for the combined IDG capabilities to monitor sub-sea critical infrastructure to customers and for further development of IDG capability to provide broadband communication, surface and sub-surface situational awareness, as well as iceberg detection and oil spill detection using satellites, autonomous systems and remotely controlled unmanned systems beyond line of sight,"* Curlett said.

In January 2023, both NATO and the EU agreed to create a taskforce to examine resilience and critical infrastructure protection. In 2023, the IDG conducted a virtual event with stakeholders from government and industry to look at the requirements for the protection of critical infrastructure that will help shape the live exercise in 2024.

Meanwhile, plans to introduce new high-altitude long-endurance (HALE) UAVs into the mix have been cancelled. Early studies conducted by IDG on Arctic SATCOM coverage found there was potential for HALE UAVs to provide a communications node north of 70° North, where a redundant communications infrastructure was absent. However, it is expected that Starlink and OneWeb, deployments over the Arctic will cover this latitude instead.

"The IRSA capability has been operationally demonstrated and is ready to be matured further based on customer requirements and is technically ready to perform today," Curlett said, "The IDG stands ready to enter service agreements with satellite providers and stand up the organisation and the infrastructure this will require funding from future clients."

Elsewhere, in 2023 the USN already started deploying prototype parts of the Arctic Mobile Observing System (AMOS) under an Office of Naval Research (ONR) programme. AMOS includes specially-designed buoys for Arctic conditions and UUVs that operate under the ice. The ONR stated that AMOS will enable 2-way communications (vehicle-to-vehicle, vehicle-to-node and node-to-shore), under-ice mobile vehicle navigation, and extended-duration autonomy, with endurance for 12 months and a sensing footprint goal of 100 km from the central node.

Conclusion

With new Arctic policies being introduced by the major powers and several simultaneous efforts underway to expand communications and surveillance capabilities, the polar region could start to get busy in the coming years.

The expansion of satellite capabilities will go a long way to improving ISR coverage, but further work will be needed to establish a high-bandwidth service that can support the expected increase in demand from military and commercial customers. As the Arctic becomes more contested, the need to gather and absorb all the new data, process and exploit it will become paramount. The lack of existing infrastructure and forces stationed permanently on the ice means that advanced planning, the ability to react quickly to ISR information and communicate with deployed forces will be essential. ■

Credit: Terma

The Bifrost satellite project completed its Critical Design Review in November 2023. Funded by the Danish DALO and Swedish FMV, it will demonstrate the feasibility of an AI-based surveillance satellite and is slated for launch using SpaceX Falcon 9 rocket in 2025.

Breaking and Entering

Thomas Withington

Legacy tactical communications waveforms are still proving their worth in the face of aggressive electronic warfare while new threats lurk on the horizon.

"Anything under 100 hops-per-second gets jammed to shit," was the observation of one tactical communications expert at a conference recently attended by this correspondent. Under discussion was the vulnerability of land forces tactical radios to communications jamming (COMJAM) systems. There are no prizes for guessing where such vulnerabilities have been observed. After all, Europe is currently hosting only one large conventional war. Securing radio communications has long been a military preoccupation ever since they started being used in anger during the First World War. Frequency-hopping is one tried and tested technique aimed at reducing the opportunities for red forces to jam radio traffic.

Frequency-Hopping Spread Spectrum (FHSS) techniques, as they are properly known, use an elegantly simple principle. Imagine two radios, A and B, communicating with one another on a frequency of 560 MHz. Let us suppose that these two radios never change the frequency that they are using from 560 MHz. If the bad guys are in range of A and B's transmissions and they tuned their radio to 560 MHz they would hear the traffic. The bad guys would then have two choices: They could just listen to the traffic and exploit what they were hearing as communications intelligence (COMINT). Of course, radios A and B might not be carrying voice traffic, but instead zeros and ones of data. The red force eavesdroppers could still try to decode and exploit this data. Alternatively, the red force could tune a jammer to a frequency of 560 MHz and transmit electronic interference which will be picked up by the receiving radio, drowning out the communications traffic.

Suppose the frequencies used by radios A and B kept changing and did so hundreds, if not thousands, of times per second within a specific frequency bandwidth. Rather than using a fixed frequency of 560 MHz, our two radios are now spreading their transmissions across a 100 kilohertz band. This means radios A and B have a bandwidth of 560.0 MHz to 560.1 MHz within which they can keep moving their transmission. Clever processing in the radios keeps changing the frequencies of the traffic, spreading it across the waveband. The changes occur thousands of times per second. At one moment, the traffic is using a frequency of 560.083 MHz, the next a frequency of 560.012 MHz. To the casual observer, there is no way of knowing the next frequency that will be used. Only radios A and B can determine this as they are both loaded with software that stipulates the frequency hopping scheme. The software also instructs the radios how to assemble the traffic, all arriving on different frequencies, into coherent voice or data.

Credit: L3Harris

Picture shows an RF-7850 Falcon III family radio from L3Harris. Ukraine has been using the RF-7850M-HH variant in this family, and Ukrainian users have noted its good frequency hopping capabilities and resistance to electronic countermeasures. However, Russia's electronic warfare practitioners are continuing to evolve their approaches.

Hopping mad

The benefits of FHSS are that, taken on their own, each change in frequency resembles nothing more than a tiny speck of radio frequency (RF) energy that appears for a fleeting moment in the spectrum. This is scarcely enough to exploit for COMINT or COMJAM. Even if red forces were to jam a specific frequency, in a microsecond, the transmission will have moved to another frequency entirely and the jamming will be ineffective. Forget eavesdropping – unless you have the software keys detailing how to reassemble the traffic, all this will be is electromagnetic gibberish. For all intents and purposes, FHSS is the electromagnetic equivalent of the Wack-a-Mole arcade game. You can hit the rubber mole with your mallet when it appears for a split second, but you cannot anticipate where the mole will emerge next.

As the interjection from the conference delegate illustrates, some forms of FHSS technologies are becoming increasingly vulnerable to COMJAM. This vulnerability is helped in no small measure by advances in computing. Contemporary electronic warfare (EW) systems, particularly electronic support measures (ESMs) which continuously watch and analyse behaviour in parts of the radio spectrum, can recognise patterns. FHSS is pseudorandom. What this means in practice is that to the casual observer the profusion of tiny spots of RF energy spread over myriad of frequencies appears to be entirely random. However, it is not, as the hopping is the result of com-

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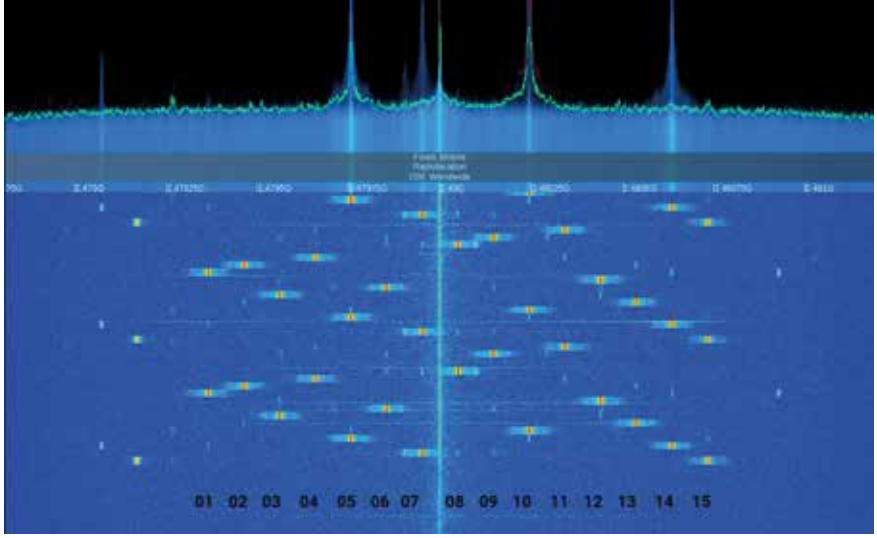
plex mathematical calculations made by the FHSS software. Today's ESMs can be programmed to watch specific wavebands and to recognise what may be happening. Frequencies of 30 MHz to 6 GHz are routinely used for military Very/Ultra High Frequency (V/UHF) communications.

Let us return to our example above involving radios A and B using FHSS techniques spread across a 560.0 MHz to 560.1 MHz waveband. Suppose there is no traffic in a 10 kHz band on either side of these frequencies. The ESM may flag this as strange and determine that the hop pattern, although moving across random frequencies, performs regular changes at similar times per second. Through pattern recognition, the ESM may determine that this 560.0MHz to 560.1MHz channel is being used for FHSS traffic. Determining the hop pattern does not necessarily help COMINT cadres hack into the traffic to exploit it. The same problem regarding the FHSS software keys remains. Nonetheless, it could help their COMJAM comrades to jam the transmissions. Unleashing a powerful jamming signal covering a 560.0 MHz to 560.1 MHz waveband could effectively wipe out the channel and the link between the radios.



Credit: WITest

This screen shot depicting a slice of the radio spectrum shows how frequency hopping is performed. Each of the oblong shapes shown beneath the frequency scale in the middle of the picture represents a single hop of a transmission.

The vulnerability of FHSS radio communications to evolving ESM technology is a cause for concern. American and allied land forces are avid users of the Single Channel Ground and Airborne Radio System (SINCGARS). SINCGARS debuted with the US Army during Operation Desert Storm in 1991, where it aided ground tactical communications during the US-led liberation of Kuwait from Iraqi control. The SINCGARS radio waveform can perform frequency-hopping communications at rates of at least 100 hops-per-second. Hop rates such as these could render the radio vulnerable to COMINT ESMs which may be able to recognise SINCGARS FHSS traffic.

SINCGARS radios have been supplied to the Ukrainian military by the US since 2014, the same year Russia performed her first invasion of Ukraine's Donbas and Crimea. The waveform has acquitted itself well in the face of determined jamming by Russian land force

Credit: US Army

Despite having a design dating back to the 1980s, the SINCGARS tactical radio system remains in widespread NATO use and has performed well in Ukraine despite being targeted by Russian electronic warfare. SINCGARS is expected to remain in routine service until the end of this decade.

tactical EW systems. The US Army launched a SINCGARS waveform modernisation in 2017: "There is still life in the waveform yet," said Brian Wenink, director of L3Harris's ground high assurance radio portfolio, and Robert Mariuz, the company's senior product manager for software applications and waveforms, adding, "The US Army is continuing to evolve SINCGARS hardware and software in its combat net radios. SINCGARS is an affordable and widely fielded solution." The upgrade improved the waveform's communications security (COMSEC) and transmission security (TRANSEC). Whether the upgrade also improved the waveforms' FHSS performance is unknown.

SINCGARS has stood the test of time, but thoughts are turning to its eventual replacement which at the NATO level comprises the SATURN waveform. As with SINCGARS, SATURN is a somewhat unwieldy acronym, translating as Second-Generation Anti-Jam Tactical Ultra High Frequency Radio for NATO. The waveform is transmittable across frequencies of 225 MHz to 400 MHz. Details remain classified on SATURN's hop rate, although this is likely to be significantly improved compared to SINCGARS. SATURN is currently being introduced across NATO. Both SATURN and SINCGARS will run concurrently for some time to ensure interoperability. NATO also uses a legacy waveform for ground-to-air/air-to-ground communications known as Havequick-I/II, which uses frequencies of 225 MHz to 400 MHz. Unusually Havequick does not seem to be an acronym, and this waveform is older than SINCGARS, having been introduced initially with the US military in 1980. Open sources note that Havequick-I/II has a hop rate exceeding 100 hops-per-second.

"SINCGARS and Havequick-I/II are legacy, frequency-hopping waveforms," says Silver Andre, chief executive officer of CR14, and a former Estonian Army signals expert. "Despite their age, they remain in widespread use due to their proven reliability, simplicity of operation and compatibility." For Andre, the FHSS characteristics of these waveforms "still offer a degree of security against interception and jamming ... However, their life expectancy is diminishing as potential adversaries develop more sophisticated electronic warfare capabilities." These EW capabilities include the "faster and more powerful signal processing tools," described above "that can exploit vulnerabilities in these older systems."

Credit: Thales

NATO's SATURN tactical communications waveform is destined to replace both SINCGARS and Havequick-I/II over the coming five-to-ten years. Although a narrowband waveform like its predecessors, it offers a step change in capability and security.

Threats

Alongside the advancing electronic warfare capabilities discussed above, the ability of adversaries to counter COMSEC/TRANSEC capabilities like FHSS through cyberattack is a threat. Frequency-hopping techniques are essentially software-based, which potentially makes them vulnerable to hostile cyber-exploitation. Andre warned that cyber techniques can "exploit vulnerabilities in the software and hardware used for encrypted communications." If hackers succeeded in obtaining the software governing the frequency hopping schemes used on a tactical communications network this could potentially compromise security.

Quantum computing, Andre highlights, could also become a potential threat. There is insufficient space in this article to dive into the technical aspects of how quantum computers can attack COMSEC/TRANSEC protocols. The key fact to remember is the breakneck speed at which quantum computers could tackle the mathematics of encryption. Even the calculation speeds of today's conventional computers pale in comparison to such technology. "Though still in development, quantum computing presents a theoretical threat to traditional encryption methods, potentially rendering them obsolete," Andre warned. These concerns were shared by Mariuz and Wenink, who noted: "Quantum computing is approaching the point where the scale could cause a concern." The US National Institute of Standards and Technology, which promotes US scientific and industrial innovation has published draft algorithm standards pertaining to the quantum computing threat to encryption. "There is a lot of work going on under the hood to make sure that we are preparing and are ready for the challenge quantum computing may pose," they added.

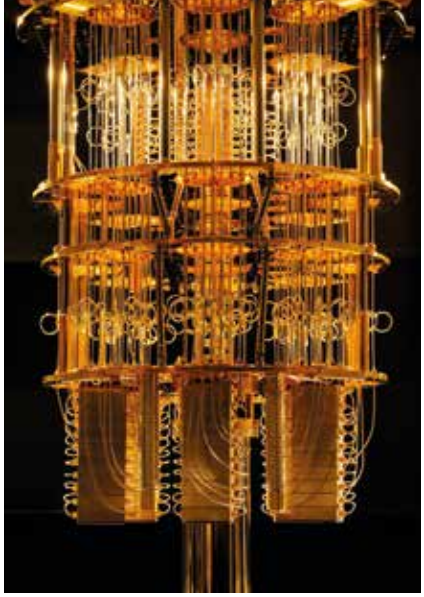
Mitigation

This is not to say that advances such as quantum computing, alongside artificial intelligence (AI)-enabled EW and cyberwarfare will render current COMSEC/TRANSEC approaches null and void. Measures can be taken to mitigate, if not eliminate, these threats. Nonetheless, it is important to note that there is no one 'silver bullet' that can address all dangers. As is often the case, a layered ap-

proach is the answer. "Adaptability is key," said Andre. "The dynamic nature of electronic warfare necessitates adaptable and flexible communications systems." EW is never static, and neither should the response to it be: "Adversaries will employ a combination of conventional and cyber tactics, requiring a holistic security approach." L3Harris started "taking a holistic look at communications and transmission security over the past few years," note Mariuz and Wenink, explaining, *"We focus on information assurance. An important thing to mention is there can be vulnerabilities we talk about that are not always in the encryption. A lot of what we look at is whether a radio has been initialised properly. How is the encryption key material loaded into the radio? How is data stored?"*

As much as quantum computing presents a threat, so Quantum Key Distribution (QKD) offers a potential solution for safeguarding COMSEC and TRANSEC. Once again, the particulars of how QKD works would require an article it its own right. Broadly speaking, the QKD approach involves using qubits. Whereas as a bit, the basic unit of data, has a binary state as a zero or a one, a qubit can be both. Photons are usually employed to generate qubits. A useful aspect of employing qubits is that any attempt to observe or interfere with traffic protected in this way becomes immediately obvious, since it results in the collapse of their fragile quantum state to become either a zero or one. Nonetheless, Andre urges caution regarding the adoption of quantum approaches for COMSEC/TRANSEC not least because these technologies are in their infancy: "Quantum communications require new infrastructure, which is not yet widely available." Meanwhile, "integrating quantum encryption with existing systems poses significant challenges." In summary Andre noted, *"quantum encryption for battlefield traffic is still years away from routine deployment. Research and development is progressing but practical widespread use in tactical military communications is likely a decade or more in the future, contingent upon overcoming current technological and logistical hurdles."*

There is another potential restraint on the adoption of such sophisticated approaches to help safeguard tactical communications traffic which is more prosaic: "The transition to more advanced waveforms and encryption methods is ongoing, but the pace is dependent on budgetary constraints, the need for interoperability and the lifecycle of existing communication systems" said Andre. While they are approaching their retirement, it is still too early to write off SINCGARS and Havequick-I/II: "We expect to see heavy use of SINCGARS in the future," said Mariuz and Wenink. Andre agreed, adding: "It's reasonable to expect these legacy waveforms to remain in service for another decade or so ... while gradually being supplanted by more secure technologies." ■



Credit: IBM

Quantum computing holds promise as an important technology that could help both improve tactical communications COMSEC/TRANSEC and help to decrypt communications. However this technology is still in its infancy.

Special operations forces armament requirements

Sidney E. Dean

Special operations forces (SOF) operate in the most challenging environments, and require weapons that will provide a tactical advantage while functioning under extreme conditions.

Special operations forces mostly use the same categories of weapons as conventional forces. However, their special mission requirements require the adjustment and customisation of weapons adopted for the SOF arsenal. Reasons include the need to operate in austere conditions, without direct or indirect support or resupply, for prolonged periods. SOF, must deploy with everything they might need on the mission; conversely, their need for mobility limits how much can be carried. SOF equipment must be as lightweight and compact as possible, and simultaneously be capable of the highest performance in each weapon category. The mission spectrum, ranging from deep reconnaissance to hostage rescue, to direct action strikes, all require a broad array of weapons. Sometimes SOF pioneer the introduction of new weapons which are subsequently adopted by conventional branches of the armed forces.

Credit: German MoD

Members of the German KSK display the HK416 A7 assault rifle with 368 mm barrel, dubbed G95K in KSK service.

Small arms

When considering small arms, SOF look for attributes such as compact size, easy field maintenance, robustness, high performance and reliability. The ability to function after immersion in salt water is especially critical for SOF operating at sea. While special mission forces around the globe utilise a wide variety of firearms, a few manufacturers have found special favour. This includes Heckler & Koch (HK), which supplies small arms to many SOF commands.

Assault rifles

The HK416 was developed specifically to meet the close-quarters combat (CQC) requirements of the US Army's Delta Force, with which it entered service in 2005. Subsequently, the assault rifle was adopted by other US special operations units, replacing the widely used M4A1 carbine, and SOF in 20 other nations have also adopted the HK416. Several attributes make the weapon particularly appealing. While based on the Colt M4, it incorporates the short-stroke gas piston system originally developed to cycle rounds on Heckler & Koch's G36 assault rifle. That system reduces fouling in the chamber, and has proven considerably more reliable than the M4's closed rotating bolt system.

Various customisation options can adapt the weapon to specific mission requirements. These include a modification kit to optimise the weapon for wet environments, including covert approach through water, with drainage holes in the bolt carrier and buffer system facilitating the drying of the weapon after submersion. Additionally, several variants have been developed to maximise flexibility and further improve performance and robustness. The HK416 A5 is available in four different barrel lengths, from the full-sized 508 mm suitable for long-range firefights, to the sub-compact 279 mm barrel optimised for CQC.

In October 2017, the German Kommando Spezialkräfte (KSK; ENG: Special Forces Command) chose the HK416 A7 variant as its new assault rifle; the weapon was also selected for the German Naval SOF Command. The German commandos noted numerous improvements over the G36 assault rifle. The 37 cm barrel makes the weapon somewhat shorter than the standard G36 and slightly longer than the compact G36K; the new weapon is equally suited for CQC and for engagements out to 300 m, and displays a high level of accuracy even after prolonged firefights. The fire selector sets at 45° for semi-automatic fire and at 90° for full auto mode, facilitating quick selection under fire. KSK firearms instructors especially praise the location of the backup sight, which is not at the 12 o'clock position but to the side of the barrel at a 45° angle. This solution prevents the backup sight being blocked by a damaged or obstructed main optical sight; it is immediately available without needing to remove the damaged primary sight first.

Submachine guns

Close-quarters combat scenarios such as house-clearing or hostage rescue are optimally conducted with submachine guns (SMG), rather than compact assault rifles.

Credit: Heckler & Koch

A US Navy SEAL surfaces with an MP5.

In addition to being even more wieldy, SMGs are usually chambered for pistol calibre ammunition (9 mm, .40 S&W, .45 ACP) rather than 5.56 × 45 mm NATO rounds. While these munitions have high stopping power, they are less likely to penetrate walls or otherwise risk injuring bystanders or hostages. Some SMGs have specialised small-calibre ammunition which permits greater magazine capacity without sacrificing performance.

Here again, HK's SMGs are among the most frequently used by SOF. After decades of use, the MP5 and MP7 remain in service with many units across the globe. The 9 × 19 mm MP5 was introduced in 1966. It combined compact form, ease of handling, high stopping power and configuration for a sound suppressor, making it ideal for covert operations and anti-terrorism missions. Numerous variants followed, optimising the weapon for niche applications. These variants range from the 79 cm long MP5SD5 to the ultra-compact MP5K (with a total length of 32.5 cm) suitable for concealed carry under coats or jackets. The MP5SD series features an integrated sound suppressor which is significantly more effective than removable suppressors, maximising operational stealth.

The MP7 was introduced in the late-1990s. The 1.9 kg weapon is between 41 and 68 cm long and can be carried in a leg holster. The compact weapon has very little recoil even when fired in fully automatic mode. The 4.6 × 30 mm calibre ammunition has the approximate stopping power (but not the range) of 5.56 × 45 mm rounds, and is capable of penetrating CRISAT (NATO standard) body armour at 200 m. It is in use with US Navy SEALS, Delta Force, and numerous police special mission units globally.

Handguns

While the military normally considers handguns as backup weapons, those carried by SOF must also meet the highest reliability and performance standards. For certain close-range covert missions where stealth is at a premium, pistols can even be the weapon of choice given their potential for concealed carry in public and (when suppressed) lower acoustic signature. The Glock 19 has emerged as one of the more popular pistols for SOF globally, with most US SOF units adopting the weapon within the past 10 years. It fires the proven 9 × 19 mm round and accommodates various double-stack magazines with a 15 to 33 round capacity. With a total length of 17.4 cm and an unloaded weight of 600 g, the smaller brother of the 'standard-sized' Glock 17 is well suited for concealed carry. The polymer construction withstands saltwater better than metal-framed competitors; it also functions and cycles well under water. Possible attachments include a variety of optics including red dot and green dot sights, an under-barrel light, and a sound suppressor.

Credit: USMC

The Glock M19 lends itself to concealed carry.

In addition to (often modified) variants of standard handguns, SOF sometimes require highly specialised – even 'exotic' – weapon solutions. The electrically-fired P11 underwater pistol is a case in point. Developed by HK in the 1970s for the German Kampfschwimmer naval commandos, it is still in use there as well as with the SEALs and various other NATO special operations units. The 20 cm long weapon has five barrels, each of which is loaded with one projectile. Pulling the trigger closes a circuit, activating an electric pulse which initiates firing of a projectile; two 12 volt batteries in the handle provide the electrical energy for initiation of the propellant. Underwater, the weapon fires the DM101 sub-calibre 100 mm length dart, achieving a 15 m effective range. Above water, the weapon fires DM91 7.62 × 36 mm pistol ammunition with an effective range of around 30 m. The barrel is sealed by the projectile sabot during firing. Underwater this prevents formation of bubbles which would give away the shooter's position, and acts as a de facto sound suppressor above and below water. The five barrels are mounted as a single detachable barrel 'cluster' which can be quickly exchanged after firing.

Sniper rifles

Sniper rifles remain integral to the special operations mission. Given their unique operational requirements, SOF units will frequently favour different rifles than those used by scouts and sharpshooters of regular military branches.

In 2009, the US Special Operations Command (SOCOM) tendered the Precision Sniper Rifle (PSR) programme with the aim of replacing all bolt-action sniper rifles used within the US SOF community with a single model. SOCOM ultimately selected the Remington Modular Sniper Rifle (MSR) in 2013, but was forced to re-compete the contract. The new award went to the Barrett Multi-Role Adaptive Design (MRAD) in 2019. In service with SOCOM since 2021, the MRAD is designated the MK22 Advanced Sniper Rifle. "Modular" reflects the

Credit: US Army

The Barrett MRAD sniper rifle entered SOCOM service as the MK22 ASR.

fact that the rifle comes with three interchangeable barrels enabling the weapon to fire either 7.62 × 51 mm NATO, .300 Norma Magnum (7.62 × 85 mm) and .338 Norma Magnum (8.6 × 93.5 mm) rounds fed from a 10-round box magazine. A lever located behind the pistol grip facilitates removal of the barrel, bolt and magazine for easy switching of calibres in the field. The mission defines which barrel and calibre are chosen, with .300 favoured for long-range anti-personnel and .338 for anti-materiel/armour plating effects. The lower cost 7.62 mm munition is chosen for shorter-range engagements and for target practice. Depending on the installed barrel, the MRAD weighs between 6.3 and 6.9 kg (without the optional Barrett AML 338 suppressor) and measures 108 to 125.5 cm. The effective range is given as 1,500 m for the Magnum rounds and 1,000 m for the 7.62 × 51. A choice of Nightforce Precision Variable Power Scopes rated at 5-25 × 56 mm or 7-35 × 56 mm is available.

At the extreme end of the sniper rifle lineup are anti-materiel rifles firing large-calibre bullets at high velocity, capable of defeating lightly-armoured targets and high-value military equipment. Their long range and destructive power enable SOF to destroy such targets as stationary aircraft, missile launchers, radar and communications nodes or fuel stores behind enemy lines, producing asymmetric effects with a minimal amount of ordnance.

Ukrainian commandos have been using the Snipex T-Rex and Snipex Alligator to good effect against Russian forces. Both rifles were developed by the firm XADO-Holding Inc headquartered in Kyiv and are chambered for 14.5 × 114 mm rounds. Both have a muzzle velocity of 980 m/s and an effective range of 2,000 m, and can penetrate 10 mm of steel plate at 1,500 m. The T-Rex, introduced in 2017, is a single-shot manually operated bolt action weapon. The rifle weighs 25 kg and is 1.8 m long. The Alligator, introduced in 2020, is a bolt-action manually operated firearm with a 5-round box magazine; an optional suppressor can be attached in the field. The weapon weighs 25 kg and has an overall length of 2 m including the 1.2 m-long barrel. A topside handle permits balanced carriage in the field. The barrel and muzzle device can be detached, permitting the entire weapon to be transported in an approximately 120 cm length rectangular case.

Crew-served weapons

Heavier weapons provide mobile forces with high firepower for fast-paced assaults or to cover a withdrawal. As in other categories, SOF's emphasis on mobility and autonomy dictate acquiring weapons which are lighter but equally (or more) effective than those used by standard formations. In this vein, the US Special Operations Command (SOCOM) operates the Mk47 Striker automatic grenade weapon rather than the twice as heavy Mk19 used by conventional formations. The belt-fed Mk47 was developed

Credit: Rheinmetall

The 60 mm RSG60 mortar in the 'Commando configuration'.

Credit: USAF

Demonstrating the Mk47 automatic grenade launcher at the Udairi Range Complex, Kuwait, in 2020.

by the US Naval Surface Warfare Center, and was produced by General Dynamics from 2006 until the rights to the weapon were acquired by the Colt CZ Group in January 2024. The Mk47 can fire standard high velocity 40 mm grenades, as well as the programmable Mk285 smart munition produced by Nammo.

The Mk285 can be set for airburst detonation over a precise location, targeting foes fighting from behind cover. The Mk47's Raytheon Lightweight Video Sight fire control system (FCS) incorporates a laser rangefinder which measures the precise distance to the enemy's position; the integrated ballistic computer can programme the chambered Mk285 grenade to detonate over the target precisely upon travelling the measured distance. In addition to combatants in defilade, the grenade can also destroy soft targets such as unarmoured vehicles, radar and communications nodes, or fuel storage sites with high accuracy. The maximum effective range is 1,700 m, which is 200 m more than the Mk19. In addition to US Army and Navy SOF, the weapon is also utilised by Australian and Israeli SOF operators.

Frequently lacking access to artillery or air support, SOF need their own indirect fire capability. As always, weight is a major consideration. In 2019, Rheinmetall introduced the RSG60 configurable mortar suitable for regular infantry and for special operations units. The standard configuration weighs 15.8 kg and has a 3,200 m range. It can be stripped down to the 'Commando configuration' within 30 seconds by removing the base plate, reducing the weight to only 6.8 kg, and reducing the base footprint from 480 mm to 210 mm. Removing the baseplate precludes the use of more powerful charges, limiting effective range to 2,000 m.

Occasionally, SOF need to apply heavier firepower. However, heavy mortars are frequently mounted on armoured vehicles which cannot accommodate SOF requirements for a low footprint and speedy movement. Elbit Systems' Sling 120 mm mortar is designed to fill this void. The weapon has a significantly reduced recoil compared to many mortars in the same class, allowing it to be fielded on small 4×4 vehicles. The mortar is lowered to the ground for firing, but remains attached to the vehicle for quick re-stowing. The Sling is ready to fire within 60 seconds and has a 7 km range; it achieves a fire cadence of up to 16 rounds for the first minute, or a sustained rate of four rounds per minute. It can be operated by two to four soldiers. The system was tested by US Army Special Forces in 2022.

Credit: USMC/Cpl Jennessa Davey

A tube-launched Switchblade 300 lethal miniature aerial missile system is launched with the aid of compressed gas.

New horizons

SOF are looking ahead for new technologies that could act as force multipliers. Loitering munitions promise to provide ground-based SOF personnel with a vehicle-launched or rucksack-portable 'miniature air force' deployable from the field. According to SOCOM personnel, loitering capability – ranging from reconnaissance to electronic warfare (EW) to kinetic strikes – is being prioritised for the 'counter violent extremist operations' portfolio. Systems being investigated include crew-served or vehicle-mounted weapons, single-operator tube-launched capabilities, and VTOL systems. Capabilities being sought include good range and automated target recognition.

The ongoing War in Ukraine, above all else, has demonstrated the power and versatility of such weapons, which SOF around the globe will be acquiring in the near future. Loitering munitions will significantly expand the striking power and range of small, mobile formations, which will enable them to hold enemy forces and high-value targets at risk of attack from multiple unexpected directions, even far behind enemy lines.

Stars in Their Eyes

Thomas Withington

The Starlink satellite communications network is on track to provide global broadband connectivity. Starlink is also emerging as a promising passive radar technology.

SpaceX's Starlink Satellite Communications (SATCOM) system dramatically entered the news, and the public consciousness, on 26th February 2022. Two days before, Russia's President Vladimir Putin had ordered his second invasion of Ukraine. The first had come almost exactly eight years earlier, during which Russia occupied Ukraine's southern Crimea region and parts of her eastern Donbass area. SpaceX began supplying thousands of Starlink terminals to Ukraine, which have aided civilian and military communications.

Coincidentally, SpaceX began development of the Starlink network in 2014; the same year as Putin's occupation of Ukraine's Crimea and Donbas. Starlink intends to provide global, broadband communications using a constellation of thousands of low Earth orbit (LEO) satellites. LEO spacecraft typically orbit Earth at altitudes not exceeding 2,000 km (1,080 NM), though Starlink satellites tend to sit at the lower end of this band, at around 550 km altitude. Starlink's global coverage is possible because of the large number of satellites in orbit which, as of April 2024, comprised around 5,721 operational satellites, according to reports. SpaceX's plans call for an eventual 12,000 satellites to be in orbit, possibly eventually increasing this to 42,000. By the end of 2023, SpaceX had two million subscribers, reports continued. The company's own maps show that Starlink provides coverage over almost all of Europe, all north and central America, and most of South America. Australasia enjoys coverage, as does Mongolia, Japan, parts of southeast Asia and parts of western and southern Africa. SpaceX has not disclosed when it hopes to provide global Starlink coverage although this could probably be achieved by 2030 depending on the frequency of satellite launches.

Credit: Jud McCranie

A brace of Starlink satellites race across the night sky. The spacecraft can sometimes be visible from Earth. Plans are afoot for an eventual constellation size of 42,000 Starlink LEO satellites to provide global broadband coverage.

Users must possess Starlink terminals to access the network which employs an array of wavebands between 10.7 GHz to 51.4 GHz, public records note. Some of these wavebands are used by the terminals to transmit traffic up to the satellites. Other wavebands are used by the satellite to send traffic to Earth. Frequencies of 10.7 GHz to 12.7 GHz let the satellites send traffic to user terminals while frequencies of 17.8 GHz to 18.6 GHz, 18.8 GHz to 19.3 GHz and 37.5 GHz to 42.5 GHz connect the satellites to gateways. Gateways connect terminal users to websites and internet services they wish to access. For example, a person may be using a terminal to access weather reports. They send their request to access a website, via the satellite, to the gateway. The gateway connects with the desired website, hence connecting the user. A host of other wavebands connect the gateways and terminals to the satellites, or connect the satellite to Earth and vice versa so that the spacecraft can be monitored and controlled.

The eventual global coverage afforded by the thousands LEO satellites will envelop the planet in a blanket of satellite-to-Earth signals. Once the roll-out of the Starlink network and satellites is complete, all Starlink users will be able to have broadband access wherever they are. As this article will show, this presents certain opportunities for passive radar innovators.

Active vs passive

To understand passive radar, and the role Starlink could play in this technology, it is necessary to understand how conventional, or active, radar works. Radars exploit radio signals to detect, locate, identify and track targets. A radar transmits a pulse or wave of radio frequency (RF) energy which travels at the speed of light – 299,274,458 m/s. The RF leaves the radar's antenna, travels through the ether, hits a target and is reflected. By measuring, and halving, the time taken for the RF energy to leave the radar, hit the target and return, the target's range can be determined. If the RF energy's entire journey (antenna-target-antenna) takes 0.0005 seconds, the energy has travelled circa 149.6 km (80.8 NM). Divide this by two and the target is determined as being 74.8km (40.4 NM) away.

Radars also exploit the Doppler effect. A target in motion will slightly change the frequency of the radar echo when moving towards or away from the antenna. An oft-quoted example of this phenomena is the apparent rise and fall of a police car's siren. When the police car approaches a stationary observer the siren seems to rise in tone, and conversely, the siren falls in tone as the car drives away. In reality the frequency of the siren is unchanged, but to the stationary observer it appears to rise as

Author

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Credit: Thomas Withington

Passive radars exploit opportune radiation already present in the ether, such as radio and television broadcasting signals, or cellphone coverage.

it approaches. This is because the peaks and troughs comprising the soundwave take progressively less time to arrive as the distance between the observer and police car decreases. The opposite is true as the siren moves away. Suppose we have a radar which is transmitting a signal on a frequency of 8.20 GHz, and the signal hits a target travelling at 235.2 km/h (127 kn), and the recorded frequency of the radar echo is 8.19 GHz. This indicates that the target is in motion, moving away from the radar. Continuously monitoring this change in frequency allows the radar to determine the target's motion relative to the radar's position.

Active radars have one major disadvantage. As they emit an RF signal, technically anyone with a radio receiver covering the frequency of this signal can detect it, and hence the radar. If you detect the signal you can determine its line-of-bearing relative to your own position if you have a single receiving antenna. If you have two or more receiving antennas, you can triangulate the radar's location. In a military context, this can be dangerous. If you know where the radar is, you could potentially destroy it with ordnance. This inherent risk is because conventional radars generate and transmit their own RF energy.

Passive radars work slightly differently, because they do not generate RF energy, but instead rely on interpreting changes to RF signals already present in the radar's locale. This avoids the radar having to transmit its own signals and thus potentially risk becoming a target. You may not be aware of it, but you are continually surrounded by RF energy, particularly if you live in a built-up area. Radio and television broadcasting and cellphone coverage are two of the most prevalent RF sources. Passive radars will closely watch what is happening to particular RF signals across a specific area.

By way of example, Digital Video Broadcasting-Terrestrial (DVB-T), is used across much of the world for television transmissions. The International Telecommunications Union (ITU) reserves several frequencies for DVB-T use. The ITU is the United Nations organisation tasked with the global governance of the radio spectrum. Frequencies of 174 MHz to 786 MHz are retained for national DVB-T use. A passive radar will listen and sample a 'pure' DVB-T signal using an antenna which is within range of the DVB-T transmitter and store the information on the signal's characteristics. This first antenna provides the reference signal. An additional antenna, or several antennas, will monitor the same local DVB-T signals. These antennas are used to determine if there is any frequency change compared to the sampled pure signal. Aircraft flying through these DVB-T signals will create slight disturbances, as the signals collide with the planes and are reflected. By comparing the two signals it is possible for a passive radar to determine that an airborne target is out there. Additional processing can help determine the target's behaviour such as its speed and/or direction of movement.

Exploiting local RF signals frees passive radars from depending on an internal RF source to illuminate a target, and the inherent risks this might bring. Nonetheless, RF signals are not necessarily ubiquitous. For example, cellphone and DVB-T coverage will be spartan at best over the oceans. Radio signals tend to follow a line-of-sight range. Even cellphone towers by the coast transmit signals that eventually run out of power over the sea and technically continue in a straight line, moving out into space, away from the curvature of the Earth. The attraction of using Starlink's signals as a passive radar RF source is that they will soon be available worldwide.

Harnessing Starlink

Using Starlink in this way is not merely a theoretical idea. Research is advancing to employ Starlink downlink signals as an RF source for passive radar. In late January 2024, Germany's Ministry of Defence announced that the country was developing a passive radar which could exploit Starlink's signals. The work is being performed by Germany's Fraunhofer Institute for High Frequency Physics and Radar Techniques (FHR). Reports stated that the system uses a reference antenna which follows Starlink satellites as they cross the

Credit: Fraunhofer FHR

The Fraunhofer FHR has a long history of involvement in the passive radar domain. Its efforts have included using signals from geostationary satellites as RF sources.

sky. The reference antenna detects and copies the signal's characteristics as these are beamed down to Earth. A second antenna is pointed towards the area of interest the radar is monitoring. The reference signal is compared with those signals coming into the second antenna. This process ascertains if these signals are being altered by targets in the antenna's field of view.

One consideration for the Fraunhofer Institute's passive radar, known as Sabbia-2.0, is that any individual Starlink satellite will only be visible for a finite amount of time as the spacecraft crosses the horizon. The LEO satellites comprising the Starlink network are continuously moving across the sky. This is unlike geostationary Earth orbit (GEO) satellites which orbit in such a way as to always appear at the same location above Earth's equator. Open sources say that Starlink satellites orbit the Earth at speeds of 25,200 km/h (13,607 kn), so each satellite is 'visible' to an antenna on the ground for four minutes and 29 seconds as it crosses the horizon. In order to work, the passive radar's antenna must first acquire the satellite as soon as it appears in its field of view. The radar must then sample the satellite's downlink signals and copy these while continually tracking the satellite. As soon as that satellite is no longer visible, the second antenna must acquire the following satellite and repeat the process. It is necessary for this process to be as seamless as possible to ensure the radar's smooth operation.

Refining the design

Fraunhofer's representatives told this correspondent that the institute has been working on passive radar for over a decade. Initially, efforts focused on harnessing DVB-T signals as the RF source. Recent years have seen research expand into the use of satellite-based sources, particularly RF signals from geostationary spacecraft. One of the attractions of using space-based RF sources is the availability of downlink signals. The abundance of terrestrial RF tends to diminish in frequencies above ten gigahertz. However, satellite downlink frequencies exist in X-band (7.25-7.75 GHz), Ku-band (10.9-12.75 GHz) and Ka-band (18-20 GHz). As Starlink is showing, some of these wavebands could soon have ubiquitous global availability. Employing satellite RF sources is particularly attractive when you want to use a passive radar over the oceans. Fraunhofer has already developed passive radar technology to exploit 10.75-12.75 GHz Digital Video Broadcasting-Satellite (DVB-S) signals. The OneWeb broadband SATCOM network's frequencies of 12 GHz to 18 GHz have also proved useful.

"We started looking at Starlink about five years ago as a potential illuminator, and we have been developing things over the last four years," said Dr. Rodrigo Blázquez García, a radar engineer in the Fraunhofer Institute's FHR department. Realising a passive radar which can exploit RF signals from constellations such as Starlink brings unique challenges, noted Dr. Blázquez García: "The satellites are always moving ... We needed to be able to predict where the satellites are at any specific time." Fortunately, information is available in public sources on the position and velocities of individual satellites at any time. A key attraction of Starlink is the large number of satellites supporting the network. Before the advent of these constellations, "there had only been single or twin satellites which might pass over the horizon very quickly," said Professor Daniel O'Hagan, FHR's chief scientist at the defence business unit at Fraunhofer FHR: "Starlink and other constellations are much more numerous, providing us with a continual RF transmission source in space."

The movement of the RF transmitter means that imagery of still and moving targets can be processed. When coupled with the characteristics of Starlink's downlink frequencies, this movement helps provide a target resolution of circa one metre. Generally speaking in radar engineering, the higher the frequency, the sharper the target resolution. As the satellites are moving through the skies, they will cover a target on Earth with RF signals which are captured by Sabbia-2.0's antenna. The fact that targets can be shown in such impressive detail is the result of satellites' motions. The signal is transmitted from the satellite and hits a target. The echo of the signal from the target causes the signal's frequency to change vis-à-vis the reference signal. Each signal disturbance allows the radar to build up a more detailed target picture. The more times the signals repeat this behaviour per second, the richer the information becomes regarding the target the signals collide with. As the satellite is crossing the sky, the signals collide with the target at a myriad of different angles. This process is analogous to you watching an object revolving on a turntable. Your brain gathers more information as the object rotates, compared to only seeing the object once when stationary. For all intents and purposes, the satellite is the eye in the sky and the Earth is the turntable.

Credit: Fraunhofer FHR

The two antennas comprising the Sabbia-2.0 architecture are clearly visible in this picture. One antenna samples and records Starlink downlink signals, the other monitors signals for signs of disturbances caused by targets.

Credit: Fraunhofer FHR

Fraunhofer FHR will soon be performing experiments to evaluate the performance of the Sabbia-2.0 passive radar architecture onboard a moving platform.

The entire Sabbia-2.0 architecture can weigh as little at 60 kg (132 lb), meaning that it can be easily accommodated on a vehicle. Other applications are being considered for the technology. For example, Sabbia-2.0 could be configured to outfit a ship or aircraft. Once in situ, the antennas supporting the system can be positioned in such a way as to ensure that the system works as efficiently as possible. The Sabbia-2.0 antennas are electronically steered which helps track satellite signals more efficiently than using a mechanically-scanned one.

Dr. Diego Cristallini, the FHR's group leader for passive covert radar, expected demonstrations of the Sabbia-2.0 architecture using Starlink and OneWeb signals to be performed in the coming months of 2024. Prof. O'Hagen said that Sabbia-2.0 is already developed to Technology Readiness Level Six (TRL-6). According to European Union definitions, TRL-6 denotes that "technology has been demonstrated in a relevant environment." The FHR typically performs research and development up to TRL-6. Taking the technology beyond this would need to be done in partnership with the private sector.

Immediate plans call for the technology to be mounted on a trailer to show that the passive radar can be used onboard a moving platform. "The project's next steps are proceeding very satisfactorily," said O'Hagen, adding, "there is a lot of interest from multiple parties." The thoughts of Prof. O'Hagen and his colleagues are also turning to whether Starlink could be used for other purposes. One area of interest is using the network as a Global Navigation Satellite System (GNSS) alternative. Expect Fraunhofer's engineers to potentially find other applications beyond passive radar and GNSS as Starlink's rollout gathers momentum. ■

Virtually Shooting Straight

Trevor Nash

The modern Virtual Small Arms Trainer (VSAT) has moved on from purely teaching marksmanship principles to enabling integrated squad tactical training to be conducted. New technologies are helping to achieve greater levels of immersion as the use of such systems spreads.

All soldiers carry some form of small arm, and teaching them to use that particular weapon comes with a number of challenges. Perhaps the first is the overall cost of such training. This includes the cost of ammunition, transportation to and staffing of the firing range, maintenance of that range and the environmental impact of live-fire training, in particular, noise and air pollution.

As well as these tangible factors, instructors have historically questioned the efficacy of teaching new soldiers live-firing skills on a range that was subject to the vagaries of different weather conditions; an environment considered less than ideal for one-on-one coaching and providing an inability to repeat accurately specific lessons or scenarios. This situation was also compounded by the noise, smells and recoil associated with the live-fire environment that the trainee was experiencing for the first time. In other words, the gulf between initial weapon handling in the classroom and live-fire ranges generated poor 'training transfer'.

Around sixty years ago the military began to address these issues in an attempt to close this training transfer gap. The initial attempt used sub-calibre inserts that were used in full-calibre weapons to allow soldiers to conduct live-fire practise on indoor ranges, frequently using cine-film targets. In the case of the British Army, this saw a .22 barrel insert and modified magazine used to adapt the standard issue L1A1 Self Loading Rifle.

With the adoption of computer generated imagery (CGI) in the late 1980s, VSATs began to appear on the market. These initial devices simply replicated linear gallery and electronic target ranges (ETR), and were uniquely used for marksmanship training. Such devices enabled soldiers to transition from the classroom where weapon handling, basic aiming and stoppage drills were taught, to the live-fire range. This transitionary experience provided an environment where instructors could prepare trainees for what they would experience on the live-fire range in terms of its layout, the range orders/commands that they would hear there and the firing practises that they would undertake.

Early VSATs also provided an environment where soldiers could be taught the importance of stable firing positions and the correct breathing techniques. They were also used to teach how to correctly squeeze the trigger, the effects of weapon cant (positioning the weapon left or right of the vertical) and how to 'lead' moving targets.

Another significant advantage was that VSATs generated data that could be used to correct a soldier's individual errors. These errors could be evaluated by consecutively running exactly the same exercise to see if they had been eradicated.

"These early generation VSATs certainly boosted marksmanship training and served a very valuable purpose but they did not address the needs of the infantry squad and the weapons that they used on the battlefield," Hans Lindgren, Saab's Head of Business Development told ESD. "Our System Ground Combat Indoor Trainer (GCIT) allows individual shooting and engagement training, against static and moving targets, and tactical training with a focus on decision-making, communication and coordination of fires."

Credit: USMC

US Marines training using the Indoor Simulated Marksmanship Trainer (ISMT).

Author

Trevor Nash is the Editor of "Military Training & Simulation News" (MTSN) and provides simulation and training consultancy services to industry and government organisations.

The arrival of systems such as Saab's GCIT, the Guardiaris Small Arms Tactical Trainer (SATT) and the Thales SATIS (Small Arms Trainer Indoor Simulator) provided the ability to incorporate a variety of squad weapons, along with the integration of indirect fire weapons such as mortars. Crucially, these modern VSAT devices are modular and can be upgraded with new weapons or 'technology refreshes' as improvements become available.

An exemplar of such an approach can be found with the US Marine Corps and its Indoor Simulated Marksmanship Trainer (ISMT). The current iteration, ISMT III, is now being upgraded to accommodate enhancements to the M252 81 mm mortar.

Designed by InVeris Training Solutions – formally FATS and then Meggitt Training Systems – ISMT allows marines to train at any time of the day or night. "There's no weather restrictions, there's no range restrictions, there's no environmental restrictions, Marines can come in here anytime as long as they schedule it, allowing combat readiness to be at its peak," explained Chief WO 4 Harry Taylor from the 3rd Marine Littoral Regiment in Hawaii. The ability to train M252 mortar crews virtually is a vital one in Hawaii considering that "Marine Corps Base Hawaii doesn't have the ability to live fire 81 mm mortars," added Taylor.

Enhancing Capability

Like the USMC, many armed forces are looking to improve the capabilities of their VSAT devices. In Europe, the Austrian Army commissioned its first Guardiaris SATT, located at Bruckneudorf, in 2022 and since then devices have been installed at five other locations.

Each SATT comprises a parabolic projection screen with a 148° horizontal field-of-view, four projectors, four speakers to provide surround sound, a shock/vibration floor, and an instructor operator station (IOS). The IOS allows the instructor to manage exercise preparation, create scenarios, monitor the scenario and then conduct an after action review (AAR). The high-fidelity visual system is a games-based solution developed by Guardiaris and integrated with its Guard operating software that features variable time-of-day, night, different weather conditions and NVG options. Unlike competitor systems that use laser technology, SATT uses a patented IR tracking solution to accurately monitor squad members' positions and weapon alignment.

"Over the last two years we have also added short-range anti-tank weapons and a remote sniper capability," Maj Roland Nagl, the Austrian Army's SATT project leader told ESD. *"We are also looking to integrate a Remote Weapon System (RWS) capability that was developed by Guardiaris in partnership with ITEC GmbH, Madritsch and Instalaza through the Future Integrated Indoor Soldier Training (FIIST) initiative that has been funded by the European Defence Industrial Development Programme."*

As well as these enhancements to SATT, the Austrian Army is also looking to rationalise its complete approach to the application of VSAT. Maj Nagl describes this as "integrating more scenarios" and "capturing and using data to improve training." The ultimate aim is to provide a seamless training pipeline that encompasses virtual and live training domains.

"We are about to implement a new, modern training concept," Col Wolfgang Habitzl from the Austrian Army's department for weapon systems, ammunition and simulation told ESD. *"This concept is focused on the topic of firing operations and starts from the very beginning of the training of a single soldier up to unit level. It will combine all training assets you need for this training and the current project focuses on individual to squad levels."*

Col Habitzl said that this two phase project will initially see the integration of three VSAT devices and use MantisX and Cervus XCALIBR software to provide data with which to assess and improve training. As well as SATT for fire-team to squad train-

Credit: Trevor Nash

Austrian Army soldiers training using the Guardiaris SATT at Bruckneudorf.

Credit: InVeris

InVeris Training Solutions is now offering virtual reality (VR) and augmented reality (AR) solutions for virtual small arms training.

Credit: Thales

Thales refers to its family of VSAT devices as Small Arms Training Indoor Simulators, the latest versions of which use the Unreal Engine 5 graphics package.

ing, the Austrian Army also currently uses the Smokeless Range Trainer (SRT) from Laser Training Solutions for individual marksmanship training. It is expected to procure the Guardiaris Small Arms Mobile Trainer (SAMT) for pairs to fire-team training in the near future.

Central to these changes are the data capture and the associated "data analysis" process to "help us identify key performance indicators to allow us to define better training," Col Habitzl explained. "We also want to be able to display these data in a meaningful and easy to understand way."

The Austrian Army is also looking at additional components to enhance the efficacy of its weapon training process still further. These include eye tracking, capturing communications data to include voice and hand signals and monitoring individual biometric data such as heart rate and perspiration levels. This monitoring would take place in both the virtual and live training environments and focus, according to Col Habitzl, on the "continuous collection of performance data throughout the whole training programme" to allow the creation of "a profile of individual soldiers, teams and units."

Projects like the one currently underway in Austria highlight the challenges facing the military in trying to make live fire exercises realistic. The reason is that military ranges, gallery or ETR, are constructed linearly and targets are generally always in front of the firer for obvious safety reasons. Safety is not an issue in the virtual world, but technical issues have historically meant that VSATs have generally mirrored the real-world linear range.

In addressing this issue, InVeris Training Solutions has developed augmented and virtual reality-based (AR/VR) products that provide a 360° environment. Both the SRCE and SURVIVR products see the trainee wearing a high-resolution headset to provide both visual and auditory cues. The company says that the visual cues are, "overlaid on the physical world, generating obstacles, virtual characters, avatars, and assets."

Enhancing Immersion

One of the key elements of success for any virtual trainer is its ability to immerse the trainee in a simulated world – the so-called 'suspension of disbelief'. This is achieved by stimulating the trainee's senses as they would be in the real world. The major human sense is vision and current VSAT systems are tending to move towards games-based visualisation systems such as Bohemia Interactive's VBS4 or Epic Games' Unreal Engine.

In the US for example, VSAT vendor Laser Shot has used VBS for a number of years across a range of products while in late 2023, Virtra announced that it had integrated VBS4 with its own Virtra Operating System (VOS). The major benefit of this approach is that users can create their own geospecific virtual environments to allow their VSATs to exactly replicate actual firing ranges and also be used for mission rehearsal. Starting this year, simulators with VBS4 integration started being made available to new customers, while existing VOS clients will have the option to upgrade their simulators.

Historically, military users of virtual training systems have used separate Computer Generated Image (CGI) engines for different simulation systems along with a variety of simulator specific databases. A significant benefit of games-based CGI is that they are currently used by a number of nations across a range of simulation systems. According to VirTra's CEO John Givens, the integration of VBS4 allows users to, "leverage their investment in models, terrain, scenarios and other integrated components instantly for part task and collective training."

Although visualisation is seen as the key to immersion, little effort has been expended by VSAT manufacturers on generating olfactory stimulation. Smell is an important human sense that helps immerse the individual in a simulation, but little has been done in this area. One exception was Cubic Defense that has demonstrated olfactory stimulation as part of its VSAT to simulate the smells typically associated with an Afghan village. Many

consider that for the costs involved such an enhancement would be well worth the investment.

In Europe, the Royal Netherlands Army (RNLA) has embarked on a project to enhance the visual fidelity of its current VSAT devices with a longer term aim of eventually procuring a new system. The RNLA uses the Thales Sagittarius trainer that features the open platform Crystal Space video game engine. First developed in 1997, Crystal Space has been described as "effectively dead and has been for a good number of years", hence the RNLA's efforts to upgrade its VSATs.

"We have 38 fixed Sagittarius systems and two mobile systems, and the plan is to upgrade to the Sagittarius Evolution platform," Sake Blaauw, head of the RNLA's small calibre simulation bureau explained to ESD. "The conversion process is expected to take around a year and we expect the last system to be converted at the end of 2025."

The Thales Sagittarius Evolution uses the Unreal Engine 5 following the company's signing of a partnership agreement with Epic Games in late 2022. In addition to the new visual system, the latest VSAT iteration from Thales features improved weapon simulation including, "high fidelity [weapon] replicas with pneumatic recoil featuring a detailed ballistics model. In conjunction with telescopic, night vision and thermal sight simulators, they allow users to train as closely as possible to real conditions."

The added fidelity that Sagittarius Evolution provides will allow the RNLA to eventually conduct "90% of its training in the simulator," Blaauw told ESD. As to the eventual replacement of Sagittarius Evolution, "it is not yet clear what the new system will look like, but we recently started developing plans for the new trainer that will enter service in 2030."

As to the future of VSAT, the adoption of an AR solution by InVeris is indicative of how technology is being used to add capability. In the US, the US Army is currently advancing with its Synthetic Training Environment (STE) programme and in particular, the Soldier Virtual Trainer (SVT), part of which focuses on Weapon Skill Development (WSD). In essence, STE provides a common visualisation package that can be used across a multitude of applications and in many ways reflects the way that CGI products such as VBS4 and Unreal Engine are being adopted by many nations across the world.

It is not all about the mature users of simulation such as the US, UK, the Netherlands or Austria. Through its Foreign Military Sales (FMS) structure, the US Army's International Programs Office is supplying VSATs to a number of its allies throughout the world. These include a Laser Shot Mobile Marksmanship Training System (MMTS) to Albania, InVeris Training Solutions Engagement Skills Trainer II (EST II) to AFRICOM for use by Senegal, Ghana, Togo, Uganda and Rwanda as well as providing an upgrade to Jordan's EST 2000.

Closing thoughts

Although VSATs have been used for around 40 years, modern technologies have enabled them to evolve from purely teaching marksmanship to embracing tactical engagements including fire and manoeuvre, shoot/no-shoot decision making skills and incorporating the full range of squad individual and crew-served weapons. Primarily used for training, such systems can also be used for mission rehearsal.

These added capabilities have made the modern VSAT an excellent tool for transitioning the soldier from the classroom to the live-fire range. Historically, many armies have viewed these virtual and live phases of training as separate entities. However, as the Austrian Army is highlighting with its current project, they need to be considered together to maximise training effect. ■

Credit: FAAC

As part of the US Army's STE/SVT requirement, FAAC is offering its VSAT experience as part of the CAE-led bid.

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May 2024 • www.maritime-defence-monitor.com • ISSN 1617-7983

ADVANCED MARITIME SOLUTIONS ON BOARD

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Word from the Editor

Photo: author

With this new edition of Maritime Defence Monitor we will take you from the Black Sea and into the Pacific Ocean. You may be disappointed, since we do not propose to cover the situation in the Red Sea. However, as MDM aims to help you navigate the future by identifying maritime security and technological trends, your team on the bridge has selected a number of specific areas of growing concern. Notably, we will dive into diverse aspects of anti-submarine warfare, where advances in underwater sensing technologies are reshaping this domain. From small drones to quantum-based detection, numerous innovations are enhancing situational awareness and threat detection. Integrating these capabilities into naval operations seems to be crucial for maintaining maritime superiority. Recent operations in the Black Sea provide pioneering examples of these developments.

Undoubtedly, the Black Sea region remains a geopolitical hotspot, with tensions between Russia and NATO member states being maintained at a high level. Maritime security in this area involves balancing territorial claims, freedom of navigation, and military presence. As the Black Sea becomes a theatre for great power competition, understanding these dynamics and implementing confidence-building measures will be essential for maintaining security.

More broadly, as vessels become increasingly connected, ship owners and managers need to improve onboard IT protection and ensure that on-line devices are protected by the right security measures. Our reliance on networked systems grows; and so, therefore, does the vulnerability of maritime operations to cyber threats. We will guide you into a previously overlooked area, outlining how the maritime community must stay vigilant to mitigate the growing threat of cyberattack.

Apart from threats and global challenges we will also examine a major endeavour being undertaken the German Armed Forces. The German Navy and its sister service, the Luftwaffe, are going global. In our article, you will discover that this is not only a national venture. Which underlines again that oceans do not merely separate; they also connect. Globalisation would never have been possible without international cooperation across oceans. Prosperity and the associated benefit of societal stability are globally interconnected; and also subject to diverse dynamics. With this in mind, European nations are travelling into the Indo-Pacific; and beyond. With one objective: to signal to like-minded countries that the importance of collaborating with partners in the realm of defence and security policy is common ground.

Your team on the bridge wishes you pleasant and enlightening reading.

Yours Aye
Uwe

Contents

Masthead

Maritime Defence Monitor
MDM · Special Issue,
May 2024
ISSN 1617-7983

Published by

Mittler Report Verlag GmbH
A company of the TAMM Media Group

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Layout:
AnKo MedienDesign GmbH, Meckenheim, Germany

Production:
Lehmann Offsetdruck und Verlag GmbH, Norderstedt, Germany

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Exhibition Management and Advertising Administration: Renate Herrmanns

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Cover Photo: The German Sachsen class frigate FGS Sachsen (F 219) transits the North Atlantic Ocean in support of exercise Northern Viking 22.
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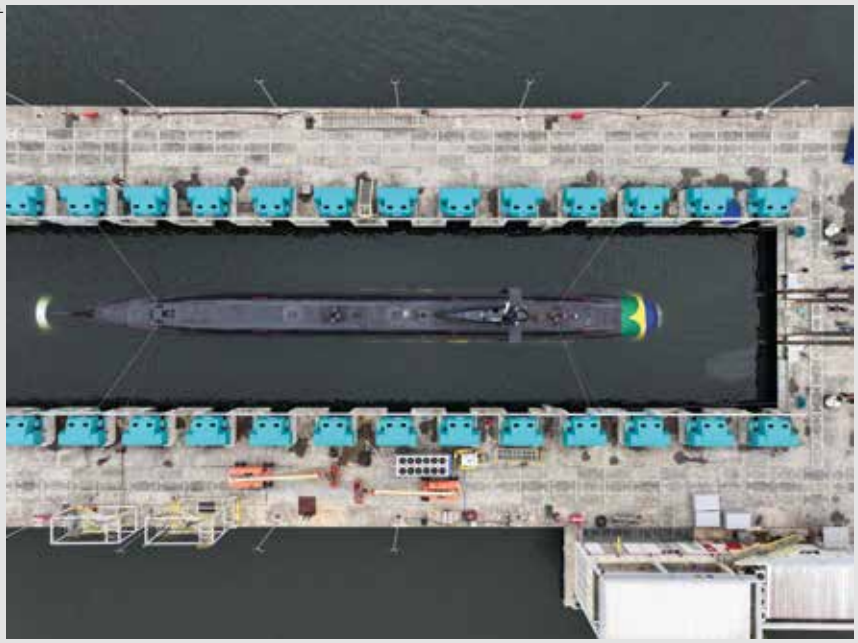
EUROPE

FRANCE: A BUSY START TO THE YEAR FOR NAVAL GROUP'S SUBMARINE BUSINESS

It has proved to be a busy start to 2024 for Naval Group's submarine business with the announcement of the selection of the French company's boats for two major overseas programmes and the commencement of work on the first of the Marine Nationale's third generation of strategic ballistic missile-armed submarines (SNLE 3Gs).

Credit: Naval Group



Naval Group's submarine business has recently been bolstered by important new export contracts, including for an evolved variant of the 'Scorpène' type for Indonesia. This photograph shows the floating out of the Brazilian 'Scorpène' Tonelero on 28 March 2024.

The first major success came on 15 March 2024 with an announcement by Dutch Secretary of State for Defence Christophe van der Maat that Naval Group's diesel-electric 'Blacksword' variant of its 'Barracuda' family had been provisionally selected to meet the Royal Netherlands Navy's requirement for four submarines to replace the existing *Walrus* class boats. Naval Group's selection comes after a lengthy and fiercely fought completion in which designs from Germany's tkMS (Type 212CD E) and Saab (C718) had also been shortlisted. The defence minister stated that Naval Group had submitted a "balanced, multi-faceted and realistic tender" that also envisaged Dutch industry playing a leading role in the project's delivery. The first pair of the quartet of new submarines is scheduled for delivery within 10 years of signature of the delivery contract.

Less than two weeks later, on 28 March 2024, Naval Group reported that it had signed a contract with Indonesia that will see two 'Scorpène Evolved Full LiB' submarines assembled by PT PAL in Indonesia under a transfer of technology arrangement. The deal follows a strategic partnership signed between the two companies in 2022 within the framework of a broader Franco-Indonesian defence cooperation agreement. As suggested by their name – and what is also understood to be the case for the new Dutch boats – the submarines will be equipped with lithium-ion batteries. According to Naval Group, this "encompasses the highest security and safety standards and allows a higher range of useful energy, a better indiscretion rate and a reduced charging time. Thanks to this technology, high speed is available no matter the state of charge, increasing the submarine's tactical mobility".

Meanwhile, on 20 March, a ceremony to mark initial steel cutting for the first third-generation French strategic submarine took place at Naval Group's shipyard in Cherbourg. Launched in February 2021, the SNLE 3G programme aims to replace France's existing four *Le Triomphant* class boats on a like-for-like basis from 2035 onwards.

MDM Editorial Commentary: Naval Group's recent export successes are an important shot in the arm for its submarine business after the significant setback suffered in 2021 that resulted from the cancellation of Australia's contract for the 'Shortfin Barracuda' type boats of the *Attack* class. They follow on from the memorandum of understanding signed with India's Mazagon Dock Shipbuilders in July last year for additional ''Scorpène' type submarines and place the French company on a firmer footing to bid for further work in the export sphere. If anything, Naval Group's challenge will now be focused on managing the influx of work obtained given the demands of the domestic SNLE 3G and *Suffren* class programmes, as well as the giant PROSUB contract in Brazil.

Whilst the result is disappointing for rival tkMS, the German company is already heavily engaged in the Type 212CD programme for The German and Norwegian navies, which seems likely to be expanded beyond the initial six submarines. It is therefore arguably Saab that has lost most from Naval Group's success, as it still needs to find buyers to expand its submarine business beyond Swedish requirements. Saab's Dutch partner Damen also loses from the decision and – although local company Royal IHC is a strategic partner in Naval Group's bid – it is also unclear to what extent the wider Netherlands' naval sector will benefit from the award.

FINLAND: PROGRESS WITH SQUADRON 2020 PROJECT

Finland has marked a major milestone in the significantly delayed implementation of its Squadron 2020 project with the celebration of the keel-laying of the first of four planned Pohjanmaa class multi role corvettes at the Rauma Marine Constructions (RMC) shipyard on 11 April 2024. The ceremony, involving the lowering into place of a 56 tonne keel section, followed the start of construction work on the ship in October 2023 in a construction hall that has been specially built to support the project. Interestingly, RMC has stated that use of a covered facility has been partly driven by the need to ensure the programme's security, a step that was replicated in a prohibiotion of 'outsiders' from attending the keel-laying event. Previous official statements suggest that sea trials of the lead vessel should commence in

2026, with all four ships slated for delivery by the end of 2029. This seems a challenging schedule in the light of previous programme delays.

THE NETHERLANDS: DAMEN PROMOTES MULTI-PURPOSE SUPPORT SHIP FAMILY

Damen Shipyards Group has unveiled a new 'family' of ship designs based on the innovative multi-purpose ship ordered by the Portuguese Navy towards the end of 2023. The Multi-Purpose Support Ship (MPSS) range, which currently incorporates 7,000 and 9,000 tonne versions, is described in a press release as combining "the vision of the Portuguese Navy, with Damen's proven process of shipbuilding, using standardised solutions wherever possible." As a result, Damen claims, the vessels can be constructed quickly, offering a reliable, cost-effective platform. Initially conceived to support the operation of drones, the MPSS can be used to undertake a wide range of duties including conducting amphibious support, emergency/disaster relief, search & rescue, diving support, performing submarine rescue and supporting helicopter operations. The lead, Portuguese ship is a MPSS 7000 variant of 107 metres in length and 20 metres in beam. It has a core crew of 48, additional accommodation for up to 100 specialists and temporary facilities for 42 more (to be used, for example, in a disaster relief operation), In addition to a 94 metre flight deck, as well as a hangar for UAVs, it has a 650 m² cargo deck and space for up to 12 TEU containers.

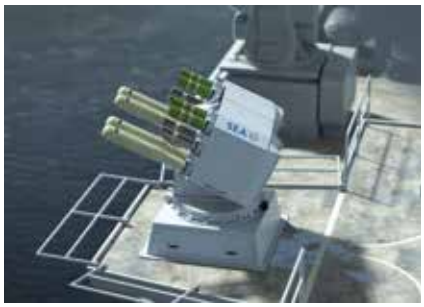
Credit: Damen

Damen has launched a new family of Multi-Purpose Support Ship (MPSS) designs optimised for drone operations.

UNITED KINGDOM: SUCCSESSES FOR COHORT PLC

On 26 March 2024, British defence technology company Cohort Plc announced that its Systems Engineering and Assessment Ltd (SEA) subsidiary had been awarded a GBP 135 million (USD 170 million) contract to supply its 'Ancilia' trainable decoy launcher to the Royal Navy. The system is being supplied to meet the navy's Electronic Warfare Countermeasures Increment 1a (EWCM 1a) requirement. The equipment will be widely installed across the Royal Navy's surface fleet, replacing its existing fixed launching system (Outfit DLH).

The contract is just one of a number of successes that the Cohort has announced in recent months. In January, the British group reported that SEA had been awarded a GBP 15.1 Million (USD 19 million) contract to supply lightweight torpedo launch systems to Canada for "a major vessel programme", almost certainly the future Canadian Surface Combatant. Subsequently, on 19 March, the group's Chess Dynamics subsidiary secured a GBP 15.7 million (USD 20 million) deal from BAE Systems Maritime Australia to supply its Sea Eagle surveillance systems for the Royal Australian Navy's *Hunter* class frigates.



Credit: Cohort Plc

A large British Royal Navy order for the 'Ancilia' trainable decoy launcher is just one of a number of significant contracts gained by Cohort Plc in recent months.

NORWAY: LONG TERM DEFENCE PLAN SUPPORTS NAVAL PROCUREMENT

On 5 April 2024, the Norwegian government presented its long-awaited plan for the armed forces' development in the period from 2025 to 2036. Expenditure will be increased by NOK 600 billion (USD 54 billion) to a total of NOK 1,624 billion (USD 147 billion) over the 12 year period, by which time the budget will be nearly twice as large in real terms as it is today. Priorities for the increased investment include improved situational awareness capabilities, a new surface fleet, strengthening air defence capabilities, and increasing the capacity and volume of the army and home guard.

A core part of the new plan is a significant investment in maritime capabilities. Justifying this step, Prime Minister Jonas Gahr Støre stated that, "Norway is a maritime nation with a strong maritime heritage. The government is committed to strengthening the navy with new frigates, submarines and other ships." More specifically, the plan encompasses:

- Five frigates with helicopters, including an option for an additional ship
- At least one additional submarine, here too with the option of a further unit. This will be in addition to the four U212CD boats already under contract under a joint procurement arrangement with Germany
- Up to ten large and 18 smaller ships, for a total of 28 new standardised ships. These include 12 new coast guard ships, of which six will be coastal and six will be ocean-going vessels.

MDM Editorial Commentary: The five new frigates are to be procured, operated and maintained in a strategic partnership with "a close ally". Previous statements suggest that these ships will be optimised for anti-submarine warfare. Doubtless many European nations will attempt to be the preferred ally given the extent of the prize envisaged, with France, Germany, Italy, the Netherlands, Spain and the United Kingdom all having warship designs that could meet the required role. However, Germany is already assured to benefit from the plan's naval focus given the strength of the existing partnership on the U212CD programme.

Credit: Navantia

Norway's Long Term Plan on Defence confirms plans to replace the existing Fridtjof Nansen class – KNM Otto Sverdrup is pictured here – with at least five new frigates.

THE AMERICAS

PERU: SOUTH KOREAN INDUSTRY FORGES A LONG TERM STRATEGIC NAVAL PARTNERSHIP

HD Hyundai (formerly Hyundai Heavy Industries) has cemented South Korea's dominant position as the Peruvian Navy's long-term strategic partner following signature of a contract with local shipbuilder SIMA on 16 April 2024 involving the supply of four new warships. Reportedly valued at USD 463 million, the agreement involves SIMA's local construction of a frigate, an offshore patrol vessel and two utility landing craft to the South Korean company's designs. HD Hyundai will also supply an equipment and material package, as well as technical support. Importantly, HD Hyundai has also been appointed as SIMA's strategic partner for the next 15 years, leaving the Korean company well placed to achieve further contracts in pursuit of the Peruvian Navy's recapitalisation.

UNITED STATES: FLEET EXPANSION FACES MAJOR DIFFICULTIES

Two official US Navy reports published, respectively, in March and April 2024 reveal the major difficulties the US Navy faces as it attempts to grow fleet numbers in the face of the rising challenge it faces in the Pacific from China's People's Liberation Army Navy (PLAN) expansion. An updated, classified Battle Force Ship Assessment and Requirement (BFSAR) report provided to Congress in June 2023 set out an increase from 373 to 381 in the navy's target force of manned 'battle force' ships; a total that rises to over 500 when unmanned vessels are taken into account. This compares with a fleet size of 294 manned battle force ships as of mid-April 2024, a figure that has increased only marginally over the last decade.

The first new report was the annual 'Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2025'. Published in mid-March, this suggests that – even under an optimistic funding scenario that also assumes a significant enhancement in shipbuilding performance – the required numbers will not be achieved until the early 2040s. Under an alternative scenario, based on flat spending once inflation is taken into account but still assuming improved shipyard performance, a maximum of 348 vessels is achieved. The short term prognosis is particularly gloomy, with fleet numbers expected to decline below the current figure until the end of the decade. This largely reflects accelerated retirements of ships before their expected end of service lives to help fund a reconfigured fleet. This year's list of proposed early withdrawals is extended to another class of relatively new vessel, with the first four *Spearhead* (T-EPF-1) class expeditionary fast transports now slated for withdrawal. According to the report, "The Navy is challenged with maintaining crew manning and operator proficiency, and the class operational availability and material availability is below life-cycle projections".

Subsequently, at the start of April 2024, the publication of 'headline' findings arising from a 45 day Comprehensive Navy Shipbuilding Review mandated by Secretary of the Navy Carlos Del Toro highlighted the problems that the US Navy faces in driving the performance of the country's naval industrial base. The conclusions of the review, which was set up "to provide an assessment of national and local causes of shipbuilding challenges, as well as recommended actions for achieving a healthier US shipbuilding industrial base that provides combat capabilities that our warfighters need, on a schedule that is relevant" made dismal reading. Many of the navy's most significant programmes are facing years of delay, including between 12 and 16 months for the top priority USS *District of Columbia* (SSBN-826) strategic submarine, between 18 to 26 months for the carrier USS *Enterprise* (CVN-80) and from two to three years for the more recent 'blocks' of *Virginia* (SSN-774) class submarines. The lead *Constellation* (FFG-62) class frigate – laid down on 12 April 2024 – is anticipated to be around three years late, likely delaying her entry into operational service until the turn of the decade.

MDM Editorial Commentary: The US Navy's struggle to expand battle force numbers reflects a problem that is playing out across many Western fleets as navies attempt to recapitalise after decades of post-Cold War neglect. Just as was the case in the period between the two World Wars, the effort required to rebuild rundown military and naval capacity is a massive undertaking that inevitably demands a heavy price and which cannot be undertaken rapidly in any event. Despite this general truth, the US Navy also seemingly faces additional problems that are largely of its own making. The disposal of large numbers of warships of modern design that were, until very recently, lauded as the next generation in cutting-edge technology is a truly shocking waste of resources that could only be contemplated by a fleet supported by the 'deep pockets' of a superpower. Beyond this criticism, the once in a generation replacement of the navy's strategic submarines is an additional challenge that is inevitably straining both budgets and infrastructure.

Looking to the future, there are grounds both for optimism and concern. Positively, it is apparent that navy leaders are fully cognisant of the need to rebuild infrastructure if expansion is to be achieved. For example, USD 17.5 billion will be spent up to FY2029 recapitalising the submarine industrial base to achieve a sustained construction 'drumbeat' equivalent to one *Columbia* and two *Virginia* class submarines each year. More negatively, it has to be questioned whether the sustained political will exists within a somewhat fractured American democracy to sustain the investment needed to achieve the desired force structure. Without this commitment, the targeted fleet structure will remain represented by graphs on a PowerPoint presentation rather than ships at sea.

Credit: US Navy

Early members of the Spearhead (T-EFT-1) class are the latest modern US Navy vessels to be retired many years before the end of their expected service lives as the US Navy struggles to expand its fleet.

AUSTRALIA: FURTHER CHANGES IN PLANNED FLEET STRUCTURE

On 20 February 2024, the Australian government released its long-awaited blueprint for the future structure of the Royal Australian Navy's surface fleet. The announcement followed the conclusion of an independent analysis of fleet structure that was commissioned in the aftermath of the country's 2023 strategic defence review. The decision to undertake the analysis reflected the evolving strategic environment in the Indo-Pacific region and concerns that the then-planned fleet structure – focused on three *Hobart* class air defence destroyers, nine *Hunter* class anti-submarine warfare (ASW) frigates and 12 *Arafura* class offshore patrol vessels (OPVs) – was no longer best-suited to meet the navy's needs. The need for the surface fleet to complement the navy's revised underwater component following the abandonment of the *Attack* class diesel-electric submarine programme in favour of acquiring nuclear-powered boats under the auspices of the 2021 AUKUS strategic alliance was also a relevant factor. The Australian government accepted virtually all the independent analysis's conclusions.

The centrepiece of the new blueprint is a shift to a two tier structure of major surface combatants, combined with a scaling back of the previously planned number of OPVs. The Tier One component will now comprise three *Hobart* and only six *Hunter* class vessels. However, it is planned to increase overall firepower by acquiring six large optionally crewed surface vessels (LOSVs) each equipped with 32 vertical launch system (VLS) cells in a nod to the US Navy's 'distributed lethality' concept. The new Tier Two component is expected to comprise up to 11 frigates optimised for ASW operations. The German MEKO A-200, Japanese *Mogami*, South Korean FFX and Spanish ALFA 3000 designs are stated as exemplars of the types of ship envisaged.

Meanwhile, the planned OPV class is regarded as "an inefficient use of resources for civil maritime security operations [that] does not possess the survivability and self-defence systems to contribute to a surface combatant mission." Accordingly, planned construction of *Arafura* class vessels will be cut in half and alternative roles sought for the six survivors. Constabulary missions will, instead, be performed by the smaller 'Evolved Cape' class patrol boats of both the Royal Australian Navy and Australian Border Force under a combined acquisition and sustainment model.

MDM Editorial Commentary: The revised fleet structure has received a broadly positive response from local commentators. The plan more than doubles the fleet of major surface combatants (if the optionally manned vessels are taken into account) and also increases lethality through the higher number of VLS cells it provides. It is also welcome that the new plans are supported with extra funding; an additional AUD 11.1 billion (USD 7.3 billion) will be allocated over the next decade to bring the future surface combatant fleet closer to fruition.

The new strategy has also clearly taken considerable steps to secure the stability of Australia's shipbuilding sector. The decision removes uncertainty relating to the often-criticised *Hunter* class's future and the continuity of surface ship construction at Osborne, South Australia. Moreover, the reduced order is likely to be counterbalanced by accelerated construction of the planned follow-on air defence destroyers in due course. In addition to cementing the critical role of South Australia in the Australian shipbuilding sector, this maintains the position of *Hunter* class builder BAE Systems – now also appointed co-lead alongside ASC Pty for construction of the new SSN-AUKUS submarines at Osborne – as the industry's leading player. However, the curtailment of *Arafura* class construction presents greater questions in Western Australia. Whilst it is envisaged that industry there will eventually benefit from Tier Two frigate and LSOV production, it has to be unclear whether or not *Arafura* designer NVL's presence will be maintained.

The announcement is not all good news for the Royal Australian Navy. Fleet strength is actually forecast to dip in the near term as the oldest *Anzac* class frigates are retired and a planned life-extension programme for the remaining ships abandoned. There are also real concerns about how the expanded fleet will be crewed given the Royal Australian Navy's ongoing personnel retention problems. Perhaps most significantly, the blueprint represents the second occasion within three years that Australia has upturned a major element of its future fleet structure plan. In addition to creating considerable uncertainty and expense, it has to be questioned how long the new model will endure.

Credit: BAE Systems

Whilst Australia's review of its future surface fleet structure has confirmed construction of the new Hunter class frigates, numbers will fall from nine to six under revised plans.

INDONESIA: ORDER FOR FINCANTIERI MULTI-ROLE OFFSHORE PATROL VESSELS

Fincantieri and the Indonesian Ministry of Defence have signed a EUR 1.2 billion (USD 1.3 billion) contract for the acquisition of two PPA type *Paolo Thaon do Revel* multi-role offshore patrol vessels. To date, seven modular PPA vessels have been ordered by the Italian Navy in various 'Light', 'Light Plus' and 'Full' configurations that incorporate progressively greater levels of weaponry and sensors. The more fully-equipped vessels incorporate sophisticated air defence radar and associated vertical launching system (VLS) cells, making the approximate 6,000-tonne displacement vessels frigates in all but name

Credit: Fincantieri

The Italian PPA type multirole offshore patrol vessel ITS Ruggiero di Lauria is believed to be one of two ships slated for transfer to Indonesia prior to completion to fulfil a near EUR 1.2 billion contract in March 2024.

The agreement follows a sales campaign conducted by the second Italian PPA, ITS *Francesco Morosini*, in the Far East during the course of 2023 and will involve the transfer of ships previously destined for Italian Navy service. Press reports have suggested that the PPA Light Plus variants *Marcantonio Colonna* and *Ruggiero di Lauria* – which are amongst those fitted with VLS equipment – are the two vessels that will be transferred.

Indonesia was previously reported to be planning the acquisition of Italian FREMM type frigates, as well as surplus members of the Italian Navy's Maestrale class. It is not clear whether this contract replaces or supplements the previous deal, although it would seem unlikely the Indonesian Navy would have sufficient funds to pursue both simultaneously. In any event, the new ships will add to a rather eclectic mix of new equipment orders that have included Anglo-Danish frigates, Dutch corvettes, and French and South Korean submarines in recent years.

TAIWAN: SIGNIFICANT STRIDES WITH FLEET MODERNISATION

Credit: Republic of China Navy

Taiwan's Republic of China Navy (ROCN) has completed deliveries of its first series production batch of stealth catamarans with the commissioning of ROCS An Chiang and ROCS Wan Chiang at a ceremony on 24 March 2024.

Having long been overshadowed by the rapid pace of its rival's People Liberation Army Navy's (PLAN's) expansion, Taiwan's Republic of China Navy (ROCN) has recently taken several important steps with its own fleet modernisation plans. Whilst still limited in comparison with its neighbours achievements, these offer the prospect of strengthening the island's ability to pose a significant asymmetric threat to any acts of aggression across the Taiwan Strait.

One of the most advanced programmes for fleet renewal is that for construction of the innovative *Tuo Chiang* class of stealthy, missile-armed catamaran corvettes. A ceremony attended by Taiwan's President Tsai Ing-wen on 24 March 2024 saw the delivery of ROCS *An Chiang* and ROCS *Wan Chiang*, the sixth and seventh members of the overall class and final units of the first series production batch to be completed. Armed with powerful batteries of Hsiung Feng III surface-to-surface missiles despite a modest full load displacement of around 750 tonnes, these vessels would complicate any amphibious operation against Taiwan's coastline. A second series production batch, incorporating improved air defence weaponry, is planned.

Amongst other projects currently underway is that for a new class of light frigate, which is being constructed in separate anti-submarine warfare (ASW) and anti-air warfare (AAW) configurations. Construction of the prototype AAW variant began towards the end of 2023 and has subsequently been followed by the start of work on the lead ASW configured ship. A total of twelve of these vessels are eventually planned to replace legacy frigate types. However, by far the most important programme is that for new indigenous diesel-electric submarines, a development that has 'game-changing' implications for ROCN capabilities. Having been officially named *Hai Kung* at a ceremony in September 2023, the lead boat was floated out by CSBC Corporation on 27 February 2024 prior to commencement of harbour acceptance tests.

AFRICA & THE MIDDLE EAST

SOUTH AFRICA: INSHORE PATROL VESSEL PROGRAMME UPDATE

On 1 March 2024 Damen Shipyards Cape Town hosted a blessing ceremony for the third and, to date, final multi-mission inshore patrol vessel (MMIPV) to be constructed as part of the South African Navy's Project Biro. The ceremony followed the delivery of the lead unit, SAS *King Sekhukhune* I, in May 2022 and her sister ship, SAS *King Shaka Zulu* in October 2023. The lightly-armed MMIPVs are based on Damen's Stan Patrol 6211 design and are intended to deliver a rapid response constabulary capability along South Africa's coastline to counter piracy, illegal fishing, and smuggling operations. Their Sea Axe Hull design, patented by Damen, is claimed to provide exceptional seakeeping behaviour, reduced fuel consumption, and enhanced safety and comfort onboard.

Whilst delivery of the final MMIPV, likely later this year, potentially marks the project's end, the total of three vessels is largely regarded as being completely inadequate to police South Africa's extensive maritime interests. However hopes for additional vessels are unlikely to be realised given ongoing real term reductions in the South African defence budget.

Credit: Damen

Damen Shipyards Cape Town is moving closer to completing its contract for three multi-mission inshore patrol vessels – SAS King Shaka Zulu is seen here – for the South African Navy.

SAUDI ARABIA: COMPLETION OF AVANTE 2200 CORVETTE ACQUISITION

Credit: Navantia

Saudi Arabia's programme to acquire 'Avante 2200', Al Jubail class corvettes from Spanish shipbuilder Navantia has reached a successful conclusion.

Saudi Arabia's programme to acquire 'Avante 2200' corvettes from Spanish shipbuilder Navantia reached a successful conclusion on 7 March 2024 with the commissioning of HMS *Unayzah*, the fifth and final member of the *Al Jubail* class, at the King Faisal naval base in Jeddah. Ordered under a EUR 1.8 billion (USD 2.0 billion) contract announced in July 2018, the ships are enlarged variants of the four *Guaiqueri* class offshore patrol vessels previously sold to Venezuela and are outfitted to the design's more capable 'combatant' standard. Although all five members of the class have been constructed at Navantia's shipyards in the Bay of Cadiz, *Unayzah* and her sister, HMS *Jazan*, are noteworthy for having been transported from Spain whilst in an incomplete state in order that final outfitting and combat management system integration could take place in Jeddah under a transfer of technology agreement with Saudi Arabian Military Industries (SAMI). Navantia has formed a joint venture with SAMI in Saudi Arabia to improve the country's naval integration and support facilities in line with the country's Saudi Vision 2030. A Naval Systems Integration and Development Centre of Excellence was recently inaugurated in Riyadh by SAMI Navantia Naval Industries as part of efforts to achieve this ambition.

MDM Editorial Commentary: The completion of the 'Avante 2200' programme marks a major achievement for Navantia, which appears to have successfully mitigated much of the impact of the Covid pandemic on the project's delivery schedule (reports at the time the contract was first signed envisaged programme completion by the end of 2022) despite some inevitable delay. The arrival of HMS *Unayzah* also marks a further step towards the recapitalisation of the Royal Saudi Naval Forces, which has seen its somewhat aging fleet seemingly suffered from a lack of investment in recent years. The Saudi navy will be further bolstered by future deliveries of the four multi-mission surface combatants (MMSCs) derived from the *Freedom* (LCS-1) littoral combat ship variant that have been ordered from Fincantieri Marinette Marine in the United States. The first of these is expected to be launched before the end of 2024.

Old and new:

Black Sea naval operations demonstrate different ways to generate effect at sea

Dr Lee Willett

Established technologies like mines and emerging technologies like uncrewed systems are shaping the way in which naval operations are being conducted in the Black Sea, during the Russo-Ukraine war. These technologies are also being used in ways that are affecting the conflict's wider development.

On 13 April 2022, the Russian Federation Navy Slava class cruiser *Moskva* was hit by two Ukrainian R-360 Neptune land-based anti-ship cruise missiles (ASCMs), while sailing off Odesa, Ukraine, in the western Black Sea.

The ship suffered significant blast, fire, and other damage; there were reports that ammunition onboard exploded. *Moskva* sank on 14 April.

Ukraine's sinking of *Moskva* was one of the most significant strategic-level occurrences in the early phases of the Russo-Ukraine war. Yet Ukraine's subsequent, continuing conduct of highly effective naval operations in the Black Sea region demonstrated that the sinking was not a one-off event, in terms of how naval and wider maritime activities in the Black Sea would shape the conflict.

Perhaps driven in part by concern for conflict spillover into NATO member states in Eastern Europe and the Baltic region, much of the analytical focus on the progress of the war from a Russian or Ukrainian perspective has covered developments on land. Yet, events at sea – in the Black Sea to the south, and in the Baltic Sea to the north – have demonstrated that naval activity and wider maritime developments have had significant effect on the conduct and development of the war.

Author

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Credit: Hans Anton Adams, Germany

Ukraine's sinking of the Russian cruiser Moskva in April 2022 was a sign of things to come in the Black Sea naval campaign, pointing to how Ukraine would seek to achieve sea denial effect. Pictured: Slava, the later Moskva, on her passage in the Street of Messina, August 1984.

The sinking of the *Moskva* certainly proved to be a precursor for what was to come, in terms of Ukraine demonstrating its ability to apply different technologies to achieve military effect at sea. With ASCMs being used to sink a warship at sea, for example, the war's Black Sea naval combat is presenting a classic example of conventional force-on-force engagement. However, the war's Black Sea naval combat is also a prime example of how new technology is being overlaid atop this conventional engagement, and is adding tactical, operational, and strategic effect.

In the latter instance, Ukraine has developed a highly effective sea denial campaign to target Russian ships at sea and in port, across almost the entirety of the Black Sea. The Russian Navy's strategic aim at the start of the campaign would have been to use its overmatched naval power to seize control of the sea across the Black Sea region, to cut off Ukraine's maritime trade, and to be able to use the Black Sea's northern and western littoral waters to project power ashore including to seize key territory around Odesa. Instead, to date, the Ukrainian armed forces' campaign of using uncrewed strike capabilities – mostly uncrewed surface vessels (USVs), but also uncrewed aerial vehicles (UAVs), uncrewed underwater vehicles, ASCMs, and air-launched land-attack missiles – has delivered almost the reverse outcome, with Russia's Black Sea Fleet being forced to largely retreat across the Black Sea to waters east of Crimea.

The different types of Russian ships that have been damaged, destroyed, and even sunk by this range of Ukrainian strike capabilities has demonstrated Ukraine's ability to conduct a flexible strike campaign, at sea and ashore, as part of its strategy of combining existing and emerging technologies

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to deny Russia free use of the sea. Notable incidents include:

- Attacking the Admiral *Grigorovich* class frigate Admiral Makarov with UAVs and USVs, while the ship was in port in Sevastopol
- Extensive damage inflicted on the Kilo class submarine *Rostov na Donu*, which was hit by air-launched Storm Shadow cruise missiles while in port, again in Sevastopol
- Ukrainian Bayraktar TB2 UAVs being used in successful strikes on several occasions against Russian patrol vessels and fast-attack craft, at sea and in port
- The *Tarantul* class corvette Ivanovets being hit and apparently sunk by a Magura 5 USV while out at sea off western Crimea
- Numerous amphibious and other landing craft, including *Ropucha* class large landing ships, being sunk or disabled in various UAV, USV, and ballistic missile strikes.

USV impact

As a result of these and other attacks, Russia's Black Sea Fleet has effectively been withdrawn to Russia's coast in the north-eastern corner of the Black Sea, and to Russia's naval ports there such as Novorossiysk. Through these and other attacks, Ukraine has actually achieved – to this point at least, in the war – sea denial at the tactical and operational levels. Ukraine's achievement in this respect is having strategic-level impact on the war, as Russia's ability to project power ashore into Ukraine is severely restricted, and its capacity to move and secure its own forces and resources at sea on its southern flank is being denied.

Ukraine's effective achievement of sea denial points to several key developments in the broader conduct of naval warfare. First, Ukraine has demonstrated the highly

Credit: NATO

Ships from NATO's SNMCMG2 are pictured during the Romania-led Exercise 'Poseidon' in the Black Sea in 2017. In the context of the Russo-Ukraine war, NATO member state navies – led by the alliance's Black Sea region countries – are starting to contribute in several different ways to addressing the Black Sea mine threat.

Credits: Security Service of Ukraine – ssu.gov.ua. Screenshot hum

Through using uncrewed surface vessels (USVs) and other stand off, uncrewed systems Ukraine has employed an effective sea denial campaign in the Black Sea while largely keeping its own personnel at distance from the at-sea threat. Here pictured (left) Avdiivka, the most recent version of the project Sea Baby (above an elderly drone), used by the Security Service of Ukraine as a multi-purpose platform.

effective, and adaptable, integration of uncrewed technologies into a campaign of naval engagement using traditional naval capabilities, including surface vessels and ASCMs.

Second, Ukraine has been able to achieve such strategic-level effect at sea without having a standing naval force of its own. Much of Ukraine's navy was sunk or seized during Russia's invasion of Crimea in 2014.

Third, Ukraine's USV campaign has demonstrated its ability – and adaptability – in harnessing new technology with fluid command-and-control (C2) structures to generate effect at the place and time of choosing at sea, even where and when it has neither personnel nor naval capability at sea. Whether using USVs or UAVs, Ukraine is developing a tried-and-tested capacity for the effective conduct of 'first person use' uncrewed system operations, where a ground-based operator wearing a pair of goggles uses remote C2 to simply drive the vehicle into the target.

Indeed, such is the regularity with which UAVs or USVs are now being used to strike targets ashore or at sea – in the Russo-Ukraine war including in the Black Sea, but also in the Yemen-based Ansar Allah (Houthi) rebel strikes against commercial and naval ships in and around the Red Sea – that such systems are now being referred to as 'one-way attack drones', rather than uncrewed vehicles.

The use of a guided aircraft to strike ships at sea is, of course, an operational approach that goes back to the Japanese 'kamikaze' attacks of the Second World War, with such attacks seen for the first time during the Battle of Leyte Gulf in October 1944. What is different now is that, while the aircraft is still being guided, the 'pilot' is guiding the aircraft onto the ship target remotely, and not from the cockpit.

In a keynote address at the Undersea Defence Technology (UDT) conference held at the ExCel exposition centre, London on 9 April 2024, Rear Admiral Jude Terry – the UK Royal Navy's (RN's) Director People and Training – said that Ukraine had demonstrated the ability to use USVs launched from shore and to deliver effect in the maritime domain without even having to deploy personnel or naval capability (including C2) at sea.

"It becomes about enhanced technology removing people from the up-threat perspective to deliver effect on the adversary," said Rear Adm Terry.

The admiral noted that many Western navies are still wedded to using a sea-based C2 structure to enable use of uncrewed systems at sea. The lessons of Ukraine's USV use in the Black Sea is that there are different ways of conducting crewed/uncrewed teaming, different ways of generating effect at sea, and different ways of using C2 including not necessarily needing to have such infrastructure at sea, said Rear Adm Terry.

As regards Ukraine's crewed/uncrewed teaming approach, this demonstrated to other navies that there are different ways of doing things, including using different skills, that those navies might not have thought about had they not seen it demonstrated in the war, Rear Adm Terry continued. While aircraft carriers, for example, will still be needed going forward including to deliver a range of effects from maritime security to high-end operations involving 'fifth generation' aircraft, the use of crewed/uncrewed teaming will provide more options for carriers to deliver effect, including at the warfighting level.

Overall, the admiral added, "What it has demonstrated is that ... people are the innovators," with technology being the enabler for that innovation.

Mine warfare

The second notable area of the Black Sea naval fight that demonstrates the use of established technologies in new ways is in the field of mine warfare.

Mines are being used extensively by both sides as a means to achieve sea denial effects, particularly in littoral regions. While the use of mines is, of course, a long-established technology, technique, and tactic in naval warfare, their use in the war at sea in the Black Sea is demonstrating nonetheless some emerging threats, in

Under the Maritime Capability Coalition, two retired UK Royal Navy minehunters – the former HM Ships Grimsby and Shoreham (pictured) – are being transferred to the Ukrainian armed forces to help rebuild its naval capability.

both technology and operational terms.
There are three key components that demonstrate the changing nature of the mine warfare threat, Philippe Méléard, the international business development lead for mine warfare at France's Naval Group, told the UDT conference. These are, he said: drifting mines; buried mines; and the deployment of mines in significant numbers across the region (in other words, at scale). Those two mine types will make up a large part of the future mine threat, Méléard added.
The use of drifting mines is perhaps the most significant new development. According to the US Naval History and Heritage Command, "Drifting mines are placed in the water and move with the current." The inherent capacity of drifting mines to move freely with the flow of the water is creating a significant threat to all shipping using the region, including naval and commercial ships. Moreover, the twin facts that war is underway in the Black Sea and that the Bosporus/Dardanelles Straits have been closed by Turkey, under the 1936 Montreux Convention, to naval ships that are not resident in the Black Sea means that options for any international response to deal with the threat – even just to commercial shipping – are limited.
With this type of mine already recognised as difficult to detect with the technology currently available, the added complication is the scale of the threat, Méléard explained. He noted that there could be hundreds of drifting mines in the Black Sea.
Drifting mines are a threat to both sides in the war, including because they take the threat out into blue water (whereas fixed mines are used largely in littoral regions, including around choke points).
Russian naval operations would be impacted, along with its commercial shipping operating along its own sea lines of communication (SLOCs). Indeed, it has been reported that Russian naval logistics ships are now sailing with naval escorts. For Ukraine, while its naval assets operating at sea are limited in number, efforts to maintain its maritime trade – including the Black Sea Grain Initiative – are crucial in providing the country with an economic lifeline. So, anything putting at risk the secure passage of ships along Black Sea SLOCs is of significant concern to Ukraine.
The risk to such SLOCs is evident. In December 2023, a Panama-flagged vessel heading for a port on the Danube River estuary to collect grain was damaged in a mine strike. According to media reports, the Ukrainian armed forces said the mine was Russian.
As regards buried mines, these are very hard to detect using current sonar technologies, said Méléard. This means a high risk of the mine remaining undetected, until events occur such as ocean current moving mud on the seabed or critical underwater infrastructure being installed.
In the longer term, as and when the war is over and when external access to the Black Sea is restored, NATO likely will move to address the MCM threat that will continue to drift across the region, looking for technology and operational options for detecting the mines and negating the threat. Méléard noted it will be important for NATO Black Sea member states to lead on this.
The first steps along this path have already been taken.
On 11 January 2024, the defence ministers from Bulgaria, Romania, and Turkey met in Istanbul, Turkey to sign a strategic-level, trilateral agreement to tackle the Black Sea mine threat. The agreement is known formally as the Black Sea Mine Countermeasure Task Group (MCM Black Sea) accord. A statement issued by the Turkish government noted that the three countries would improve co-operation and co-ordination to address the region's mine risk more actively. The MCM Black Sea deal is designed to contribute to the safety of navigation in the region, and in particular to develop a co-operative approach to dealing with the drifting mine threat. While recognising the requirements of the Montreux Convention and reiterating Turkey's national-level desire to maintain its decision to implement the convention in order to contribute to the Black Sea maritime security balance, the statement noted the regional requirement to ensure use of a maritime trade corridor across the Black Sea to enable the movement of resources like grain.
According to Turkey's statement, the accord also reflected the requirements set out in the NATO Vilnius Summit declaration in July 2023 for NATO regional allies to work together in local efforts to improve maritime security. The alliance communique itself stated "We underline our continued support to allied regional efforts aimed at upholding security, safety, stability, and freedom of navigation in the Black Sea region including, as appropriate, through the 1936 Montreux Convention."
A Romanian defence ministry press release stated that the MCM Black Sea task group command would rotate every six months, and that two planned at-sea activations would occur each rotation, with the aim being to ensure a continuous level of vigilance and preparedness, contributing to NATO's deterrence and defence posture on its southern flank.
While the broad thrust of the MCM Black Sea task group concept reflects NATO requirements for member states to co-operate in building regional maritime security, and while the Romanian statement noted that NATO's standing naval forces could participate in MCM Black Sea activities, the concept is not formally a NATO activity, instead being a trilateral regional partnership.
Another example of a national-level co-operative initiative established by two NATO members and aimed at growing Ukrainian naval capability to augment Black Sea security (from the alliance's perspective) is the trilateral UK/Norway/Ukraine Maritime Capability Coalition, established in December 2023.
Designed to provide a blueprint for re-building Ukraine's navy, the first major step announced as part of the arrangement was the transfer of two retired RN *Sandown* class MCM vessels (MCMV), the former HM Ships *Grimsby* and *Shoreham*. Additional steps include transferring 23 onshore/offshore raiding craft, and 20 Viking amphibious vehicles. While the decision to transfer the two MCMVs was taken before the war broke out, the transfer cannot be completed while the conflict continues, given Turkey's commitment to continue implementing the terms of the Montreux Convention.
In the absence of MCMV capability – but demonstrating once more the impact of new technology – Ukraine is using UUVs to conduct MCM operations.

Wider effect

Ukraine's ability to deny the use of the Black Sea to Russia's navy has impacted the war in wider ways.
Russia has long harboured desire to break through – from land or sea – into the southwest of Ukraine, around Odesa. However, Ukraine's effective strike at sea campaign – including targeting Russia's landing ship fleet – has denied Russia the opportunity and capacity to conduct an amphibious assault in that direction. Ukraine's use of mines has been a factor here, too.
From an offensive perspective, Ukraine has been able to use the sea to conduct its own raiding activities, including sending covert forces into Crimea to destroy a Russian radar site that was being used for C2 of Russia's own 'kamikaze' UAVs. ■

AUKUS Submarine (SSN-AUKUS): Status Update

Conrad Waters

A major element of the trilateral AUKUS defence security partnership between Australia, the United Kingdom and the United States that was first announced in September 2021 is to support the acquisition of conventionally-armed, nuclear-powered attack submarines (SSNs) for the Royal Australian Navy. Subsequently, in March 2023, a pathway to the achievement of this capability was revealed. This will ultimately see a trilaterally developed submarine – SSN-AUKUS – based on the United Kingdom's next-generation design but incorporating American submarine technologies entering service with both the Royal Navy and Royal Australian Navy. Given that construction of the new boats is scheduled to begin before the end of the current decade for delivery from the late 2030s onwards, the programme needs to be delivered at pace if the desired timetable is to be achieved. This article provides an update on progress to date.

The AUKUS trilateral security partnership

Heralded as a landmark agreement that "will help sustain peace and stability in the Indo-Pacific region", the AUKUS trilateral security partnership announced by the three countries leaders in September 2021 was essentially a response to China's increasingly assertive stance as a regional power. The first initiative taken under the new agreement, sometimes referred to as 'Pillar 1' was to support the Royal Australian Navy's acquisition of a strengthened underwater capability based around nuclear-powered but conventionally-armed submarines. Significantly, the decision involved abandonment of Australia's previous plans to construct a class of twelve diesel-electric *Attack* class submarines to Naval Group's 'Shortfin Barracuda' design in a major setback for the French group. The increased speed, endurance and flexibility provided by nuclear propulsion compared with the more incremental improvements offered by the *Attack* class against the backdrop of a deteriorating security environment was probably the main factor in this decision.

The announcement launching the AUKUS pact stated that the partner countries would immediately embark on an 18 month effort to seek "an optimal pathway" to deliver the new Australian capability. Subsequently, a joint steering group comprising senior officials from all three countries met on 12 occasions between December 2021 and February 2023 to determine the way forward. This steering group examined a wide range of potential options for Australia's acquisition of SSNs. This led to a further joint announcement by the nations' leaders on 13 March 2023 setting out how Pillar 1 of AUKUS was to be achieved.

Credit: Crown Copyright 2023

SSN-AUKUS – based on the United Kingdom's next-generation design but incorporating American submarine technologies – will enter service with the Royal Navy and Royal Australian Navy as part of the AUKUS partnership.

The agreed pathway involves a phased approach to the introduction of the Australian SSN capability. This has four major stages, namely:

- The embedding of Australian naval and civilian personnel within the American and British fleets and associated industrial bases from 2023 onwards. This is to be accompanied by a steady increase in visits by Royal Navy and US Navy SSNs to Australian ports.
- The commencement of forward rotations of American and British SSNs to Australia from 2027 onwards to accelerate the development of personnel, infrastructure and regulatory capabilities needed to establish a sovereign capability to operate SSNs.
- The purchase of three *Virginia* (SSN-774) class submarines from the United States – with potential options for two more – from the early 2030s onwards.
- The development of the British based SSN-AUKUS submarine for construction both in Australia and the United Kingdom for service in the respective countries' fleets. It is intended that the Royal Navy submarines will start to enter service from the late 2030s and be followed by the Australian boats early in the following decade.

Credit: US Navy

USS Santa Fe (SSN-763) pictured operating with Royal Australian Navy Collins class submarines. A phased pathway will see Australia start operating American-built Virginia class submarines before transitioning to deliveries of locally assembled SSN-AUKUS submarines in the early 2040s.

Significant steps have already been taken to implement the early stages of this optimal pathway. For example, Australian personnel have started to be embedded in the British military and AUD 1.5 billion (USD 1 billion) has been approved for early priority works at the HMAS *Stirling* naval base in Western Australia to prepare the facility for SSN rotational deployments. This forms part of a wider package of AUD 18 billion (USD 12 billion) earmarked for construction and support infrastructure in South and Western Australia over the next decade to bring the endeavour closer to completion. Meanwhile, signature of the US National Defense Authorization Act for FY2024 in December 2023 provided the legislative agreement needed by the Biden administration to implement key parts of the pathway, including the future transfer of *Virginia* class submarines, the training of Australian personnel and the simplification of onerous US export control requirements. It has been reported that Australia will provide USD 3 billion to the United States in coming years to help ease bottlenecks in American SSN construction.

SSN-AUKUS

Although the delivery of SSN-AUKUS forms the final phase of the critical pathway to provide Australia with a SSN capability, the long lead times associated with the design and construction of a new submarine mean that time is short if planned deadlines are to be met. In particular, SSN-AUKUS requires substantial investment in expanding British infrastructure to build and maintain submarines whilst also creating an entirely new sovereign Australian industrial base in this sphere.

The foundation for the SSN-AUKUS submarine is the previous British Submersible Ship Nuclear Replacement (SSNR) programme, which was originally intended to provide the successor to the Royal Navy's *Astute* class boats. This programme started to gain traction in September 2021 when BAE Systems and Rolls-Royce were each awarded contracts valued at GBP 85 million (USD 107 million) to undertake three years of conceptual design studies for the submarine platform and its nuclear propulsion. In essence, SSN-AUKUS will be based on this SSNR conceptual work, whilst also benefitting from a number of American submarine technologies. These have been stated to include elements of the propulsion plant, a common vertical launch system, and weapons. The AUKUS partners also intend to develop a joint combat system evolved from the AN/BYG-1 Combat Control System found aboard both the *Virginia* class and also Australia's current *Collins* class submarines. Although there has been much speculation, few tangible details of likely design characteristics have emerged to date.

Delivery of the British element of SSN-AUKUS is being overseen by the Submarine Delivery Agency, an executive agency of the UK Ministry of Defence. The plan for the construction of SSN-AUKUS envisages fabrication commencing at BAE Systems' Barrow-in-Furness facility in Cumbria towards the end of the 2020s. The shipyard is currently heavily committed to delivering the final members of the *Astute* class, as well as the new Dreadnought strategic submarines. Having rundown its workforce in the Cold War's aftermath to a low of fewer than 5,000, the facility has been steadily expanding employment in recent years and further expansion is on the cards. BAE Systems anticipates its submarine workforce will peak at around 17,000 (compared with today's 13,500) to support SSN-AUKUS. It is also envisaged that the shipyard's facilities will double in size to around 160,000 m² over this time. Nevertheless, it is recognised that transition to production of SSN-AUKUS will exacerbate pressures on an already stretched supply chain, with the involvement of elements of Australian industry with the relevant expertise seen as potentially beneficial in this regard.

Whilst Barrow will be responsible for the construction of Royal Navy SSN-AUKUS units, assembly of all the Australian members of the class will take place at a new Submarine Construction Yard at Osborne in South Australia. Osborne is the focal point of much of Australia's existing naval shipbuilding industry and was where its existing *Collins* class submarines were constructed. Substantial investment will be required throughout the coming years to allow work on the new submarines to start by the end of the decade. A contract signed in December 2023 envisages preliminary enabling works for the new facility commencing in the course of 2024. The Australian government estimates that up to 4,000 workers will be required to design and build the necessary infrastructure at Osborne. Between 4,000 and 5,500 additional jobs will be created in South Australia to build the new submarines once construction is underway. Although the Royal Australian Navy's AUKUS submarines will be built in Australia, manufacture of all SSN-AUKUS nuclear reactors will be entrusted to Rolls-Royce in the United Kingdom. The group's facilities at Raynesway, Derby are being doubled in size to accommodate the expanded workload and well over 1,000 jobs will be created across a number of disciplines. Two satellite offices have been opened in Glasgow and Cardiff to help access an expanded labour pool.

Credit: BAE Systems

BAE Systems' Barrow-in-Furness facility will be the focal point of construction of the Royal Navy's SSN-AUKUS submarines. This photo shows HMS Anson, one of the current generation Astute class, at the time of her launch.

Credit: Australian Naval Infrastructure Pty Ltd

Assembly of all the Australian SSN-AUKUS submarines will take place at a new Submarine Construction Yard at Osborne in South Australia.

The detailed design and long-lead items phase

The expansion of British facilities is being underwritten by the signature of GBP 4 billion (USD 5 billion) of contracts marking the commencement of a five year 'Detailed Design and Long Lead Items' (D2L2) phase on 1 October 2023. The agreement was made with key United Kingdom participants BAE Systems, Rolls-Royce and Babcock International with a view to taking forward "the programme through the design, prototyping and purchase of main long lead components for the first UK submarines". In addition to allowing construction to commence in the coming years, the investment is intended to ensure the stability and resilience of the domestic supply chain. The D2L2 scope includes early fabrication of steel in a new assembly shop at the Barrow site that is planned within this phase of the contract
A contemporaneous announcement by BAE Systems set the value of its contract award at GBP 3.95 billion, although this probably includes amounts allocated to the group's principal partners in the nuclear-powered submarine enterprise. In any event, the Ministry of Defence investment will support implementation of much of the expanded industrial infrastructure referenced above. Another important aspect is the involvement of Babcock to apply its extensive experience of submarine support and maintenance to maximise SSN-AUKUS availability throughout their intended service lives.
It is currently envisaged that the end of D2L2 will be followed by the implementation of a new contract phase from October 2028 onwards that will encompass construction of the first Royal Navy submarines. At this time, no firm decision has been made on the number of British units that will be completed.

USS Texas (SSN-775) seen preparing to undock after completing a maintenance period. The challenges of creating the infrastructure and workforce needed to allow Australia to build and then sustain a flotilla of nuclear-powered submarines are immense.

Developments in Australia

Whilst delivery of the first Australian AUKUS submarines is scheduled to follow someway behind their British counterparts, the extent of the work required to develop the necessary national infrastructure means that the urgency to ensure Australia is 'sovereign ready' is equally as great. An Australian Submarine Agency was established on 1 July 2023 to exercise management and oversight of the endeavour. Headquartered in Canberra and headed by Australian Vice Admiral Jonathan Mead, the agency has a broadly similar remit to its British counterpart.
An important element of early Australian activity has been to develop Australian supply chains to facilitate local industry's participation in AUKUS production, as well as in the broader British and American submarine supplier network. A Defence Industry Vendor Qualification Program was launched in January 2024 to support this wider ambition. The programme will work with 26 companies in its initial wave to qualify supplies across four product families to meet American supply chain requirements. The next wave will expand the programme to qualify suppliers into both the United States and United Kingdom supply chains, commencing in mid-2024. Substantial investment is also being made in training the workforce that will be needed to build and sustain the new submarines, including the creation of a Skills and Training Academy at Osborne to deliver education, training and skilling for the submarine and naval shipbuilding workforce
A further series of announcements in March 2024 laid the foundations for future SSN-AUKUS construction and sustainment. In a logical move, it has been determined that ASC Pty Ltd – builders of the *Collins* class – and BAE Systems will work in partnership to deliver the new submarines, ultimately through the formation of an incorporated joint venture. In addition to strengthening the connection derived from BAE Systems' leadership of SSN-AUKUS design and construction in the United Kingdom, the decision will undoubtedly benefit from the British company's existing presence in Osborne through the *Hunter* class frigate programme.
ASC Pty will also be responsible for sustainment of Australia's *Virginia* and SSN-AUKUS class boats, building on the role it currently undertakes for the country's existing submarines. Although an element of uncertainty exists, open source reports suggest that five Australian SSN-AUKUS boats are planned.
It has also been reported that Australia will invest GBP 2.4 billion (USD 3.1 billion) in the United Kingdom's industrial base to support delivery of British-sourced components. Some of this funding will supplement the United Kingdom's own investments in Rolls-Royce's Raynesway facility and some allocated to expanding capacity at Sheffield Forgemasters. The latter is a British Ministry of Defence-owned heavy engineering firm that will supply critical cast and forged products for the new submarines.

The pathway ahead

There has been considerable scepticism, particularly in some parts of the Australian press, about the practicality of delivering the SSN-AUKUS programme within the ambitious timetable envisaged. The challenges inherent in the programme, which depends on the expansion of overstretched industrial bases in the United Kingdom and United States and the creation of an entirely new capability in Australia, are certainly immense. The stakes could also certainly not be higher given the deterioration of the security environment in the Indo-Pacific region.
Despite these doubts, it is hard not to be impressed with the sense of urgency – backed by a massive financial and political commitment – that has typified the early stages of the efforts to deliver AUKUS Pillar 1. If the current rate of progress can be maintained, the realisation of the SSN-AUKUS project holds out the prospect of delivering a transformation effect to the partner nations' maritime security and industrial capabilities in the years ahead. ■

Credit: US Navy

Interview

Sir Nick Hine, KCB: Managing Director AUKUS & International

Successful achievement of the SSN-AUKUS programme's objectives will require a huge international effort in developing the infrastructure and skills needed to support this next generation of nuclear-powered submarines. Currently tasked with sustaining the entirety of the British Royal Navy's submarine fleet, defence and engineering conglomerate Babcock International Group PLC has a key part to play in this endeavour. MDM recently interviewed Sir Nick Hine, Managing Director of Babcock's AUKUS & International business about the once in a generation challenges and opportunities the programme presents.

MDM: Please explain the significance of the AUKUS submarine programme to the United Kingdom and the other partner nations in strategic terms?
Sir Nick Hine: AUKUS is the biggest, most ambitious strategic security partnership in our lifetime. It is a trilateral agreement which will play a vital role in both deterrence and defence, particularly in the Indo-Pacific region. Historically, the United States has only shared its submarine capability with the United Kingdom but this new collaboration welcomes Australia into the equation. It gives the three nations, all of which are part of the Five Eyes Intelligence Alliance, the opportunity to work together on a state-of-the-art submarine programme and help Australia deliver its strategic goals in the Indo-Pacific region. In a period of increased geopolitical instability, Australia needs to develop its sovereign defence capability, and develop it at pace. AUKUS is central to this.

Credit: US Navy

Australian, British and United Stares personnel pictured against the backdrop of the US Navy Virginia class submarine Indiana (SSN-789) during an exercise in the Arctic. The AUKUS submarine programme has been born out of what Babcock's Sir Nick Hine claims as the "most ambitious strategic security partnership in our lifetime", providing the three partner nations with the opportunity to collaborate on a state-of-the art submarine programme.

MDM: What are the benefits to the Royal Navy in building its next submarines as part of an international partnership? What are the potential downsides of this approach?
Sir Nick Hine: There are multiple benefits to the Royal Navy working with its allies on its next generation submarines. Building at a larger scale reduces cost and risk, while at the same time allowing the creation of stronger and more resilient supply chains. Working with the United States and Australia allows both countries increased interchangeability and interoperability in equipment and skills. Submarine programmes are inherently complex and close collaboration between governments and industry is therefore particularly important. This is a national endeavour for Australia; a programme of huge scale, where the nation will benefit from the same world class platforms as the Royal Navy. The AUKUS submarine programme therefore ensures our allies around the world are well positioned to deal with any threats.

MDM: What new capabilities will the SSN-AUKUS provide over and above those embedded in current nuclear-powered attack submarines, such as the *Astute* and *Virginia* classes? What technological and operational changes are likely to influence the design of the new boats?
Sir Nick Hine: Australia's inaugural nuclear-powered submarines will benefit from enhanced technology over their predecessors. The new nuclear-powered submarines will be quieter and have better crew facilities. They will be more efficient and have improved power distribution and propulsion.

MDM: Can you summarise Babcock International's role in the AUKUS submarine programme, including the specific capabilities your company adds to the project?
Sir Nick Hine: Babcock is a world leader in nuclear sustainment and there is no one better qualified to be a partner to the Australian Government to assist the delivery of the nation's inaugural nuclear-powered submarines. We can support the infrastructure, skills and regulatory environment needed to achieve this endeavour because we have lived this for 60 years through supporting the Royal Navy in the United Kingdom. We operate Britain's only nuclear licensed sites with the capability to conduct the deep maintenance, defueling, and ultimate disposal of nuclear submarines. In addition, Babcock is the premier warship sustainment company in Australia and New Zealand, making us well placed to build on our role of providing Australia with critical support services.
It is also worth noting that we have partnered with American global defence giant Huntington Ingalls Industries (HII) to

support and develop capability under the AUKUS trilateral agreement.
For Babcock, this is an opportunity to leverage our technical capability. It will allow us to grow both our British and international business, creating high quality jobs at home while also allowing us to expand our activity in Australia, helping to solve our customers' most complex challenges.

MDM: Please outline the main challenges that need to be overcome in delivering the SSN-AUKUS project to time and to budget? What steps can be taken to mitigate these?
Sir Nick Hine: To ensure AUKUS acts as an effective deterrent, delivering capability at pace is crucial. Babcock has welcomed the Australian government's recent announcement that ASC Pty Ltd – the former Australian Submarine Corporation – will be the sovereign sustainment partner to support the *Virginia* (SSN-774) class submarines and, then, SSN-AUKUS. We are proud, long-standing partners of ASC and work with them to sustain Australia's current *Collins* Class submarines. We stand ready to support them into the future. The Australian government has clearly stated ASC will need support from British and American partners, such as Babcock, to deliver this capability.
There is also a critical skills shortage – and a competitive jobs market – which needs to be addressed. While speed is of the essence, it is important to acknowledge that AUKUS is a multi-decade programme. There are once-in-a-lifetime opportunities for young people living in Australia, the United States and the United Kingdom to support this huge endeavour, where people who will soon be finishing school could feasibly work on it for the majority of their career. At its peak, AUKUS will support more than 21,000 jobs in the United Kingdom alone. We need to be ambitious and creative in the planning for this, encouraging people into a career in defence and ensuring we have the right partnerships in place to increase skills and get them working on the programme.

Credit: Babcock International

Babcock operate Britain's only nuclear-licensed sites with the capability to conduct the deep maintenance, defueling, and ultimate disposal of nuclear submarines. This image shows work underway on the reconstruction of Number 10 Dock at the group's Devonport Royal Dockyard to support future nuclear-powered submarine refits.

MDM: What progress has been achieved since the pathway to delivering SSN-AUKUS was announced in March last year? What are the next critical steps?
Sir Nick Hine: The establishment of AUKUS is, of itself, a huge achievement but there is a lot to get done. Infrastructure should be a major, immediate focus. We need shovels in the ground to prepare for the build, support and operation and we need to turn our minds to the regulatory and support requirements needed to maintain and sustain nuclear-powered submarines into the future. As mentioned previously, skills provision is another critical next step. Being able to say you work in defence and play a role in creating a safer and more secure world should instil a huge amount of national pride. Accordingly, we need to be encouraging people into this rewarding career.

MDM: Finally, what implications, if any, does SSN-AUKUS have for the partner nations' wider industrial base, for example in the nuclear sphere?
Sir Nick Hine: This is a fantastic opportunity for UK PLC. As a nation, we are world leaders in submarine design and build. Babcock has played a historically important role in this; our patented weapons handling and launch systems are found on all Royal Navy submarines and we have a world-leading record in sustainment. With AUKUS, Babcock, and other key strategic partners will need to build on this, which means upscaling for provision, skills, and the supply chain. AUKUS presents us with the opportunity to make the nuclear domain more stable in industrial terms. It is a generational opportunity, and we need to embrace it tri-nationally.

MDM's questions were asked by Conrad Waters.

Credit: Babcock International

Sir Nick Hine KCB is Managing Director – AUKUS & International at Babcock International

Biography:
Sir Nick Hine KCB

In early 2023, Babcock appointed Sir Nick Hine KCB as Managing Director – AUKUS & International to lead this newly established division that aims to deliver key capabilities in support of the trilateral security treaty. Sir Nick is a former British Royal Navy Vice Admiral with decades of experience in naval strategy and submarine operations. He joined Babcock in the United Kingdom from the Royal Navy, where he was the Second Sea Lord. He brings with him a wealth of wider Government and industry facing knowledge which will be invaluable to the delivery of the AUKUS security partnership's objectives.

Adding mass, adding value

UUVs bring underwater sensing quantity – and quality – to the naval fight

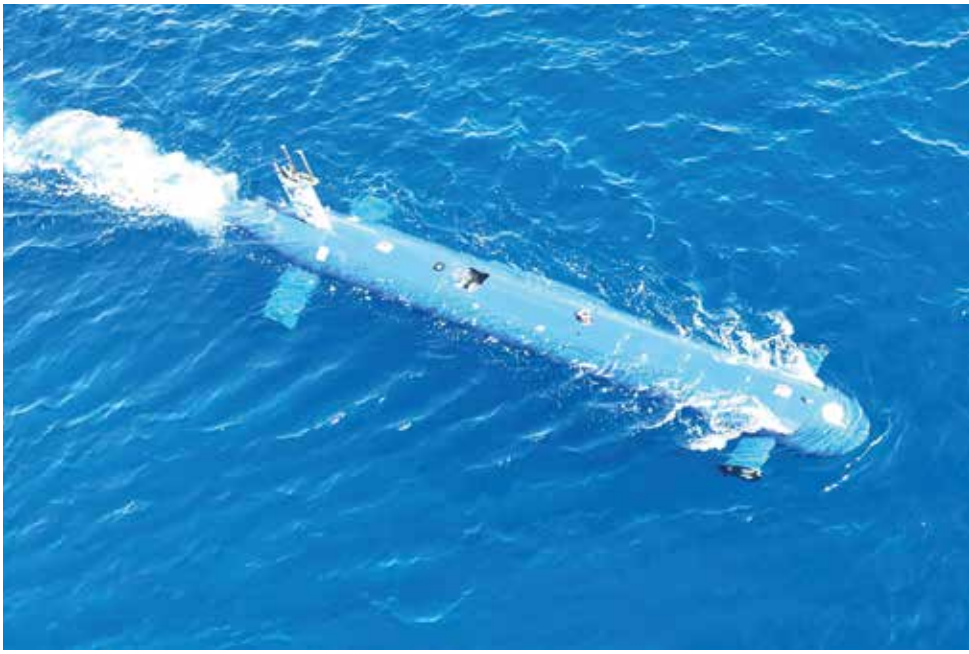
Dr Lee Willett

The Euro-Atlantic maritime theatre is a significant geographic space. Across it, from the High North to the Eastern Mediterranean, are key maritime straits and choke points. Given the current contested nature of the Euro-Atlantic maritime battlespace – something evident even before conventional high-end conflict (including war at sea) broke out in Ukraine, in 2022 – there is a need to deploy sensing capability at these maritime choke points, and elsewhere, to either secure or deny access to the waters around these locations.

The contested nature of the Euro Atlantic's maritime battlespace, and the need to secure such maritime access, points to the continuing – and increasing – importance of the underwater domain. Naval assets operating unseen in the underwater domain bring covert effect and operational deniability: a navy may, even, not risk deploying naval forces to certain waters just due to the concern that an adversary's underwater assets might be present. In this battlespace, requirements to generate defensive capability or to deliver offensive effect all underline the importance of robust sensing capacity in supporting these outputs.

While mostly out of sight, submarines are far from out of mind in today's Euro-Atlantic battlespace. For the last decade, senior NATO submarine commanders have been talking about the increasing presence and capability of Russia's submarine force. Even though still mostly out of sight, during the Russo-Ukraine

Credit: IAI/Elta Systems



UUVs are playing an increasingly important role for NATO navies in tackling the 'dull, dirty, and dangerous' tasks in underwater sensing. The IAI/Elta Systems BlueWhale autonomous submarine system is pictured, at the 'REPMUS' exercise in 2023.

Credit: Michael Nitz, Naval Press Service

Russia's lead Project 885/885M Yasen class nuclear-powered attack submarine (SSN) Severodvinsk in her passage of Great Belt in July 2022.

Author

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Credit: US Navy

The US Navy Virginia-class submarine USS New Mexico is pictured off Tromso, Norway in 2021. With NATO submarines pushing east of Tromso into the Barents Sea, UUVs can play a key role in providing underwater sensing capability across choke points like the GIUK and Bear Island gaps.

war Russian submarines have made high-profile deployments into key waters.

In July 2022, Russia's lead Project 885/885M *Yasen* class nuclear-powered attack submarine (SSN) Severodvinsk deployed from the North Sea through the Kattegat/Skagerrak maritime choke point into the Baltic Sea, heading for St Petersburg and Russia's Naval Day parade. In the Mediterranean, various defence media sources have reported the presence of different Russian submarines types, including Kilo class diesel-electric submarines (SSKs). In the war itself, Kilo class boats in the Black Sea have fired Kalibr sea-launched cruise missiles (SLCMs) against targets ashore in Ukraine. Prior to the war, back in 2020, Russia had sailed a Project 949A *Antyey/Oscar* II class nuclear-powered guided-missile submarine (SSGN) into the Baltic.

Russia's submarine capability – especially now that most of its different SSN, SSGN, and SSK types carry land-attack/anti-ship Kalibr SLCMs – now poses a different threat to NATO than in the Cold War days. Russian boats can – and do – still deploy through the Greenland-Iceland-UK (GIUK) Gap to present a '360-degree' threat to NATO including with the Kalibr capability. However, the strike range provided by Kalibr means that Russian boats can also drop deeper within their own bastions (notably, the Barents Sea) and still threaten major targets at sea and ashore across the Euro-Atlantic theatre.

Rather than an access point out into the North Atlantic (as it was for the Soviet Navy in the Cold War), Russia may see the GIUK Gap today as more of a barrier to keeping US Navy (USN) SSNs out of the Norwegian and Barents seas. Yet now that NATO submarines are already pushing further north including into the Barents Sea to generate forward presence, just as they did in the Cold War, so the Bear Island Gap – running from Norway's Svalbard Island, down past Bear Island itself, to Norway's North Cape – has assumed similar strategic and operational importance to the GIUK Gap.

Given the naval operational context in the Euro-Atlantic theatre, and how its maritime flanks – the High North, and the Eastern Mediterranean/Black Sea – are used by Russia to try and spread insecurity outwards from the Russo-Ukraine war, and by NATO to try to contain and constrain Russian activities at sea and ashore, the underwater activity across the theatre covers large distances; the choke points become increasingly significant in strategic terms; and NATO navies find themselves needing to generate mass across extended distances for extensive periods of time. This operational context is particularly important – and testing – in the underwater domain.

More important

Speaking at the Undersea Defence Technology (UDT) exposition, which took place at the ExCel exhibition centre in London in early April, Rear Admiral James Parkin – the UK Royal Navy's (RN's) Director Develop – underlined the enduring importance of the sub-surface maritime battlespace.

"Nowhere – nowhere – is more important for us than the underwater domain," he said. For a navy like the RN, the underwater domain has strategic-level significance. Rear Adm Parkin noted that the UK's nuclear deterrent is deployed below the surface, and that the UK relies on the underwater domain to secure sea lines of communication (SLOCs) including those on the seabed such as cables.

The UK's deterrent, SLOCs, and critical underwater infrastructure (CUI) are all secured in large part by various underwater sensing capabilities. Underwater sensing is a multi-layered activity. However, the vast waterspaces across the Euro-Atlantic theatre stretch even the collective numbers and capability of a large alliance like NATO.

Underwater sensing starts in the air, with maritime patrol aircraft (MPA). For NATO in the Euro-Atlantic, the predominant capability is the Boeing P-8A Poseidon MPA – with the US, UK, and Norway already deploying P-8A, and with Canada, Germany, and (possibly, although by no means definitely) Italy set to follow suit.

Surface ships bring various organic underwater sensing capabilities, including hull-mounted and towed-array sonars plus embarked anti-submarine warfare (ASW) helicopters equipped with sonar buoys and dipping sonars. The collective mass generated by NATO navies' surface forces is significant in numbers terms. However, with some of these navies needing to project forward presence more widely around the world and to meet an increasing operational demand at home, operational numbers in Euro-Atlantic waters are still

Credit: US Navy

US personnel deploy a REMUS 100 UUV during a 'REPMUS' serial off Sesimbra in 2019. The 'REPMUS' exercise has grown, since its 2010 inception, into a major international activity for testing uncrewed systems like UUVs.

tight. The increasing North Atlantic ASW threat in particular has prompted senior NATO naval commanders to state that NATO Allied Maritime Command's (MARCOM's) Standing NATO Maritime Groups (SNMGs) need more 'tail ships' (frigates or destroyers fitted with towed-array sonars).

Below the surface, the challenge is perhaps more – and maybe even most – acute. NATO submarine numbers have dropped sharply since the Cold War, yet it is in the underwater domain where Russia has been demonstrating particular focus and development.

Credit: US Navy

Multinational personnel at a 'REPMUS' shore facility analyse sonar information from a UUV. A physical communications network, architecture, and associated standards are all integral to developing an effective command-and-control (C2) structure, by which UUVs and other uncrewed systems can communicate and share sensor information.

Speaking at the Royal United Services Institute (RUSI) Seapower conference in London in April 2023, the Royal Norwegian Navy's (RNoN's) then Chief of Navy Rear Admiral Rune Andersen said that, despite questions over Russian performance in its war in Ukraine, "[the RNoN doesn't] transfer that to some of the maritime capabilities that have been prioritised for several years, in particular the submarine fleet, which is modern and capable." "We don't underestimate the quality or effectiveness, and we see that in our daily operations," the admiral continued. He added that Russian Northern Fleet assets have largely been unaffected by the war, and have consequently increased in relative importance for Russia.

While NATO is largely perceived to still retain a technology and capability edge in the underwater domain, Russian developments and activities have closed this gap. Moreover, given the strategic importance of certain waters and the geographic distances involved in covering them, NATO's submarine numbers will be increasingly stretched, especially as several key NATO submarine navies are in various stages of transitioning to new submarine fleets.

Moreover, given the contested nature of naval operations across the Euro-Atlantic theatre in the underwater domain, NATO's submarine navies will find challenge in what it is they want their boats to do. Russia's increasing submarine activity and capability levels across the theatre are leading the alliance's submarine-operating navies to prioritise forward-deployed ASW operations. Yet, behind this up-threat presence remains the requirement to cover the 'dull, dirty, and dangerous' tasks that enable the maintenance of an extensive underwater sensing network.

This is where uncrewed underwater vehicles (UUVs) are playing an increasingly critical role for the alliance.

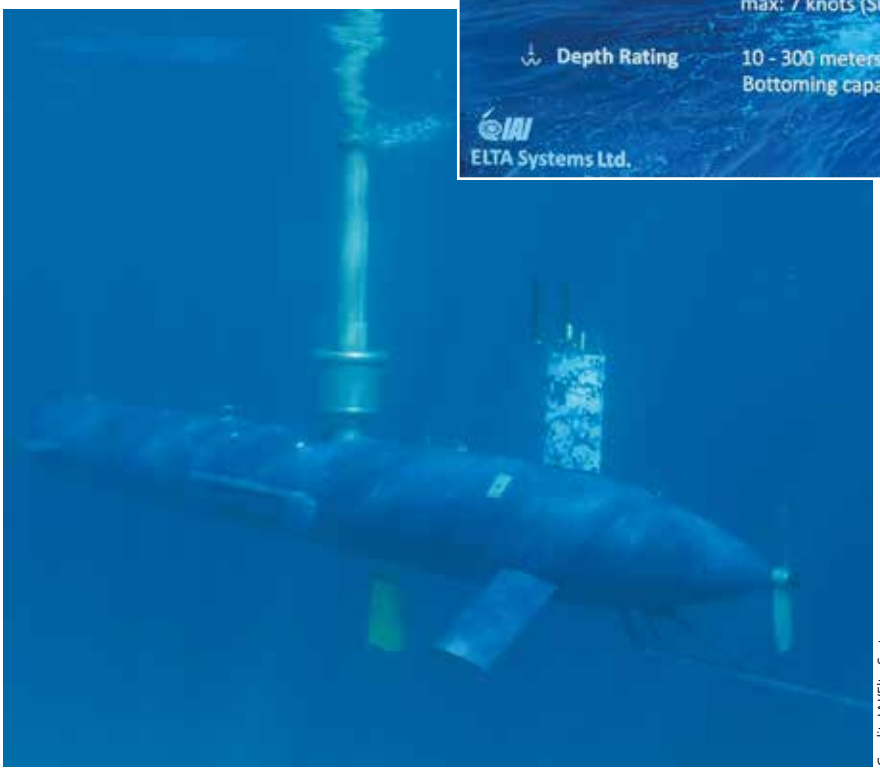
Why UUVs?

NATO has several different tasks it needs UUVs to cover with sensing capability.

In ASW terms, while submarines provide the forward-deployed operational output and effect, UUVs (not only AUVs, but also underwater gliders) are well suited to providing sensing barriers across choke points like the Bear Island or GIUK gaps in support of the broader, 'dull, dirty, and dangerous' sensing tasks.

AUVs and gliders also provide the kind of flexible and sustainable sensing capability needed to support a task like intelligence,

surveillance, and reconnaissance (ISR). Moreover, as has been demonstrated in the Black Sea during the Russo-Ukraine war, underwater sensing capability is also needed for mine countermeasures (MCM) operations. Here, both Russia and Ukraine have conducted extensive mine warfare activities to deny their adversary access to key waters. For Ukraine, with a naval surface force structure denuded by the war and during Russia's 2014 annexation of Crimea, it currently relies on UUVs to conduct MCM operations.



Credit: IAI/Elta Systems

BlueWhale is pictured dived at 'REPMUS' in 2023. The vehicle was able to successfully track AUVs operating as target trainers, and then transmit the tracking data to a ground station in real time, using its onboard SATCOM system.

Credit: H. Uwe Mergener

At UDT 2023 IAI presented Blue Whale, its XL-Underwater Drone.

Submarines are clearly best suited to key high-end tasks including forward-deployed ASW, ISR, and indicators and warning (INW). However, as Rear Adm Parkin explained, crewed platforms have become increasingly expensive to the point that not enough of them can be acquired to meet the task requirement set against the budget available. This affects mass, said Rear Adm Parkin. "Mass wins wars," he added.

The use of systems like AUVs and gliders underlines the increasing importance of autonomy. Rear Adm Parkin spelled out five effects that autonomous capability development should focus on in the near term, namely: scout, screen, sweep, supply, and shoot. The first three of these relate to underwater sensing.

Sensing barrier

The capability to conduct scout, screen, or sweep tasks will be core requirements for UUVs when operating across the range of key underwater sensing roles and operational tasks for which autonomous systems are well suited. Whether to picket choke points, to hem in an adversary's submarines, or to sanitise access routes for follow-on force deployments of carrier strike groups (CSGs) or amphibious task groups (ATGs), UUVs can perform such tasks through presenting a 'barrier' to adversary naval capabilities. To integrate UUV capabilities and communications to support roles like these, NATO itself has developed the ASW Smart Barrier Initiative, for which the Allied Underwater Battlespace Mission Network will provide the integrated communications architecture.

The physical communications network and associated architecture required to underpin underwater command and control (C2) must be fully coherent to enable the 'plug and play' concept of operations required for allied UUVs to construct and operate any such barrier. To conduct C2 of UUV-based, barrier-style operations, the network must be able to pass around the C2 directions required and pick up, process, and share the data and information needed by the operators.

NATO's ASW Smart Barrier Initiative has been tested at the Portuguese Navy-/MARCOM-hosted 'REPMUS'/'Dynamic Messenger' maritime uncrewed systems (MUS) combined exercise, which takes place in September each year off Troia, southern Portugal. The two exercises take place in tandem, running for two weeks and one week, respectively.

'REPMUS' developed as a Portuguese Navy-led activity to test the concepts and capabilities of new MUS technologies. Since its inception in 2010, it has grown into a significant international event. 'Dynamic Messenger' took place for the first time in 2022, with MARCOM's intent being to use 'Dynamic Messenger' to step the concepts and capabilities tested at 'REMPUS' up into the operational experimentation (OPEX) realm. The escalating nature of the security challenge to NATO at sea across the Euro-Atlantic theatre in very recent years, including with the onset of war, has seen the exercises stepping up their own output. 'REPMUS' itself is increasingly focused on OPEX, with 'Dynamic Messenger' seeking to integrate MUS OPEX more regularly into operational NATO task group activities.

The output and impact of the 'REPMUS'/'Dynamic Messenger' process on MUS technological, conceptual, ca-

pability, and operational developments is demonstrated by the complexity of the exercise itself. MUS of all types – uncrewed aerial vehicles (AUVs) and uncrewed surface vessels (USVs), as well as UUVs – are trialled and tested in all domains and in all the operational contexts navies currently are focused on for employing MUS capability. So, the exercises' serials list includes ASW, CUI security, ISR, and MCM taskings.

These tactical serials are also set in wider operational context. For example, 'REPMUS 23' included testing the use of UUVs in conducting ASW, ISR, and MCM taskings in advance of a planned amphibious assault on a peninsula. Offshore, further ASW activities took place, building and refining multinational capabilities to be integrated into sensing barriers under the ASW Smart Barrier Initiative. Inshore, for CUI security, the exercise conducted a multi-domain CUI protection capability demonstration – incorporating UAVs, USVs, and UUVs – to locate and secure a seabed cable, and then detect and deter threats to it, drawing particularly on MUS-generated ISR information. The activity was designed to piece together not only the individual MUS system capabilities, but also their co-ordination and communication, to tackle the CUI risk.

Overlaying all these activities was a focus on developing an effective C2 network, including the underpinning architecture and the associated system and communications design and network standards (bringing a focus on developing the appropriate standardisation agreements [STANAGs]).

Underwater sensing played a crucial role across the exercises' operational activities. In remarks at the opening ceremony of the Distinguished Visitor Day, which took place at the overlap of the two exercises, Vice Admiral Mike Utley – MARCOM's Commander, and an RN officer – underlined the important role of MUS in delivering sensing output, including in the underwater battlespace.

"We need improved persistence and understanding. We have threats to our CUI, improving threats in mine warfare, as well as some traditional ones in ASW and in the air," Vice Adm Utley said. "Plus, we have the multi-domain aspects, which more than ever require us to understand our battlespace."

MUS capability

According to NATO, more than 90 MUS demonstrated their capability at 'REPMUS' itself. This number included more than 40 UAVs, more than 15 USVs, and more than 35 UUVs.

Amongst the UUVs present was the IAI/ELTA BlueWhale (ELI-3325) autonomous submarine system.

According to an IAI factsheet, BlueWhale is designed for high-endurance, low-profile missions, supporting ASW, ISR, and MCM tasks, and can operate in "hard-to-access littoral waters, choke points, and open seas". It can also conduct forward scouting missions to support submarine and special forces operations.

The factsheet added that BlueWhale can conduct detection and targeting of surface and sub-surface targets, perform onboard data processing, and distribute information in real-time. Mission endurance is between two and four weeks, depending on the operational requirements. BlueWhale is rated to a depth of 300 m. When submerged, its maximum speed is 7 kt, with an operational speed of 2-3 kt. The vehicle is air-, land-, and sea-deployable, using a 40-ft shipping container.

To support the sensing and communications task, the 10.9 m, 5.5-ton BlueWhale UUV is fitted with radar, EO/IR, signals intelligence (SIGINT), SATCOM, magnetic sensors, and flank and towed sonars. BlueWhale shares the information it gathers via its SATCOM system, when deployed at periscope depth. The SATCOM system is housed in the vehicle's deployable mast, within which sensors are fitted and secured.

For 'REPMUS'/'Dynamic Messenger', the towed array sonar fit was an Atlas Elektronik ASW-2500 system. BlueWhale was deployed to the exercise to support the ASW serials.

"The idea is trying to emulate as much as possible the intelligence-gathering capability of submarines," Udi Erell – Naval Specialist at ELTA Systems Ltd – told the UDT conference. The reason for this, he explained, is to add mass, with only limited submarine numbers being available.

BlueWhale was first unveiled in early 2023. Erell noted that a first step in its development was adding the SATCOM capability, and the second was working with Atlas Elektronik to add the towed sonar capability.

The Atlas ASW-2500 towed-array system is a low-frequency, passive sonar, with the ASW-2500-A system being the transmitter and ASW-2500-P being the receiver. The passive sonar provides detection, classification, and tracking, while an active source is added to assist submarine detection, Lisa Trunk – Atlas Elektronik's Autonomous ASW Programme Manager – told the conference.

The 17 mm-diameter towed array has a 20 m-long acoustic section. The array can be deployed down to a 500 m depth.

Combining BlueWhale and the towed array provided a new capability, Sela Meyouhas – an underwater sensor specialist, and ELTA's Autonomous ASW Project Manager – added. This combined capability is referred to as BlueWhale-ASW.

For the exercise, Meyouhas continued, the objective was to demonstrate and prove autonomous detection, tracking, and reporting. The dynamic test targets were a Saab AUV62-AT ASW target trainer (provided for the exercise by FMV, Sweden's defence procurement agency) and a Teledyne Gavia AUV (provided by the Royal Danish Navy). A NATO submarine and surface ship were also present for these serials.

The ASW exercise area, west of Troia and south of Sesimbra, presents challenging acoustic sensing conditions, with the Setubal Canyon bringing a deep drop-off.

The target AUVs were deployed at 80 m depth cruising at 4-6 kt, using either echo repeating mode for bi-static sonar detection or a pre-programmed passive setting mode to create the effect of onboard machinery noise. The AUVs transited from west to east, simulating an intrusion route, while BlueWhale-ASW patrolled from north to south – effectively providing an ASW barrier, Meyouhas explained. Deployed at 60 m and towing the array, BlueWhale-ASW managed to maintain continuous tracking of both target vehicles in both detection modes. Once BlueWhale-ASW ascended to periscope depth, establishing a communications channel, track data was transmitted into the NATO C2 structure via a ground control station.

BlueWhale-ASW's capabilities were further demonstrated when it autonomously detected, tracked, and reported the submarine approaching from the south, affirming the UUV's capability against real – rather than simulated – underwater targets.

Overall, the BlueWhale-ASW vehicle was successful in both autonomous passive detection and autonomous bi-static detection and tracking. This proved its capability to conduct autonomous ASW.

"BlueWhale is ... a vehicle that can support ASW operations, and support an ASW force," said Meyouhas.

During 'REPMUS', BlueWhale-ASW also conducted ISR operations in support of the amphibious assault, including deploying its mast sensors to provide a live sweep of the landing area in advance of the assault. ■

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Naval Fleet Protection Technologies

Sidney E. Dean

Naval warfare in the 21st Century is marked by potent new categories of offensive weapons and tactics, as well as upgrades to traditional weapon types. Fleet protection technologies must adapt to meet these new and enhanced threats.

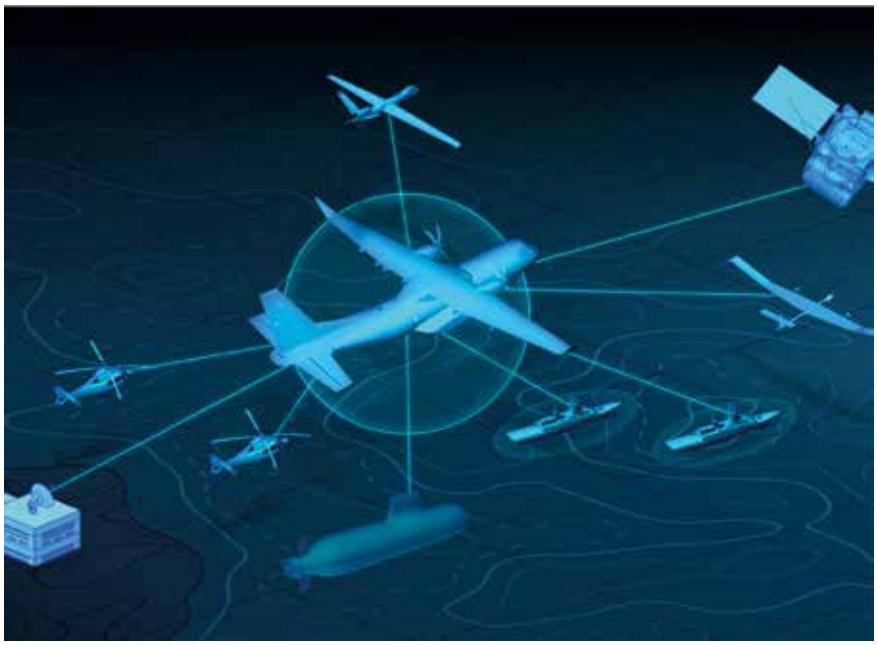
The current threat picture

Conventional maritime threats posed by warships, submarines and aircraft abide. Technological enhancements – including stealth attributes, faster weapon systems and improved sensors – make these maritime attack platforms even more potent. Moreover, asymmetric threats have become well-established. These include suicide attacks using explosives-laden boats, and swarm attacks by missile-armed fast craft. High-end threats include so-called 'carrier killer' ballistic missiles such as the Chinese DF-26B and hypersonic anti-ship missiles (ASMs) such as the DF-27. While the accuracy and effectiveness of such weapon systems are the subject of debate, their potential to target high value large vessels such as aircraft carriers or amphibious warships must be taken seriously. The same holds for more conventional ASMs such as air, surface and shore launched cruise missiles. The range, accuracy and stealth attributes of such missiles are being enhanced in arsenals across the globe. Their potential was demonstrated in April 2022 through the sinking of the Russian cruiser RFS *Moskva* by Ukrainian-produced R-360 Neptun ASMs.

Unmanned aerial, surface and underwater vehicles (UAVs, USVs and UUVs) have emerged as a newer threat. While originally considered as reconnaissance or surveillance tools, they are now capable of carrying automatic weapons, short-range missiles, and torpedoes. Artificial intelligence (AI) is endowing them with autonomous attack capabilities and the ability to carry out swarming missions, potentially overwhelming and penetrating even major warships' defences. Here, too, the Ukraine war serves as a wake-up call.

Another bellwether is the current standoff in the Red Sea. Here Houthi forces are tying down two international naval forces comprised of around a dozen major warships, including a US Navy aircraft carrier. During one attack on 30 January, 2024, a cruise missile launched from Yemen came within two kilometres of USS *Gravely* (DDG-107) before the destroyer shot it down with a close-in weapon system or CIWS. The capability of comparatively unsophisticated forces to pose a credible threat to the most advanced western fleets underscores the potential threat from the navies of major or even regional powers. A multi-tier approach to countering such threats is required.

Credit: Airbus



Integration of sensors and platforms – illustrated here as the Airbus Fully Integrated Tactical System (FITS) – is key to locating and identifying threats.

ISTAR as the first step in fleet protection

The first step in achieving fleet protection is detecting and identifying threats. This begins with surveillance satellites. After these, long-range maritime reconnaissance aircraft – both manned and unmanned – form the next tier of an effective Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) capability. The Boeing P-8 Poseidon is arguably the most modern and capable large maritime patrol aircraft. It has an unrefuelled range of up to 1,200 nautical miles and can linger over a surveillance area for four hours on a typical mission (these parameters can be expanded through aerial refuelling). With a maximum altitude of 12,500 metres and a standard cruising altitude of 10,000 metres it observes large swaths of territory at a time. The sensor suite encompasses synthetic and inverted synthetic radar (SAR/ISAR), electronic support measures (ESM), electro-optical/infrared (EO/IR) sensors, and 129 sonobuoys carried in a rotary dispenser. This enables detection of the full spectrum of surface and submerged maritime targets down to the size of a deployed periscope. Five internal and four external weapon mounts permit direct engagement of surface and submarine targets by Harpoon ASMs, AGM-88 anti-radiation precision guided bombs, Mk 54 torpedoes, and mines. Alternately, targeting data can be relayed to friendly ships or aircraft.

Medium sized aircraft are also potent ISTAR platforms. The Airbus C295 can be configured for unarmed maritime surveillance, armed maritime patrol or anti-submarine

Credit: US Navy

The US Navy's MQ-4C Triton achieved initial operational capability in September 2023.

and anti-surface warfare (ASW/ASuW) missions. Its mission bay is equipped with the Fully Integrated Tactical System (FITS), which fuses data from the aircraft's various sensors with input from external sources such as satellites, manned and unmanned aircraft, surface vessels and submarines. The resulting tactical operating picture can be shared across the network of friendly forces, and supports the aircraft's deployment of torpedoes, ASMs, mines and depth charges. The unarmed C295 MSA (Maritime Surveillance Aircraft) variant achieves the highest mission endurance in its class, with up to 11 hours on station.

Unmanned systems integrate with and augment manned aircraft. The current state of the art is represented by the MQ-4C Triton UAV developed by Northrop Grumman. With a service ceiling of 15,400 metres and a 24-hour mission endurance, the aircraft has a mission range of 8,200 nautical miles; it is configured for global operations including the Arctic. During a single mission its high-fidelity radar, EO/IR and ESM sensors can sweep four million nautical square miles of ocean surface to locate and identify surface and subsurface threats to friendly forces, all while remaining undetected by hostile vessels.

Long-range ISTAR platforms can provide early warning but cannot replace shipboard sensors for detecting incoming threats at closer range (and guiding countermeasures to defeat these threats). All modern warships are equipped with multiple and overlapping sensors, including air and surface search radars, sonars and ESM. The US Navy is currently introducing the AN/SPY-6 Air and Missile Defense Radar (AMDR) on its *Arleigh Burke* Flight III destroyers. Details of the AMDR are largely classified, although Raytheon has previously stated that the new radar, when compared to the legacy AN/SPY-1, can detect objects "half the size at twice the distance." The AMDR is scalable; variants could be fitted onto vessels ranging from large USVs to aircraft carriers. Other naval services are also updating radar capabilities. One example is the German Navy, which is replacing the SMART-L radars of its *Sachsen* class frigates with the TRS-4D/LR ROT long-range rotating radar. Hensoldt and IAI/ELTA have partnered to provide the air and surface surveillance radars, which are also suitable for the maritime Ballistic Missile Defence (BMD) mission.

At the lower end of the shipboard sensor spectrum are high-power, night-vision capable EO/IR systems (including mounted binoculars) for detecting speedboats, divers, UAVs and other close proximity objects. An integrated laser rangefinder can provide guidance to close-in defence weapon systems. In America, the Shipboard Panoramic Electro-Optic/Infrared (SPEIR) programme will introduce the next generation of visual sensors to the US Navy fleet. L3Harris was selected as lead contractor for the programme in April 2022, with entry into service expected to begin in 2027. As expressed by L3Harris, SPEIR will elevate EO/IR sensors "from a dedicated weapons support sensor to a full passive mission solution capability." The sensors will be mounted on the superstructure of surface combatants ranging from frigates to aircraft carriers and could potentially also serve on larger USVs. The system will support missions including ASM defence, counter-unmanned aerial systems (CUAS), counter-fast attack craft, and anti-terrorism/force protection at sea and in port. The firm's SPATIAL sensor system will form the basis for SPEIR. Multiple sensors will be mounted on each ship, providing both narrow-field and 360° field of view.

Systems such as the US Navy's Cooperative Engagement Capability (CEC) facilitate the use of shipboard weapons to achieve their full capability. CEC permits aircraft and ships to share sensor data and hand off targets to the unit best positioned for intercept, even if it does not have the target on its own radar. The European Union is currently developing the basis for an equivalent system under the EU Naval Collaborative Surveillance Operational Standard (E-NACSOS) project. This project aims to develop protocols, interfaces and targeting architecture to collaboratively identify, classify, track and defend against new and asymmetric air and missile threats. Naval Group is leading a consortium of 20 firms from 12 nations tasked with delivering the new capability. Prototyping and testing are expected to conclude by late 2027.

Credit: US Navy

Even Aegis-equipped warships rely on high-powered binoculars and other short range sensors to identify nearby threats.

Defensive weapon systems

Defensive weapons options include interceptor missiles, deck-mounted projectile weapons, embarked helicopters, and – as a future addition to the arsenal – directed energy weapons. These weapon categories are constantly being upgraded and expanded.

Interceptor missiles: While interceptor missiles are currently being used against UAVs, they are primarily designed to engage sophisticated, high speed, manoeuvring threats (aircraft, cruise missiles, ballistic missiles) at some distance from the ship. The Standard Missile (SM) family developed by Raytheon Missile Systems is a prime example of this weapon type. The SM-2 (RIM-66/67) is optimised for medium-range fleet area air defence and ship self-defence, but also has an extended area air defence projection capability. Depending on variant, the SM-2 has an operational range between 90 and 200 nautical miles. The latest variant, the SM-2 Block IIIC (RIM-67D), was approved for Low Rate Initial Production (LRIP) in 2023. It features a dual-mode (active/semi-active) radar seeker for enhanced target discrimination and interception performance, especially against advanced, highly manoeuvrable threats. The extended range of the Block IIIC variants will also provide ships with a greater intercept envelope, especially when faced with saturation attacks. In 2027 the Navy hopes to field the Block IIICU upgrade. This will have similar performance to the IIIC but will be equipped with a new Guidance Section Electronics Unit (GS EU) to address pending obsolescence issues.

The SM-6 (RIM-174) missiles, also conceived to counter ASMs and combat aircraft, can additionally perform terminal stage intercept of short and medium range ballistic missiles. With a service ceiling of 33,000 metres, a speed of Mach 3.5, and an official range of 130 nautical miles, they can therefore defeat incoming threats ranging from those at very high altitudes to sea-skimming cruise missiles. The SM-6 Block IB variant will feature a significantly greater range than earlier variants and is expected to achieve Mach 5 or greater speed. With deliveries slated to begin in 2027, the enhanced variant will improve the US Navy's capability to counter enemy hypersonic ASMs.

Several high-performance European and Asian interceptor missiles are also in development or in the early stages of operational use. One example is MBDA's Sea Ceptor, the naval variant of the Common Anti-Air Modular Missile (CAMM). It was originally developed for use aboard British Royal Navy frigates but can be deployed on vessels as small as offshore patrol vessels. In service with the Royal Navy since 2018, Sea Ceptor is compatible with various vertical launch systems and is being expanded with extended range (ER) and medium range (MR) variants for service with various fleets.

Credit: L3Harris

The 360° wide field of view element of SPIER will consist of three infrared cameras and three colour visible cameras mounted on a single three-axis stabilised pedestal.

Credit: Royal Navy

Concept image of a Sea Ceptor interceptor launching from a Royal Navy Type 26 frigate.

Guns: One major drawback of missile interceptors is their high cost. Pitting missiles costing several hundred thousand dollars or more against drones costing only thousands is not viable in the long term. Accordingly, guns firing airburst munitions with proximity fuses have recently found new applications in the force protection role against attack drones and small surface threats, both manned and unmanned. Leonardo's OTO Melara 76/62 Super Rapid gun variant has a maximum firing rate of 120 rounds per minute and an effective range of 16,000 metres when firing High Explosive – Pre-Formed Fragment ammunition; The firm's new Vulcano 76 munitions extend the gun's range to 40,000 metres, and can utilise optional proximity fuses to combat incoming aerial or surface targets. Smaller calibre weapons such as 57mm guns are also effective against UAVs and manned or unmanned boats. For example, Northrop Grumman is developing a new 57mm high explosive guided munition for the US Navy's Mk 110 gun mount. It is designed to defend against fast moving surface craft, drones and swarming threats. According to the firm, the new projectile has an on-board seeker to acquire moving targets and can manoeuvre in flight to achieve an intercept course. The fuse can autonomously select either proximity or point-detonation mode to maximise its kill probability.

Railguns: The US Navy pursued an electromagnetic railgun capability for 15 years before suspending the programme in 2021 in favour of hypersonic missile research. In the meantime, both Europe and Japan have intensified their pursuit of the technology, which holds out the promise of the low-cost, high-speed interception of manned and unmanned aircraft, missiles, and fast surface vessels. The European Union's TecHnology for ElectroMagnetic Artillery (THEMA) project aims to mature critical system components, including the pulsed power supply, the electromagnetic railgun itself, and s hypervelocity projectile. The EU envisages the weapon as a hypersonic interceptor with enhanced precision and lethality, complementing other defensive weapons such as missiles and guns. Tokyo is seemingly considerably further along. In October

2023 Japan became the first nation to fire a railgun prototype from a maritime platform. The weapon fires 40mm steel projectiles weighing 320 grammes and has a muzzle velocity of Mach 6.5. The prototype uses five megajoules of charge energy. The Japanese MoD hopes to increase this to 20 MJ for an operational system with greater range and muzzle velocity. The weapon is designed to intercept aerial targets, with an emphasis on hypersonic cruise missiles.

Manned Aircraft: Embarked helicopters remain a solid option for defeating approaching air and surface threats at close to intermediate distance from a vessel. Naval helicopter armaments can include crew-served machine guns, air-to-surface missiles, and anti-submarine torpedoes. Defensive ASW – including detection and direct attack operations – is an established mission for shipboard rotary aircraft. During the ongoing operations in the Red Sea, coalition helicopters have repeatedly destroyed both explosive-laden USVs and aerial attack drones with their crew-served weapons.

Directed Energy Weapons: Electronic warfare (EW) capabilities have proven partially effective against unmanned systems – especially UAVs – in the Russo-Ukrainian war and are likely to prove a major defensive option against maritime drone swarm attacks as well. Tools such as frequency hopping and redundant navigation and targeting systems for unmanned systems will, however, limit the effectiveness of EW as a standalone weapon against drones, as well as against precision guided ordnance. Alternative types of energy weapons are therefore being tested for their suitability in these roles. Major advantages attributed to directed energy (DE) weapons include 'deep magazines' (unlike projectile weapons, DE systems can hypothetically fire as long as their energy supply is assured) and a favourable cost exchange ratio (a two-second burst from a 20mm Phalanx CIWS costs approximately USD 7,000, compared to an estimated USD 1 to USD 10 per laser shot).

Credit: EU

On 9 March 2024 the French warship FS Alsace shot down Houthi attack UAVs using her 76mm OTO Melara gun.

The US Navy has been experimenting with high energy lasers (HEL) on ships since 2014, with each subsequent prototype exhibiting improved capabilities against UAVs and boats, including fast inshore attack craft. The US Navy Laser Family of Systems (NLFoS) currently consists of: the Solid State Laser Technology Maturation (SSL-TM) effort; the Optical Dazzling Interdictor, Navy (ODIN); and the High-Energy Laser with Integrated Optical dazzler and Surveillance (HELIOS).

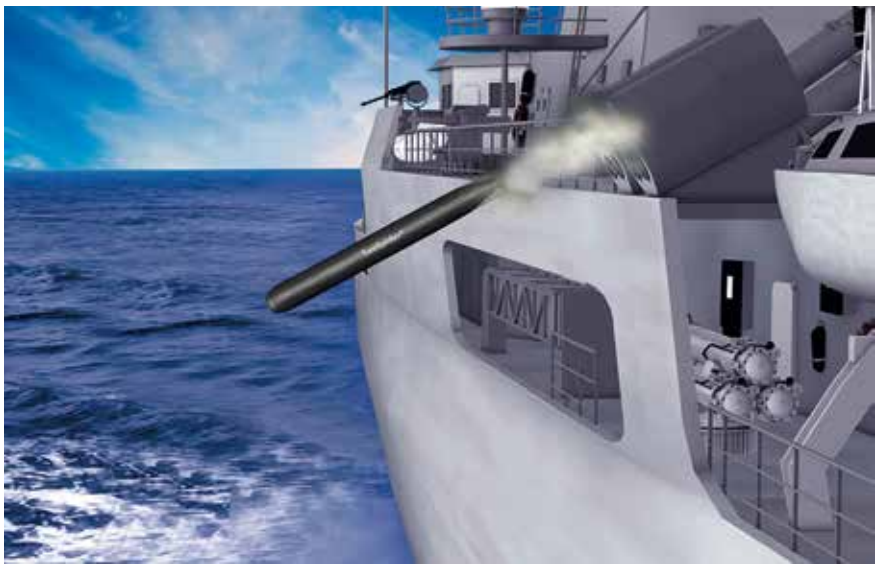
The 150 kW Mk 2 Mod 0 laser weapon system demonstrator, which emerged from the SSL-TM program, began evaluation aboard USS *Portland* (LPD-27) in 2019. It defeated its first UAV in 2020. Meanwhile, eight *Arleigh Burke* class destroyers are using the ODIN to counter surveillance sensors in hostile UAVs. HELIOS is the most recent system and was installed aboard USS *Preble* (DDG-88) for testing in 2022. Initially delivered as a 60 kW class prototype, the US Navy hopes to increase its power potential to 150 kW. In the future, the navy hopes to deploy 300+ kW SSLs capable of countering anti-ship cruise missiles (ASCM). In this respect, the High Energy Laser Counter-ASCM Program (HELCAP) programme will be tested in 2025 on land against air launched cruise missile surrogates. There will be no sea-based prototype of HELCAP; rather, the technology will flow into follow-up increments of HELIOS.

To date, maritime HEL applications range from blinding hostile sensors to downing drones or setting boats on fire. In January 2024 scientists with the Chinese Academy of Aerospace Aerodynamics published a paper discussing laser's potential for combatting hypersonic missiles. In wind tunnel experiments simulating Mach 6 flight, the team used a HEL to ablate the missile's protective coating, thereby changing airflow and destabilising the missile's flight. Whether such an application would be practical for maritime defence remains to be seen. A major question is whether a laser could

Credit: US Navy

HELIOS was installed aboard USS Preble (DDG-88) for testing in 2022.

Credit: AtlasElektronik



The SeaSpider anti-torpedo torpedo (ATT) can launch within seconds when the system is in alarm mode.

bring down a hypersonic weapon at sufficient range to prevent impact on the ship. Overall, optimism regarding laser's potential is increasingly muted. In contrast to initial hopes for long or medium range missile defence applications, the US Navy is now considering HELs a short-range weapon to engage threats with one (or at most a few) miles from a vessel. Concerns remain regarding lasers' effective range, their beam cohesion in maritime environments, their energy requirements and the ability to defeat individual targets quickly enough to deal with swarm attacks. Additionally, some theorise that adversaries could shield their ASCMs from laser effects through reflective coatings. There is currently no visible timeline for transitioning developmental programmes to mainstream acquisitions.

High Power Microwave (HPM) weapons have performed well during land-based testing and are also being considered for shipboard applications. They can be directed against a broader area, so that a single microwave pulse could simultaneously disable the electronics on dozens of aerial or surface targets (including ASCMs and anti-ship ballistic missiles), making them more suitable than lasers for defeating swarm attacks. In January 2024 Raytheon was awarded a contract to develop and test two HPM prototypes; one each for the US Navy and Air Force. The navy prototype is to be delivered during 2024 and integrated into the land-based High Power Microwave Test Bed in 2025; following successful sub-component testing, the Navy plans to mount the prototype onto a ship for testing as early as 2026. Here, too, however, there is no established timeline for fielding an operational system with the fleet.

Anti-Torpedo Torpedoes: Torpedoes launched from stealthy hunter-killer submarines remain a major threat to surface ships, as well as to other submarines. Modern torpedoes' increasingly sophisticated seekers and guidance systems are diminishing the effectiveness of current decoy technology meant to divert torpedoes from their target. Consequently, anti-torpedo torpedo (ATT) concepts are attracting increasing interest. For example, AtlasElektronik presented its 'SeaSpider' solution at Euronaval 2022. The ATT is suitable for smaller vessels such as OPVs and Corvettes, as well as for larger warships. It is designed for all-up-round carriage in fixed launchers. The ATT launches within seconds of incoming torpedo detection. Equipped with a solid-propellant rocket motor, the agile, high-speed SeaSpider actively hunts torpedoes utilising a high frequency multi-mode sonar effective in both shallow and deep waters, destroying them by direct impact at relatively close proximity to the ship. Multiple ATTs can be launched simultaneously to combat swarm attacks. The firm aims to begin manufacturing in 2025; initial production would be configured for surface vessels, with a submarine variant to follow.

Unmanned Defensive Systems

Unmanned surface and underwater vessels are emerging not only as a threat to ships, but also as a defensive resource.

Credit: US Navy

A Devil Ray T-38 USV escorts USS Sioux City (LCS-11) in the Arabian Sea. The T-38 achieves speeds of 80 knots and can pull six G's during high-speed manoeuvres.

Credit: HII

HII introduced the Remus 620 multi-mission medium sized UUV in 2022.

US Navy budget documents underscore their utility as force multipliers in face of numerically superior enemies: "Large numbers of small, low signature, attritable unmanned missile launching vessels have the potential to improve surface force magazine depth and reduce risk to force in denied areas." Being highly manoeuvrable, they are also well suited to counter asymmetric threats such as swarm boat attacks. Small enough to be carried aboard most warship classes, they can be deployed as advance scouts or as 'guard dogs' capable of intercepting threats within a 360° radius of the ship or task force. USVs can achieve speeds of 80 knots, and be armed with a variety of weapons including surface to air interceptors, surface-to-surface ordnance such as the AGM-114 Hellfire or Spike missile, machine guns and light autocannon, or light ASW torpedoes. Some USVs can also serve as motherships for UAVs and UUVs, further extending the manned ship's effective sensor range.

The navies and industry of the United States, Europe, and Israel have all pioneered in this field. As just one example, the US Navy's 2024 budget proposal included funding for the Multi-domain Area Denial from Small-USV (MADS) programme. The proposed platform for MADS is the MAPCorp Greenough Advanced Rescue Craft (GARC). This has a 400 nautical mile operating radius and has already been equipped with the remote-controlled Kongsberg Mk50 Sea Protector (which mounts EO/IR cameras, a laser rangefinder, and a selection of weapons), the GAU-19 rotary barrel machine gun, or AGM-176 Griffin or AGM-114 Hellfire missiles. The MADS proposal would equip the boat with FIM-92 Stinger missile launchers to "provide a low-cost, persistent anti-air and anti-surface maritime defense capability," according to budget documents. The currently conceived primary mission would be armed escort for logistics ships. MADs could also potentially provide seaside security for amphibious forces in littoral zones.

UUVs come in a wide range of sizes, from small to extra-large. Their mission potential is equally broad. Small and medium systems can be deployed from surface ships. Huntington Ingalls Industries' Remus 620 medium-class UUV is a case in point. First presented publicly in 2022, the multi-mission UUV can perform EW, cyber operations, ISR, hydrographic surveys, and MCM, delivering effects both above and below the waterline. It can also carry and deploy smaller unmanned vehicles and payloads from underwater. Its 110 hour battery life and 275 nautical mile range permit the vessel to scout ahead or screen manned ships from surface or subsurface threats including attack submarines. Multiple units can be deployed by a submarine, boat or warship, and operate collaboratively.

UUVs' potential is arguably best utilised in coordination with USVs, as well as with manned vessels. The SWarming And Teaming Shoal (SWAT-SHOAL) program is one of six naval projects selected in 2023 for development under the EU's 2022 European Defence Fund. The EU's stated goal is a system-of-systems concept to integrate various types of manned and unmanned naval assets collaborating as a team across a broad spectrum of underwater missions (including collaborative engagement) against moving subsurface threats. The focus is placed on technologies to enable innovative capabilities such as swarming, underwater communications, and autonomous operation to enhance naval forces' versatility and capabilities in the underwater domain. Navantia is acting as project coordinator.

Leveraging AI to Enhance Fleet Defence

The latest US Navy/Marine Corps/Coast Guard Tri-Service Maritime Strategy was released in December 2020. The document finds that "new and converging technologies will have profound impacts on the security environment. Artificial intelligence, autonomy, additive manufacturing, quantum computing, and new communications and energy technologies could each, individually, generate enormous disruptive change. In combination, the effects of these technologies, and others, will be multiplicative and unpredictable. Militaries that effectively integrate them will undoubtedly gain significant warfighting advantages."

Perhaps no single element will be more momentous than AI. Offensive weapon systems are increasingly being equipped with highly sophisticated AI supported guidance, targeting and control systems. While western nations continue to stress the 'man-in-the-loop' requirement before lethal force is applied, some adversaries are less concerned with collateral damage or rules of engagement; countering machine-controlled offensive systems will require defensive systems with comparable or superior capabilities. Viewing only the defensive aspect, it will be artificial intelligence which enables combat systems to process the vast amount of sensor data flowing in from dispersed platforms and collate the information into a usable form. Advances in AI will enable true autonomous operations by unmanned platforms and permit these platforms to coordinate operations with one another. Intercept of ultra-high-speed missiles will require computers capable of micro-second decision-making to prioritise targets and calculate vectors. The list goes on. While the horror-scenario of purely machine-driven warfare is not imminent, no single party can afford to fall behind in the AI race and hope to prevail.

Keep on Keeping on: Dutch LCF Modernisation

Richard Scott

On 1 March 2024, the Netherlands' State Secretary for Defence, Christophe van der Maat, outlined multi-billion Euro plans to procure a new maritime air and missile defence (IAMD) capability to replace the Royal Netherlands Navy's (RNLN's) current four *De Zeven Provinciën* class air defence and command frigates ('luchtverdedigings en commando fregatten' or LCF) from the mid-2030s.

Detailing the top-level requirements to the House of Representatives in a so-called 'A-letter', van der Maat said that the new capability would involve the acquisition of an indigenously-developed surface combatant and above-water combat system, together with a yet to be decided air defence missile system sourced internationally. The Ministry of Defence's Materiel and IT Command (COMMIT) – the new name given to the Defence Materiel Organisation (DMO) in April 2023 – intends to forge a partnering arrangement with local industry at an early stage in order that the two main suppliers – Damen Naval for the ship platform and Thales Netherland for the radar/fire control system – can contribute fully to the planning and development process.

In the meantime the existing LCFs – HNLMS *De Zeven Provinciën, Tromp, De Ruyter* and *Evertsen* – are required to stay in service for a decade or more while their replacements take shape. To this end, significant investment has been made to extend all four frigates in service beyond their original design life, with the last two ships now likely to serve through to 2036-2037. And having already received a number of substantive upgrades, including a new extended range radar, the *De Zeven Provinciën* class is set to receive further improvements. These include a replacement medium-calibre gun and new anti-air, anti-surface and strike weapon systems during the course of this decade.

Author

Richard Scott is a well-known author and commentator on naval operations and technology.

Credit: US Navy

HNLMS De Zeven Provinciën underway in the Atlantic in May 2021 during the 'At Sea Demonstration/Formidable Shield 21' exercise.

Design and development

The *De Zeven Provinciën* class frigate design emerged in the wake of the collapse of the NFR90 frigate programme. What was then Royal Schelde – now Damen Naval – was contracted in 1993 to support project definition for a national frigate platform. Subsequently, in June 1995, the company was awarded a build contract for two frigates. This was later increased to four ships.

Credit: Richard Scott

The APAR X-band multifunction radar performs horizon search, multi-target tracking, missile guidance support, and terminal illumination for the LCFs' ESSM Block 1 and SM-2 Block IIIA missiles.

As conceived, the LCFs were primarily roled for fighter control and medium-range air defence. In addition, they were equipped with appropriate facilities to host and support an embarked flag staff. A strict 'design-to-cost' philosophy was adopted in order to drive cost out of design, engineering, and manufacturing and so bring the programme within its approved budget ceiling. This approach – based on the development of functional requirements rather than prescribed specifications – drove a number of cost/capability trade-offs, and a decision to apply military standards only where strictly necessary. As a result, commercial off-the-shelf equipment could be adopted in many areas of the ship provided it met appropriate technical standards, Furthermore, the application of rigorous military standards for shock, noise, electromagnetic compatibility, and redundancy was limited to those critical equipments/areas required to support the combat system and propulsion.

Another important consideration for the LCF design was crew size: whereas the earlier *Tromp* class air defence frigates had a complement of over 300, the De Zeven Provinciën class ships operate with a standard crew of 172, increasing to 183 with the embarked helicopter flight. This reduction was achieved through widespread systems integration, increased automation, and detailed consideration of human factors in both operational spaces and crew living areas.

The combat system delivered for the LCF programme hinged on two component

Credit: Thales

The Thales Nederland SMART-L MM/N extended long-range L-band radar is key to the MBMD upgrade programme.

parts. One was the national 'Guardion' combat management system (CMS). This was developed and integrated by the RNLN's in-house Centre for the Automation of Mission-critical Systems; now vested in the Maritime IT department within COMMIT's 'Joint Informatievoorziening Commando' [JIVC] information technology organisation. The other was an anti-air warfare system (AAWS) developed by a Hollandse Signaalapparaten (now Thales Nederland) led consortium under the Trilateral Frigate Cooperation with Germany and Canada.

The AAWS married a fire control cluster with a sensor suite comprising the APAR X-band multifunction radar, the SMART-L L-band volume search radar, and the SIRIUS dual-band infrared search and track system. It was noteworthy in that, for the first time in a naval application, it implemented the interrupted continuous wave illumination (ICWI) technique for missile guidance: ICWI uses mid-course guidance and sampled data homing to enable a single fire control radar (in this case, the Block 1 version of APAR) to support multiple simultaneous engagements using semi-active radar homing missiles – either the Evolved SeaSparrow Missile (ESSM) Block 1 (for self-defence) or the Standard Missile-2 (SM-2) Block IIIA (for area defence).

Commissioned into the RNLN between April 2002 and June 2005, the four LCFs were declared fully operational in 2006. This followed extensive testing to demonstrate AAWS functionality and performance, as well as to validate the ICWI missile guidance technique fully.

Fleet 'spine'

Two decades after entering service, the *De Zeven Provinciën* class frigates remain the warfighting 'spine' of the RNLN surface fleet, and continue to routinely serve in national, multinational, NATO and EU operations: as a case in point, *Tromp* in late March 2024 commenced tasking in the Red Sea in support of Operation 'Prosperity Guardian' (the US-led multinational effort to protect shipping from Houthi missile and drone attacks).

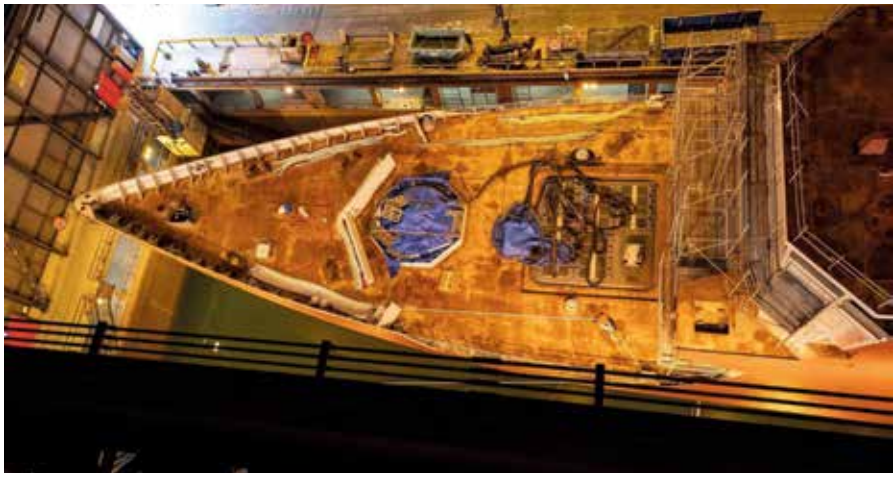
In recent years, the four LCFs have been cycled through an upkeep and conservation programme, codified as the Instandhoudingsprogramma LCF (IP-LCF). This has embodied a broad package of improvements intended to address materiel obsolescence, maintain seaworthiness, and ensure compliance with prevailing safety and environmental legislation. Beginning implementation in 2018 with the refit of *De Zeven Provinciën* at the 'Directie Materiële Instandhouding' (DMI) facility inside Den Helder naval base, the IP-LCF covers 41 discrete sub-projects extending across all areas of the ship. In its totality, the work encompasses the replacement, renewal, or modification of over 1,000 individual systems, equipment, and peripherals, and the laying of approximately 30 km of new cabling.

These discrete addition and alteration packages can be split into two categories. The first comprises those sub-projects focused on maintaining compliance with the latest standards in areas such as ammunition safety, environmental compliance, occupational health and safety, and safe navigation. Examples include a modernised bridge, and a new ballast water treatment system. A second category of sub-projects has been addressing materiel and/or functional obsolescence onboard, most notably the CMS and the integrated monitoring and control system (IMCS). In the former case, the Guardion CMS has been upgraded with new server hardware, plus new RH Marine workstations and Baytek large-screen displays in the command cen-

Credit: Richard Scott

The LCF frigates – HNLMS De Ruyter is pictured here – are each fitted with five eight-cell Mk 41 vertical launch modules.

Credits: COMMIT



The Leonardo 127/64 LW Vulcano medium-calibre gun and associated ammunition handling system is being refitted to all ships of the De Zeven Provinciën class. HNLMS Evertsen is the first ship to receive the replacement gun

tre. With regard to the IMCS, RH Marine has upgraded the workstations inside the technical centre, introduced new software-based ship control functionality, and developed an interactive electronic state board to support damage control/firefighting co-ordination.

De Zeven Provinciën, *Tromp* and *De Ruyter* have all now completed their IP-LCF embodiments. *Evertsen* is currently completing its IP-LCF implementation at DMI as part of an extended refit, due to complete in early 2025, which also includes the installation of a new main gun.

Owing to delays in the LCF replacement programme, the *De Zeven Provinciën* class ships will now remain in service for some time longer than had originally planned. To ensure that the frigates can continue to operate safely, and remain operationally relevant, a new budget line – 'Langer doorvaren LCF: Materiële zeewaardigheid' (translated to Longer sailing LCF: Material seaworthiness) – was established by COMMIT in 2023. This funds a series of further measures to address diminishing sources of supply and obsolescence in both hardware and software. Examples include general ship systems such as cooling, heating and fire alarms; minor electronic systems; and networks and computer systems. The project also includes the adaptation of trainers and simulators; education and training resources; documentation and manuals; equipment management; and logistics support/sparing. In addition, the software associated with integration of the ESSM Block 1 missile is approaching obsolescence.

Modifications associated with this budget line will be embodied during overhauls in the period 2024-2029. A software modification will be introduced to enable the two oldest ships – *De Zeven Provinciën* and *Tromp* – to continue to use ESSM Block 1 through to their end of life. The two youngest frigates – *De Ruyter* and *Evertsen* – are to receive a radar system upgrade allowing them to integrate the ESSM Block 2 missile. *De Ruyter* and *Evertsen* will also receive other hard-kill and soft-kill improvements given their longer remaining service life.

MBMD upgrade

A major sensor/command system upgrade conferring a Maritime Ballistic Missile Defence (MBMD) capability has been rolled out in parallel with the IP-LCF programme. This enables the *De Zeven Provinciën* class ships to detect and track ballistic missile threats at ranges out to 2,000 km, as well as to provide fire-control quality cues to co-operating 'shooters'.

Key to the MBMD upgrade is the introduction of the Thales Nederland SMART-L MM/N extended long-range L-band radar. An active electronically scanned array radar combining dual-axis multibeam processing with a patented extended long-range waveform proven in live at-sea testing, SMART-L MM/N is designed to operate in a number of rotating and staring modes to support volume air surveillance and/or ballistic missile long-range search and track. The system has a maximum instrumented range of 2,000 km in staring mode.

Alongside SMART-L MM/N, the MBMD upgrade has additionally required the integration of a Tecnobit LINPRO multilink processor (enabled to exchange data via the Link 16 JREAP-C beyond-line-of-sight message protocol) and modifications to the Guardion CMS. In the latter case, the Maritime IT department within JIVC worked to develop the interface for the new radar, and also to embed a BMD planning tool.

De Zeven Provinciën proved this new MBMD capability in two live-fire events conducted as part of the multinational 'At Sea Demonstration/Formidable Shield 21'

Credit: Nevesbu

Nevesbu has been contracted by both Leonardo and COMMIT to develop the integration and associated design change package for the 127/64 LW gun installation, the revised ammunition compartment, and the new automated handling system.

(ASD/FS-21) exercise in the North Atlantic in May 2021. In the first case, the ship demonstrated its integrated air- and missile-defence capability by engaging two low-altitude air-breathing threats while simultaneously tracking a ballistic missile target; in the second, *De Zeven Provinciën* provided tracking data enabling a US-guided missile destroyer to launch an SM-3 Block IA exo-atmospheric interceptor against a ballistic missile target still outside the range envelope of its own radar ('launch on remote').

De Zeven Provinciën, *Tromp* and *De Ruyter* have all completed the MBMD upgrade, with *Evertsen* receiving the capability during its current refit. The expectation is that, from 2025, the LCF frigates and their MBMD capability will be offered as a Voluntary National Contribution to the NATO Ballistic Missile Defence programme. It is intended that the SMART-L MM/N radar will be cross-decked to the LCF replacements as the *De Zeven Provinciën* class ships leave service.

Replacement gun

The next major upgrade – now underway on *Evertsen* – is the introduction of the Leonardo 127/64 LW Vulcano medium calibre gun and associated ammunition handling system. The acquisition of a new gun system reflects the obsolescence of the original 127/54 Compact gun systems, which were acquired second-hand from Canada and date from the late 1960s. Although refurbished and upgraded around the turn of the century, these mountings are now well beyond their 30-year design life and proving increasingly unreliable and difficult to support. Also, the existing ammunition handling system is not compliant with modern working/safety practices.

In 2018 the then DMO established the 127 mm replacement programme to deliver a new medium calibre gun system to the *De Zeven Provinciën* class frigates together with a semi-automatic ammunition handling system. This programme also includes the adaptation of the magazine, and associated integrated logistic support. In April 2020 it was announced that Leonardo had been contracted to supply of its 127/64 LW Vulcano gun, which will confer the ability to fire extended-range, precision-guided Vulcano munitions as well as conventional ammunition. Alongside the gun system itself, the company's scope of supply also includes a new automated ammunition handling system and a naval fire support mission planning tool.

It is recognised that the installation and integration of the 127/64 LW Vulcano gun and its ammunition handling system represent a complex engineering task requiring a major redesign of the spaces in the forward section of the hull. The maritime technology/naval design house Nevesbu has been contracted by both Leonardo and COMMIT to develop the integration and associated design change package for the mounting installation, the revised ammunition compartment, and the new automated handling system. As a subcontractor to Leonardo, Nevesbu has been focused on the system design task; while for COMMIT, Nevesbu has undertaken spatial and functional integration of the new equipment in compliance with shock/hazard standards and prevailing health and safety legislation.

Another requirement is to extend the ship's electrical system (the 127/64 LW Vulcano gun using electric rather than hydraulic drive). Thales Nederland is taking responsibility for integration of the new gun with the CMS.

As previously mentioned, *Evertsen* is receiving the gun upgrade during its current refit in Den Helder. While lessons learnt from this first installation are expected to reduce the time required for

subsequent retrofits, the complex and intrusive nature of the medium-calibre gun retrofit means that it can only be performed during deep refit. This means that *De Ruyter*, as the final ship to receive the 127/64 LW Vulcano, will not be upgraded until 2029. The intention is to cross-deck all four 127/64 LW Vulcano mountings to the LCF replacements as the *De Zeven Provinciën* class ships are phased out of service.

Anti-ship and strike missiles

Another investment designed to maintain the operational relevance of the LCF frigates is the procurement of a replacement maritime surface-to-surface missile to succeed the current RGM-84L Harpoon Block II anti-ship missile. Kongsberg Defence and Aerospace was in late 2022 contracted by the DMO to supply its Naval Strike Missile (NSM) following a competitive evaluation, including technical assessments performed by the TNO research organisation. NSM deliveries are planned to begin before the end of 2025.

In April last year, following Russia's military offensive against Ukraine, the Dutch government announced plans to proceed with the acquisition of a maritime strike capability – in the shape of the US-built Tomahawk Block V cruise missile - for both surface ship and submarines. This will make the RNLN only the second European naval service to introduce Tomahawk into service. The four LCF frigates are all planned to receive Tomahawk, which can be accommodated within the ships' existing 40-cell MK 41 strike length vertical launch system. A proof-of-concept firing from *De Ruyter* is planned in the third quarter of 2024 on the US Navy's Point Mugu sea range off California. Integration of Tomahawk into the LCF frigates will require the installation of additional weapon control equipment and associated software. Current planning assumptions – subject to final confirmation of the Foreign Military Sales (FMS) case – foresee the first full Tomahawk implementation starting in 2026 as part of a scheduled maintenance period. This would see the first LCF become operational with the Tomahawk Block V missile in 2027.

The introduction of a new lightweight torpedo is also planned for the *De Zeven Provinciën* class. In this case, the US Mk 54 weapon will be introduced as a replacement for the legacy Mk 46 Mod 5 lightweight torpedo. The Mk 54 will be carried by embarked NH90 helicopters, and also loaded in ship-mounted Mk 32 Mod 9 twin torpedo tubes.

Credit: Richard Scott

HNLMS De Ruyter pictured alongside during the DSEI 2023 event at ExCel, London, in September 2023.

Electronic warfare

The LCF ships have been equipped from build with the Thales UK (formerly Racal) Sabre electronic warfare (EW) system. As originally installed, Sabre combined radar band electronic support measures (ESM) and active electronic countermeasures (ECM) subsystems. The active ECM component – a multi-mode self-protection jammer – has now been retired from service.

Reflecting the more demanding threat environment, the 'Langer doorvaren LCF: Elektronische oorlogvoering' (Longer sailing LCF: Electronic warfare) project has been established to procure a modernised EW capability. In the first instance, this is intended to deliver a more modern ESM able to achieve greater detection range (for improved situational awareness and earlier threat warning) and improved signals measurement/analysis (to provide unambiguous emitter identification). In addition, *De Ruyter* and *Evertsen* – as the two frigates with the longest remaining lifespans – are also planned to receive a modern ECM system to disrupt threat radar seekers. The planned EW improvements are expected to be embodied during refit periods through to 2029. The EW upgrade also demands the purchase of a new trainer/simulator to fully reflect the new equipment installation on board.

Anti-air missiles

Work is underway to recapitalise the RNLN's inventory of self-defence and area defence anti-air guided weapons. In the first case, the Netherlands is a partner in the US-led development and manufacture of the ESSM Block 2 missile, which replaces the earlier Block 1 guidance section with a dual mode active/semi-active X-band radar seeker in order to counter the latest generation of fast, low-altitude, and highly manoeuvrable anti-ship cruise missile threats. A new warhead is also being introduced.

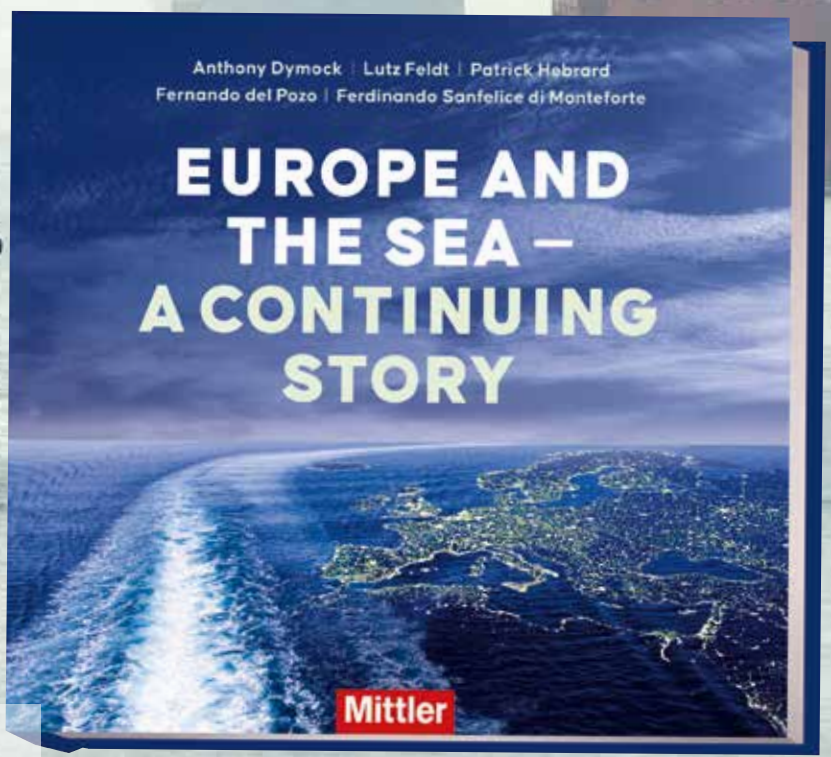
Guidance and control of ESSM Block 2 will be enabled by the latest APAR Block 2 radar. APAR Block 2 features an all-new digital radar front end (embodying a new gallium nitride transmit/receive module and digital beam forming) and a scalable, reconfigurable architecture to facilitate future upgrades. It also introduces the Joint Universal Weapon Link datalink to provide guidance support for ESSM Block 2. Only *De Ruyter* and *Evertsen* will receive the APAR Block 2 retrofit, which is planned to take place in the late 2020s. The intention is that, when *De Ruyter* and *Evertsen* retire, both APAR Block 2 radars will be transferred to two of the four new-build LCFs (the other two ships receiving new systems at build).

De Ruyter and *Evertsen* are also in line to receive an upgrade to their inner-layer hard-kill defences. In this case, the Raytheon/RAM System GmbH RIM-116 Rolling Airframe Missile system is to replace the current Thales Goalkeeper 30 mm close-in weapon system.

As regards area air defence, the Netherlands has signed FMS agreements with the US Navy for additional buys of the SM-2 Block IIIA missile to sustain its war stock inventory and meet peacetime firing requirements until 2030. This offtake – being delivered under FY 2019 and FY 2021 production – was negotiated as part of a larger FMS buy with other international SM-2 customers. ■

EUROPE AND THE SEA

A CONTINUING STORY



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Maximilian Verlag GmbH & Co. KG | Stadthausbrücke 4 | 20355 Hamburg

Developments in Anti-Submarine Warfare & Underwater Situational Awareness

Interview with Chris Tucker, Sonar Product Technical Authority, SEA

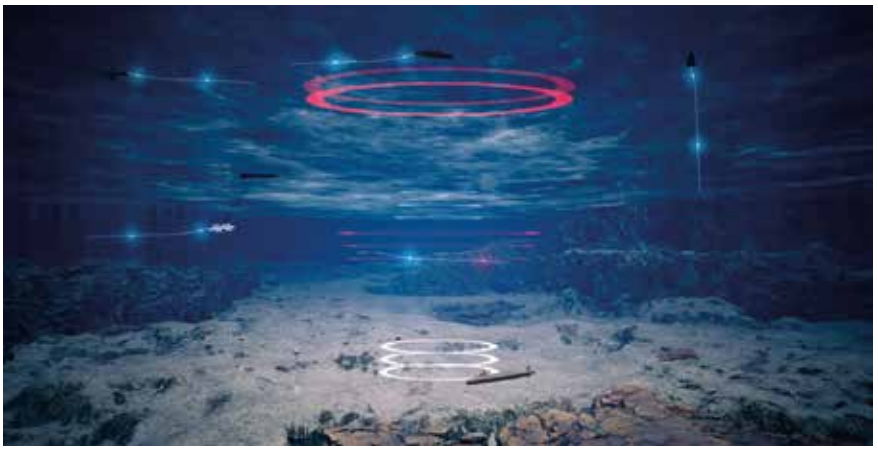
The need to deploy the capacity to secure the underwater domain is becoming an increased area of focus for navies across the globe. MDM discussed recent trends in the sector with Chris Tucker from Systems Engineering and Assessment Ltd (SEA), a subsidiary of British defence technology company, Cohort Plc

MDM: The importance of being able to deploy effective anti-submarine warfare (ASW) capabilities has returned to prominence in recent years. Could you provide SEA's assessment of the key factors that have been driving the underwater domain's increased relevance?

SEA: The increased relevance of the underwater domain has been driven by three key factors.

First, the strategic advantage of operating underwater is increasing as navies of all sizes continue to grow their fleets. Submarines are increasingly being used for intelligence gathering, reconnaissance and special operations, and this heightened undersea activity underscores the need for effective ASW capabilities to maintain situational awareness and protect critical assets.

Credit: SEA



The strategic importance of the undersea domain is increasing as navies expand both crewed and uncrewed capabilities in this area. Given this context, effective situational awareness is critical.

Credit: US Navy

US Navy personnel recover a Mk 18 Mod 2 unmanned underwater vehicle. The majority of today's uncrewed and autonomous platforms are relatively small, limiting their ability to hold large energy stores and therefore impacting their persistence. Accordingly, the need for efficient low Size, Weight, and Power (SWaP) sensor technology is growing in importance.

Next, as more countries develop these submarine capabilities, the threat is developing and changing all the time. This means submarine technology has advanced significantly, making modern submarines stealthier, faster, and more capable. They can operate at greater depths and for longer durations, making them harder to detect and track.

And lastly, the increased susceptibility of subsea critical national infrastructure has led to increased demand for ASW capabilities. Moreover, the protection of sea lines of communication (SLOCs) is vital for global trade and economic prosperity. Submarines can disrupt these routes by attacking merchant vessels, necessitating robust ASW measures to safeguard maritime commerce.

MDM: What, in SEA's opinion, are the key technological changes that are impacting ASW operations? How are these different, for example, from the technology impacting ASW during the Cold War era?

SEA: The vast amount of data is certainly one of the key differences between the Cold War era and the present day. As ASW systems onboard traditional naval platforms have become more capable, the amount of data presented to operators and the command chain has increased, making decision making more difficult.

Additionally, the advancement of uncrewed vessels means more sensors in the ocean, further increasing the amount of data and the complexity of decision making. Correct implementation and use of autonomy and edge processing is going to be vital to both the operation of autonomous vessels and the processing of these large data sets in order to aid effective decision making.

MDM: The increased prevalence of unmanned and autonomous vehicles is certainly regarded as having a significant impact across the naval 'battlefield'. Could you provide some further insights as to how such vehicles are impacting ASW technology?

SEA: Uncrewed and autonomous vehicles are improving ASW technology; enhancing sensor coverage, improving detection and tracking capabilities and enabling autonomous decision-making.
The majority of autonomous platforms are intended to provide persistence. However, because they are also typically small, the ability to hold large energy stores is limited. Power density is increasing through the development of commercial low carbon technologies but there will still be a need for efficient low Size, Weight, and Power (SWaP) sensor technology. This is starting to be seen within ASW technology, thereby enabling autonomous vehicles to host persistent sensor capabilities.

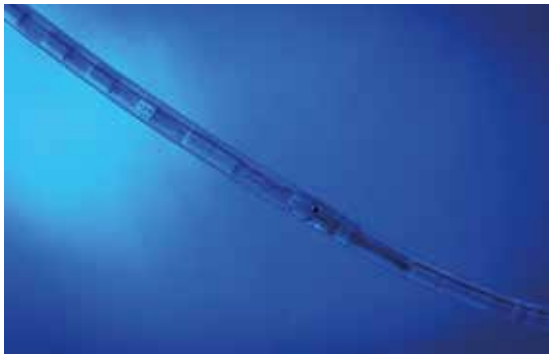
MDM: The greater emphasis being given to securing the underwater environment presents particular challenges to navies that have not fielded ASW and underwater situational awareness technology in the past. Broadly speaking, what options are available for such fleets?
SEA: Other than building a dedicated fleet of ASW vessels, two main options are available to navies for short to medium term adoption of ASW capabilities. They can adapt their existing fleet to include ASW operation. This is one of the advantages of SEA's KraitSense ASW system – described further below – which has been designed to give non-specialist platforms a leading ASW capability. The alternative is to adopt uncrewed solutions. These are lower in cost but currently pose a higher risk due to their lack of maturity.

Credit: SEA

SEA's KraitSense system consists of a small footprint launch and recovery system and other inboard components for the operation of a thin line towed array. It was designed to enable smaller vessels within a navy's fleet to be provided with ASW capabilities.

MDM: SEA is widely recognised as having particular strengths in the area of underwater situational awareness. Can you explain the technology SEA offers in this area and the operational advantages it brings?
SEA: Utilising our decades of knowledge and experience in the underwater domain, SEA has developed a suite of low SWaP ASW and underwater situational awareness (UWSA) technologies for both crewed and uncrewed vessels. For example, the KraitSense system consists of a small footprint launch and recovery system and other inboard components for the operation of a thin line towed array known as KraitArray. KraitSense has been specifically designed to enable smaller vessels within a navy's fleet to be fitted with ASW and UWSA capabilities, as well as being capable of being retrofitted to vessels which already have a comprehensive sensor fitment and where space is therefore likely to be at a premium.
The KraitArray and KraitSense system has also been designed to be operational from uncrewed vessels, as demonstrated in recent years during trials upon many uncrewed surface and underwater vessels such as the United Kingdom's extra-large uncrewed underwater vehicle (XLUUV). The use of common array and processing technology means that a navy can have a common ASW sensor and UWSA outfit for both their crewed and uncrewed vessels, reducing the cost of adoption and through life costs. This also enables navies to increase their effective area of operation, increase detection range, and provide a higher level of persistence.
SEA also launched KraitOptimise at DSEI last year. The latest member of the Krait family of anti-submarine technology is an USWA tool which enables users to evaluate key environmental factors that can affect sonar performance through simple and intuitive visualisation of complex environmental data. The information the system provides can inform operators of the best place to locate sensors to maximise sonar performance and identify potential locations where threats may be hiding.

MDM: Has SEA learned any particular lessons from the naval war between Russia and Ukraine?
SEA: There are clear lessons to be taken from analysing the current conflict between Russian and Ukraine. One of the most significant – and of relevance to our specialism – has been the emergence of the effective use of uncrewed naval platforms. Ukraine has had to be very quick



Credit: SEA

KraitArray is the thin line towed array developed for use with the KraitSense system. It can be deployed from both crewed and uncrewed vessels.

in adopting a level of trust in these types of systems and it has paid dividends for them. This should be an example to industry and navies. By trialling and using these systems, there are very swift lessons to be learned that can also achieve an operational solution in a quicker timeframe than traditional means.

MDM: What developing factors are likely to influence control over the underwater battlefield in the medium to longer term?
SEA: Operational use; maritime safety; electromagnetic spectrum control; uncrewed platform and sensor payload security; underwater communications; and artificial intelligence (AI) are all key factors which will influence the direction and pace of development in the underwater domain. Only through the trialling of solutions and the development of effective partnerships between industry, customers and nations will these factors be understood and managed.
Amongst these factors, the progression and successful implementation of AI looks set to be one of the most significant. AI-powered systems can enhance situational awareness by analysing vast amounts of sensor data from various sources, doing so in real-time in order to provide enhanced situational awareness to naval commanders and enable better decision making and control of the underwater battlefield.
AI is also powering predictive analysis, reviewing historical data and predicting potential submarine movements, tactics, and patterns based on machine learning algorithms. This predictive analysis can help naval forces anticipate and counteract enemy submarine threats more effectively.

The Questions were asked by Conrad Waters.

Europe's Naval Shipyards: Competitive Again?

Tim Guest

Well, they certainly seem to be headed that way. While some order books might be fuller than others, construction capabilities at European shipyards overall are enough to rival leading naval shipyards in almost any global region. Moreover, construction projects now underway point to a turnaround which should gather pace, particularly if defence budgets improve.

Low investment in their navies in recent years by respective allied European governments has left many of Europe's fleets quantitatively weakened. The United Kingdom's Royal Navy (RN) is a prime example, with just 68 commissioned ships as at January 2024 compared with over 115 at the time of the Falklands War in 1982. That said, some countries, like Spain and Turkey, currently have clear self-reliance initiatives in play that include bolstering their naval forces and tonnage. So, while years of defence-spending tightening has led, in some cases, to smaller, neglected navies and thinner order books for Europe's shipyards, the capabilities and competitiveness of those yards to meet requirements for the most technologically sophisticated vessels, either at home or abroad, remains strong.
This article considers the latest fortunes of Europe's naval shipyards, using a few selected examples as benchmark indictors as to the direction of travel.

Credit: BAE Systems

HMS Cardiff, the second ship of the Type 26 class, is expected to be floated out of BAE Systems' Govan yard on the River Clyde in the autumn of 2024.

Analytical overview

To gauge what kind of demand Europe's shipyards might expect for their services in the coming years, a look at recent summary market analysis from Mordor Intelligence's *Europe Naval Vessels Market Size and Share Analysis - Growth Trends and Forecasts (2024-2029)* is informative. This estimates the size of Europe's naval vessel market in 2024 will reach USD 35.44 billion by year end and also projects it will grow to USD 57.62 billion by 2029, suggesting considerable added build potential for European naval shipyards. While the report covers a range of vessel types, from aircraft carriers, corvettes, and destroyers, to frigates, submarines and more, it suggests that the market has been "propelled" by recent frigate and offshore patrol vessel (OPV) developments. This is due to performance demands by customers for what it lists as their "lethality, speed, and manoeuvrability" to meet requirements driven by increases in such challenges as drug trafficking and illegal migration by boat in the waters of the Mediterranean, particularly around Albania, Italy and Spain.
Indeed, when it comes to frigates, the report suggests that at over 3,000 tonnes and with their mix of defensive and offensive weaponry, these vessels are increasingly popular with navies worldwide, as their multi-role nature sees them suited to a wide range of applications, from ship escort and anti-piracy roles, to patrolling, and strike group participation. The report's authors even suggest that many countries are increasing their defence budgets specifically to be able to afford frigates, including where aged frigate fleets need replacing with more modern vessels incorporating the latest sensors and anti-ship, anti-submarine and air-defence weapon systems. In fact, the report projects that during the forecast period to 2029, there will be steady frigate-build growth, with "the majority of frigate procurement planned in Europe", a statement it backs up citing the United Kingdom Ministry of Defence's (MoD's) award to BAE Systems for Type 26 frigates for the RN. All eight of these are being built in Govan, Glasgow, with the first, HMS *Glasgow*, currently undergoing outfitting at BAE Systems' Scotstoun yard, and HMS *Cardiff*, the second ship of the class, well underway in its construction at Govan. The programme is expected to last until the mid-2030s and supports the steady growth in the construction of frigates at European yards and beyond during the report's forecast period. The paper also reminds readers of the United Kingdom's plans to increase RN frigate and destroyer numbers in the longer term.

Author

Tim Guest, is a freelance journalist, European Correspondent for ESD, and a former officer in the British Forces.

Meanwhile, on the continent, players such as Navantia, Naval Group, Fincantieri and ThyssenKrupp are cited as some of naval shipbuilding's dominant companies, most having several yards dedicated solely to naval work and all with business strategies in place to win orders from both European and overseas customers. In addition, some of these yards are increasingly collaborating on a number of major programmes. One of the most significant – which has been stated as having the potential to reinvigorate naval shipbuilding across Europe – is the European Patrol Corvette (EPC) project. Its first, initial design phase began in October 2023 following signature of a contract between Europe's Organisation for Joint Armament Cooperation (OCCAR) and a consortium coordinated by Naviris that includes Fincantieri (Italy), Naval Group (France) and Navantia (Spain) within its key membership. France, Greece, Italy, Norway and Spain have all officially joined the project, while Ireland, Portugal and Romania are observers. [1] Importantly for industry, the participants agreed that a key objective of the project to build these vessels is to maximise collaboration between Europe's shipbuilding industries and shipyards. A statement from Naval Group at the time of the launch ceremony said the EPC programme represented a step forward in European defence cooperation that will contribute to European second-line vessel dominance, strengthen European industry in-house skills and know-how, and increase shipbuilding efficiency, with a corresponding decrease in the delays that are currently experienced delivering ships to navies.

Credit: Fincantieri

Seven PPA ('Pattugliatori Polivalenti d'Altura') multi-purpose patrol vessels were initially ordered for the Italian Navy.

Developments at key yards: benchmark indicators

Europe's allied nations within NATO have had a rude awakening these past few years. Even before Russia's invasion of Ukraine, their budgetary contributions to the alliance had been called (possibly with good reason) into question during the 'first' Trump Presidency, threatening the organisation's longer term stability. Nevertheless, Indonesia's recent award of a EUR 1.18 billion contract to Italy's leading naval yard, Fincantieri, for two PPA ('Pattugliatori Polivalenti d'Altura') multi-purpose patrol vessels suggests overseas confidence in European naval shipyards' construction capabilities and competitiveness despite the uncertainties of the underlying geopolitical backdrop. The fact that the award was

Credit: Fincantieri

Two PPA vessels bound for Indonesia are currently under construction at Fincantieri's joint Riva Trigoso-Muggiano shipyard (Muggiano is shown here), highlighting the company's group strategy to grow its defence business, including export opportunities.

Credit: PGZ

The first keel section of ORP Wicher, the lead 'Miecznik' programme multi-role frigate. The programme has marked a milestone turnaround in the fortunes of the Polish shipbuilding sector.

gained despite the existence of extremely competent regional yards in the likes of South Korea is all the more telling.

Fincantieri does have a group strategy to grow its defence business, including export opportunities, and already has an established relationship with Jakarta. This includes a deal for six FREMM type frigates and two second-hand, ex-Italian Navy *Maestrale* class vessels first reported in mid-2021 but for which negotiations are reportedly, still ongoing. However, the Italian MoD's efforts to showcase the PPA class vessel, ITS *Francesco Morosini*, in Southeast Asian ports during 2023 seem to have paid off with the announcement of this latest contract. The two vessels for Indonesia are currently under construction and being fitted out at Fincantieri's joint Riva Trigoso-Muggiano shipyard complex and were originally part of an intended seven-strong PPA contingent for Italy's navy before the Indonesian deal was concluded. The original order was awarded in 2015 to a consortium of Fincantieri and Leonardo. With support from the Italian MoD and navy, the Italian companies intend to foster their relationship and explore further opportunities with the Indonesia in line with its business plans to strengthen the company's overall presence in the geopolitically 'hot' Southeast Asia region.

Fincantieri is just one among the many leading European shipyards which continue to prove successful in gaining contracts to deliver complex and technologically advanced ships. For example, Anglo-Polish collaboration on the Polish Navy's 'Miecznik' (Swordfish) frigate programme – also known as Project 106 in Poland – will see three multi-role vessels based on Babcock International's Arrowhead 140 design deliver increased combat capabilities to the Polish Navy. At a shipyard level, the ships are being built at the Polish Armaments Group (PGZ) Stocznia Wojenna shipyard in Gdynia. Here a keel laying ceremony for the first of the three ships – ORP *Wicher* – took place at the end of January. The programme involves the largest investment in infrastructure such as building halls, equipment and machinery that the shipyard has ever experienced. Indeed, Paweł Lulewicz, president of PGZ Stocznia Wojenna, said at the time of the keel-laying ceremony that the event would not have been possible without the extensive changes the yard has recently undergone. However, he also wore the shipyards heart on his sleeve when he said, "These changes are primarily the result of the crew's trust in the management board and the good, joint work of our team – workers, engineers and specialists in purchasing and cooperation, thanks to which we have managed to turn the fortunes of this shipyard around over the last few years – from bankruptcy to a profit-generating company cooperating with world-class players."

ORP *Wicher*'s keel laying was actually the first in 23 years for a new Polish Navy combat vessel at the yard's Jana Śmidowicza Street facility in Gdynia, according to the company. *Wicher* will be followed by *Burza* and *Huragan*, with the importance of the whole programme for Poland's shipbuilding industry summed up in words of PGZ's management board president, Sebastian Chwałek, who said it marked the beginning of a new stage in the history of the country's shipbuilding industry, as it was the first time such a significant combat vessel has been built on Polish soil. The programme, which involves extensive knowledge sharing with British partners Babcock and Thales UK, should see ORP *Wicher* enter service in 2029, with the remaining two vessels operational by 2032, thereby marking the completion of the Miecznik programme.

British Government official, Investment Minister Lord Dominic Johnson, who – along with the MoD, RN and the UK Defence and Security Exports (UKDSE) unit of the Department for Business and Trade – has been involved in the negotiations resulting in the agreements between the main British companies involved and PGZ, said the agreement was a major vote of confidence in the UK's "world-class industrial expertise", adding that the partnership with Poland would further strengthen the Polish fleet by putting some of the "best UK capabilities behind it". This obviously

Credit: Babcock International

Sharing Babcock's Arrowhead 140 (Type 31) design is fundamental to the Polish frigate programme.

Credit: Navantia/Spanish MoD

Two coastal hydrographic vessels for the Spanish Navy will be built at Navantia's shipyard in San Fernando, Cádiz, Spain. The agreement was signed by the Secretary of State for Defence, María Amparo Valcarce, and the president of Navantia, Ricardo Domínguez.

includes the shipbuilding and naval design/architecture strengths of Babcock. Johnson added that long-term economic and defence cooperation between the two countries would also further bolster "the UK's competitive export offer" for such naval construction capabilities. Many of his comments were echoed by James Cartlidge, UK Minister for Defence Procurement. He noted that having an important NATO ally choose warships for its fleet based on the British Arrowhead 140 base design for the RN's Type 31 Inspiration class frigates, would not only enhance the Polish fleet but would also enhance interoperability between the two navies.

So, while Polish yards are set to build the vessels, the programme's collaboration between the three main stakeholders – PGZ, Babcock and Thales UK – is crucial to the overall PGZ consortium, (mention should be made that MBDA UK has also recently been contracted by PGZ to provide the naval air defence system aboard the vessels). In particular, it is Babcock's expertise in shipbuilding and naval architecture that underpins its key roles as the provider of a design licence agreement for its Arrowhead 140 frigate and as the platform design provider and strategic technology partner for the Miecznik Programme. As if that is not enough, it is also a member of the programme management office that oversees the vessels' design and construction. These important roles for Babcock in Poland's frigate programme should be no surprise based on the company's extensive naval sector expertise in the United Kingdom and elsewhere. The company actually established Babcock Polska five years ago to specifically support delivery of the frigate programme. Its HQ in Warsaw and an office in Gdynia employ some 30 Babcock personnel.

Back home, Babcock's manufacturing facility at its Rosyth shipyard in Scotland is the digitally-led yard from which the company conducts its ongoing efforts to drive further export opportunities of the Arrowhead 140 design, helping to roll out the vessel's blueprint, engineering processes, and knowledge sharing for export customers around the globe. Indonesia is currently another customer set to complete new Arrowhead 140 series frigates.

Spanish footnote

Aside from its prominent place in the EPC Programme, it is also worth noting Navantia's recent corvette and hydrographic vessel contracts. Both underline a healthy order book at the company's home shipyards for ships destined for the Spanish Navy, as well as significant export customers such as the Kingdom of Saudi Arabia. The latter saw the March commissioning and delivery to the Royal Saudi Naval Forces of the fifth and last corvette of the Al-Sarawat project, with all the ships having been built at Navantia's Bay of Cádiz shipyards. Final construction and systems integration works of later ships have, however, taken place in Jeddah in collaboration with Saudi Arabian Military Industries (SAMI); Navantia and SAMI have formed a joint venture allowing the Spanish shipbuilder to position itself in the Arab market and area of influence, which fits its overseas business strategy. The joint venture projects a global workload of around seven million hours and 6,000 jobs over five years, according to a company statement.

As for the two coastal hydrographic vessels (BHCs) for the Spanish Navy, the Spanish MoD and Navantia agreed their construction in December 2023 to replace the hydrographic vessel *Antares*. She was built in the 1970s and is the only one of four *Castor* class vessels still in use. The ships will be built at Navantia's San Fernando shipyard in the Bay of Cádiz. Here the work over the next four years will support 700 jobs.

Conclusion

Space precludes mention of every European shipyard, every kind of naval vessel, and every new development being undertaken by the continent's shipyards. However, the examples provided are evidence of the vast wealth of experience and ability to deliver high quality products that typify the region's shipbuilding sector. From the programmes underway, the collaborations and knowledge-sharing taking place, and the obvious overseas interest being shown, Europe's naval shipyards certainly remain competitive on the world stage to meet the most technologically demanding naval vessel requirements. Given today's threatening atmosphere, government defence budget-holders and defence ministries would be well advised to keep order books full for their home-grown yards, bolstering their allied naval fleets, fast, in the face of the gathering storm. ■

Editor's Note:
Confusingly, even official websites relating to the project contain inconsistencies as to the precise status of the various participants.

Devonport Royal Dockyard: A Glimpse behind the Dockyard's Walls

Conrad Waters

On consecutive days in February 2024, Babcock International Group hosted members of the investor and media communities at a series of presentations at Devonport Royal Dockyard in Plymouth, South West England. Conrad Waters, MDM's Joint Editor in Chief, was present at the media event. Here, the group's Chief Executive Officer (CEO) David Lockwood and Chief Corporate Affairs Officer John Howie explained the British defence and security enterprise's current performance and future plans against the backdrop of the dockyard's impressive facilities. The events provided a rare opportunity to view the massive programme of transformation that is currently underway at one of Europe's most important naval complexes.

A strategic facility

Tracing its origins to the seventeenth century, Babcock International's Devonport Royal Dockyard facility was privatised in 1997 prior to being acquired by Babcock ten years later. Co-located with HM (His Majesty's) Naval Base Devonport – which remains in government hands – the combined site is claimed to be the largest naval support facility in Western Europe. Spread across an area exceeding 650 acres (2.7 km²) bordering the River Tamar, it encompasses four miles (6.4 km) of waterfront, 25 tidal berths, five basins and 15 dry docks.

Devonport Royal Dockyard's main function is to act as the primary centre for the maintenance of the British Royal Navy's nuclear-powered strategic and attack submarines throughout their service lives, as well as supporting their eventual defuelling and disposal. This infrastructure suffered from lack of investment in the post-Cold War era but is now being transformed as part of a major programme of capital expenditure. Inevitably, the recapitalisation of these support facilities, which comprise a complex of docks and other maintenance assets clustered around the yard's Number Five Basin, were a focal point of the visit.

The most significant modernisation project that is now being undertaken at Devonport is the Submarine Waterfront Infrastructure Future (SWIF) programme. This is aimed largely at supporting maintenance of the new generation of *Astute* class attack submarines. Babcock signed a GBP 750 million (USD 937 million) contract with the UK Ministry of Defence's Submarine Delivery Agency (SDA) to implement SWIF in November 2023 and its completion is due before the end of 2027. The project includes the reconstruction of the existing 10 Dock to house submarine refits, the provision of a new non-tidal maintenance berthing within Five Basin, as well as construction of associated buildings and services. Although primarily focused on the *Astute* class, the project will also benefit the existing *Vanguard* class submarines, as well as the future *Dreadnought* and SSN-AUKUS classes.

Credit: Babcock International

Devonport Royal Dockyard and the adjacent naval base are claimed to be the largest naval support facility in Western Europe. Submarine refitting facilities are located around the large basin to the left of the image whilst the Frigate Support Centre can be seen in the centre.

The media visit provided the opportunity to view the extensive work that is being carried out to implement the infrastructure upgrades, which have included the demolition and clearance of existing buildings and other site preparatory work. The modernised dock has to be sufficiently robust to withstand a severe seismic event, necessitating the strengthening of adjacent infrastructure. Once completed, the upgrades will make an important contribution to reducing the backlog of submarine refits that have had a detrimental impact on the readiness of the Royal Navy's undersea flotilla.

Credit: Babcock International

The cathedral-like structure of Devonport Royal Dockyard's Frigate Support Centre (FSC).

Frigate support challenges

Another highlight of the media visit was the tour of the dockyard's Frigate Support Centre (FSC), which was first opened in the mid-1970s to facilitate the refits of *Leander* class frigates. The vast, cathedral-like structure provides three covered docks to allow work to progress in all weather conditions. It has recently been almost entirely devoted to implementing life extension (LIFEX) work on the majority of Type 23 'Duke' class frigates that remain in Royal Navy service. This has proved to be a complex project, with the challenges of refurbishing ships that have served far beyond their originally planned 18 year service lives being much more significant than was initially envisaged.

The end result has been frequent changes in the overall scope of the Type 23 LIFEX programme, the individual ships scheduled to go through it, and the length of individual refits. Of the life extensions completed to date, that for HMS *Iron Duke* proved particularly challenging to accomplish. Taking nearly 50 months by the time it was concluded in mid-2023 and costing approximately of GBP 100 million (USD 136 million), the package of work required the insertion of more than 2,000 steel patches to return the ship to a seaworthy condition. However, the LIFEX project is now progressing to a largely successful conclusion, with Babcock keen to point out that they are meeting all current programme requirements. The FSC is likely to be kept occupied in the medium term maintaining the Type 23s until the class is finally withdrawn in the 2030s.

A major question mark, however, hangs over the FSC's longer term future. The size of surface combatants has grown since the support centre was first opened and the next generation of Type 26 and Type 31 frigates will not be able to fit within the docks' confines. One possibility might be to utilise the structure to dismantle decommissioned nuclear submarines once a trial project at Babcock's facility at Rosyth in Scotland involving the former HMS *Swiftsure* has been completed. In any event, it seems likely that further investment in infrastructure will be required to maintain the new frigate classes.

More than supporting the fleet

Whilst Devonport Royal Dockyard is inevitably focused on naval projects, Babcock was also keen to use the media event to showcase the facility's broader capabilities.

Credit: Babcock International

The Royal Navy's strategic submarine HMS Victorious seen approaching Devonport Royal Dockyard prior to commencing a life extension programme. Devonport is the focal point for the refit of British submarines.

These are being leveraged through the inclusion of the so-called South Yard part of the dockyard within the new Plymouth and South Devon Freeport. This offers government incentives in the form of relaxation of customs duties and some other taxes to encourage investment.

An early indication of the attractions of the regime has been provided by Babcock's investment in an innovative manufacturing facility within South Yard to produce 'Jackal 3' High Mobility Transporters (HMTs) for the British Army. The contract is being fulfilled in partnership with specialist military vehicle manufacturer Supacat. It involves the initial production of 70 vehicles; 62 at Devonport and the remaining eight at Supacat's own factory. Around 90 jobs have been created at Devonport as a result of the contract's award.

The contract is comparatively small and short term in duration, being due for completion around the middle of 2024. However, it potentially has longer term significance in so far as the new Devonport factory is future-proofed so as to be ready for subsequent build programmes. Babcock state that transformational innovation technology has been used throughout the production line, including the use of its bespoke 'Pulse' software to maximise efficiency during vehicle assembly. The company anticipates that the advantages of being located in the South Devon Freeport will be of considerable benefit in bids for further orders, both domestic and in the global export markets, in the years to come.

Credit: Babcock International

'Jackal 3' High Mobility Transporters (HMTs) are being constructed at a purpose-built facility in Devonport Royal Dockyard's South Yard area for use by the British Army.

Credit: Babcock International

The recruitment and training of a highly-skilled workforce is crucial to the planned expansion of activity at Devonport Royal Dockyard.

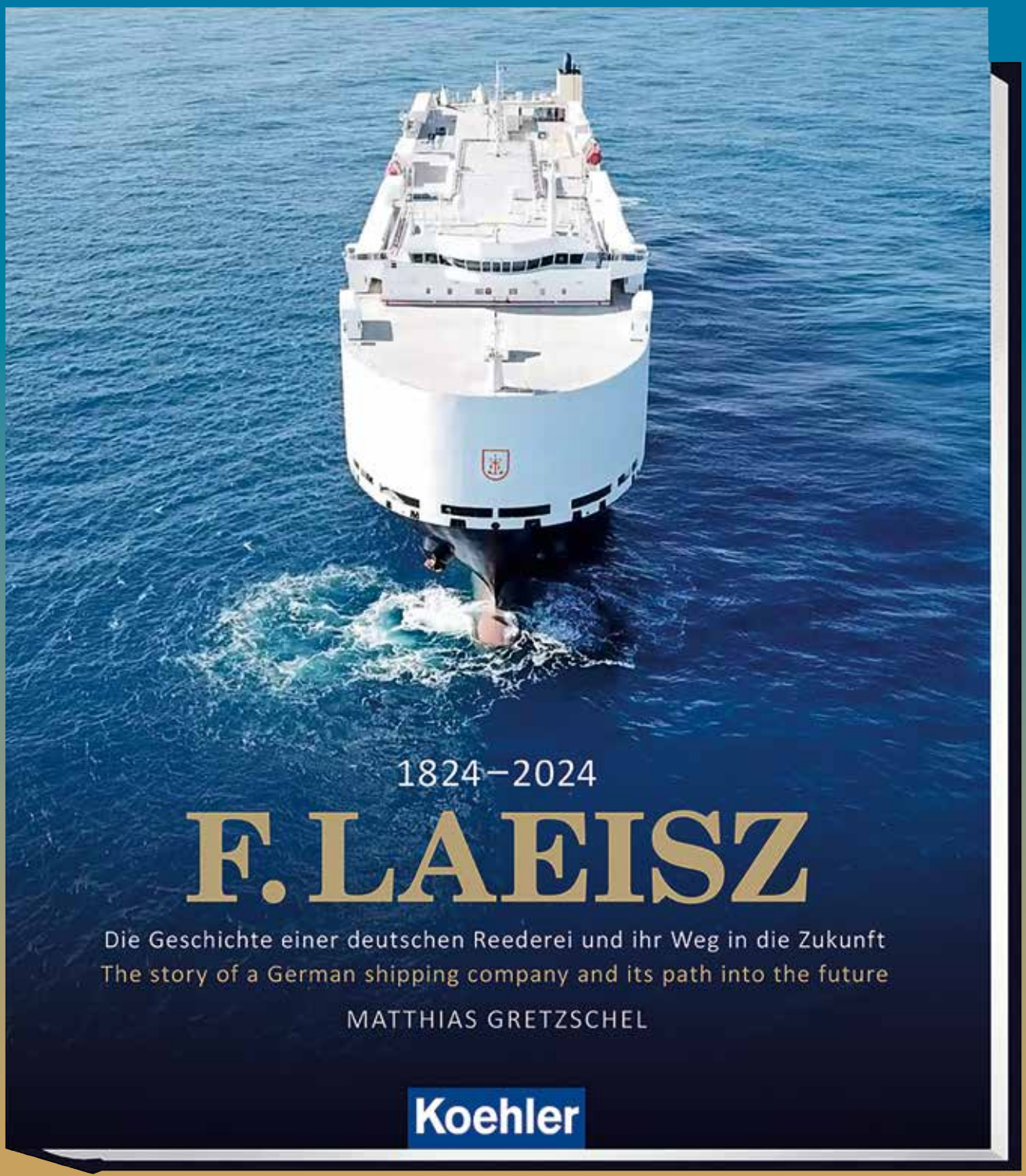
Reindustrialising the United Kingdom

The investment that is now being made in upgrading and expanding infrastructure at Devonport Royal Dockyard underpins its place as one of the region's most important employers. Babcock employs a workforce of about 7,300 employees at the dockyard and many more local jobs are supported by the area's naval facilities. These numbers are only expected to grow in future years.

Indeed, a key theme running throughout the media presentations was the huge challenge the facility's expansion presents in terms of attracting the growing workforce needed to support the associated increase in activity. Babcock CEO David Lockwood described this challenge in terms of achieving what is essentially "the reindustrialisation of the United Kingdom". It has become clear to the company that its demand for labour will not be achieved merely by pursuing traditional recruitment methods targeted, for example, at school leavers and graduates. As such, this is another area where innovation is being pursued.

One major element in Babcock's strategy is the creation of a Babcock Skills Academy that combines digital technology with hands-on-training to develop the personnel skills that the group needs. The academy was launched at Devonport in 2023 and has an initial focus on developing submarine support and critical nuclear skills. The programme will be extended to other areas of Babcock's business in due course. Whilst open to existing employees and new recruits, a major part of the plan is to retrain workers from other disciplines to provide the required expertise. More than 2,000 people are expected to pass through the Babcock Skills Academy in its first three years, and a further 10,000 over the following five years in an indication of the extent of the scheme's ambition.

All-in-all, the media visit provided a valuable insight into the level of investment now being made in revitalising British naval infrastructure after a period of relative neglect. The fact that this investment is being replicated in other facilities, particularly in the nuclear sphere, across the United Kingdom makes the scope of this reinvigoration all the more impressive. Babcock's endeavours illustrate both the scale of the challenge faced when critical assets are allowed to decline and the determination with which government and industry are rising to this challenge. ■



Matthias Gretzschel, »200 JAHRE F. LAEISZ« / Hardcover
256 Seiten / Format 24 x 28 cm / € (D) 49,95 / ISBN 978-3-7822-1535-0

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On the Eve of Destruction

Scott Savitz

The rapid seizure of operational port facilities has typically been a vital objective of any major amphibious invasion. Conversely, effective measures aimed at the denial of these facilities can significantly hinder an opponent's operations. This article looks at the continued relevance of port destruction, using the current threat posed by mainland China to Taiwan as an example.

The risk of an invasion of Taiwan

Few military problems receive as much attention as the threat of a Chinese amphibious invasion of Taiwan. China's acquisition of the world's largest navy reflects its shift towards the maritime domain, partly in the hopes of grasping the glittering prize that it has sought since 1949. The opposition of the Taiwanese people and their government are bolstered by American support, despite a stated US position of 'strategic ambiguity' regarding whether American forces would defend Taiwan in wartime. Many other nations also oppose a potential Chinese conquest of Taiwan, though they lack US military capabilities and even its ambiguous degree of commitment.

Credit: Republic of China Navy

Two of the Republic of China Navy's Tuo Chiang catamaran corvettes pictured on exercises. Despite Taiwan's efforts to deter Chinese aggression, the threat of an invasion across the Taiwan Strait remains a real possibility.

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China may aim to seize Taiwan without launching an amphibious invasion. It could conceivably coerce the island to surrender via a combination of measures: blockading the island, manipulating or severing communications channels, targeting electrical grids and other key infrastructure, 'decapitating' it by assassinating political leaders, and demonstratively destroying Taiwanese aircraft on the ground. This would echo the previous occasion in which a mainland regime conquered the island: instead of conducting an amphibious assault, it coerced the Taiwanese leadership to accept terms after a battle at sea.

On the other hand, the possibility of a full-scale amphibious invasion remains, and the degree to which China finds it enticing will depend heavily on its perception of risks and costs, both broadly defined. As in any amphibious invasion, the early capture of a port would be a critical enabler. Moving materiel and people from ships onto a beach via landing craft is highly inefficient, in terms of both the time and resources required. Unless the area around the beach has highly favourable topography or a substantial road network, forces may have difficulty breaking out from their initial positions. Landing on a beach may be necessary at the outset, but it is far more advantageous to move supplies and equipment through an established port. Using a port, including the road infrastructure adjacent to it, can drastically shorten timelines to get forces from large ships onto ground vehicles that are heading for key objectives. The ability of ports to shorten timelines is particularly valuable for China's People's Liberation Army (PLA) in a Taiwan invasion scenario, since China is impelled to seek a rapid conquest for multiple reasons. Speedily moving forces inland, rather than having them build up on a bare beach, makes

them less vulnerable to bombardment. By eliminating the need for ships to linger offshore while landing craft shuttled between them and the beach, ships could move larger quantities of personnel and equipment to Taiwan in shorter times. Speed could keep Taiwan's military forces and its population off-balance, limiting the effectiveness of the former and contributing to the despair of the latter. Perceptions of a fast-moving juggernaut could even induce swift surrender, as happened in France in 1940. A quick conquest would limit the effectiveness of any American intervention, given the long lead times to move forces to the western Pacific, or deter the United States from intervening altogether. Politically, the achievement of a fait accompli could help to quiet international voices that would otherwise support Taiwan during a protracted conflict. Finally, a quick, low-resistance conquest, leaving Taiwan mostly intact, would enable China to maximise the economic benefits it would subsequently derive from the island.

The threat of port capture

There are two broad ways in which Chinese forces could attempt to take a major port. The first is straightforward: People's Liberation Army (PLA) forces could come ashore on beaches and then seek to capture an adjacent port facility. The second, more complex one entails using Special Forces to infiltrate a port. They might emerge from a vessel or enter the facility from the land side, infiltrating it after posing as intensely muscular tourists. Some might don Taiwanese uniforms and impersonate Taiwanese soldiers, particularly if given linguistic and cultural training. A PLA soldier who inflects their Mandarin with popular expressions from Taipei, or speaks Taiwanese dialect, could be difficult to distinguish from a local. The mere knowledge that such impersonators existed could cause Taiwanese forces to impede themselves; when a few dozen Germans impersonated Americans during the Battle of the Bulge in 1944, they caused massive disruption as units and individuals all suspected and apprehended one another.

The ability of Special Forces to take over a port would be enhanced if they could suborn select Taiwanese individuals to work on their behalf. At key moments, even having a few Taiwanese civilians or military personnel remain inactive could be valuable. Once Special Forces had taken the port, while the fog of war was still thick, they could use it to get limited numbers of vehicles, personnel, and air-defence equipment ashore. Combined with a blizzard of disinformation about who actually controlled the port, these would provide enough protection to enable larger forces to disembark there and swiftly expand the perimeter. Paratroopers could also be landed around the port to take and secure its landward approaches.

Regardless of which method is used, the result of a port capture would be devastating for Taiwan's defenders. China's inability to capture Taiwan for the last 75 years has been driven by its inability to get forces onto the island: there has never been any question regarding which side would win a ground war, if their respective armies were brought to bear. Once a major port had been captured and its environs secured, further build-up could only be prevented by sinking or incapacitating an extraordinarily high percentage of both conscripted civilian vessels and PLA Navy warships in transit. The massive port of Kaohsiung, which handles most of Taiwan's port throughput, would be a particularly desirable target. Just before the pandemic, it was handling an average of 29,000 containers and 312,000 tons of cargo each day. Its main disadvantage is that its location in the island's southwest puts it over 300 km by road from Taipei, the island's capital and centre of gravity in the north. Alternatively, the ports of Taipei and Keelung each have a fraction of Kaohsiung's capacity, but are adjacent to the capital. Other ports could also be considered, such as Taichung, in the middle of Taiwan's west coast. Even the seizure of a relatively small port could accelerate the delivery of equipment and supplies ashore by an order of magnitude relative to plodding delivery via landing craft onto a bare beach. The capture of a port could also be psychologically devastating, as the population perceived the speed at which they could be overrun, deflating hopes that US intervention could protect them. The result could be rapid surrender of the island without a costly fight for the PLA, after which the world would need to accept a fait accompli.

The criticality of invaders seizing a port has long been recognised. During the largest-scale amphibious invasion in history – the Normandy landings of 1944 – the Allies

Credit: Taiwan Port Corporation

The massive port of Kaohsiung, which handles most of Taiwan's port throughput, would be a particularly desirable target in the event of the island's invasion.

Credit: US NHHC SC 191788

Destruction at the port city of Cherbourg pictured in the aftermath of the US Army's capture of the city after the Normandy landings. Effective port-denial operations meant that harbour facilities remained out of action for many weeks.

aimed to take the port of Cherbourg to accelerate their build-up of forces on the continent. While the artificial 'Mulberry' harbours that the Allies brought with them to the beaches of Normandy helped, they also knew that a real port would greatly bolster their ability to move materiel. Unfortunately, the Germans also recognised this. As the allied forces pushed outwards from the beaches and sent forces north towards Cherbourg, the Germans utterly destroyed the port over the course of three weeks. It took additional weeks for the Allies to reconstitute even select parts of Cherbourg's port capacity, and months for the port to achieve full capacity for debarkation. According to one historian:

"The harbor was strewn with a variety of different types of mines. All basins in the military and commercial port were blocked with sunken ships…the electrical control system and heating plant for the port were demolished and 20,000 cubic yards of masonry were blown into the large deep basin that had been used in peacetime for docking Atlantic liners…quay walls were severely damaged. Cranes were demolished in all areas. The left breakwater for the inner harbor was cratered so that the sea poured through." [1]

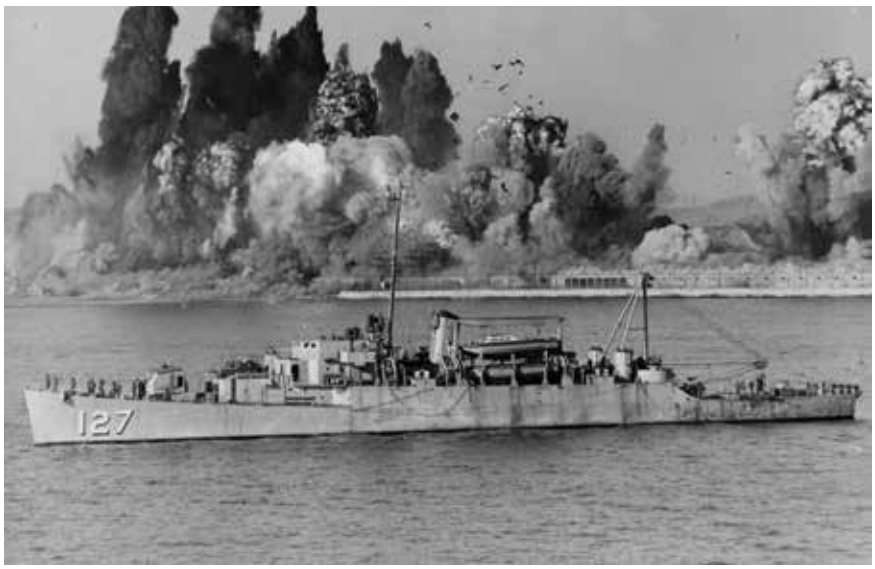
Another notable instance of port destruction took place in the Korean port of Hungnam during December 1950. As Chinese and North Korean forces pushed south, United Nations forces evacuated roughly 100,000 troops and nearly 90,000 civilians from the port, along with massive quantities of equipment, during the course of ten days. As they pulled out, the 10th Engineer Combat Battalion and Navy demolition teams destroyed the port's facilities. The final explosion let out a roar with 400 tons of dynamite and ammunition, 500 thousand-pound bombs, and roughly 200 drums of fuel. [2]

How Taiwan can destroy its ports

A Taiwanese effort echoing the Cherbourg and Hungnam operations could help to prevent a port's imminent capture from facilitating the rapid Chinese takeover of the island. Port-destruction activities can broadly be divided into those on the land and sea sides of the port. On the land side, cranes and other handling equipment can be destroyed in numerous ways, such as severing wires, fouling optics, and smashing controls. Pipes, pumps, and storage tanks can be damaged with small-arms fire. Live wires can be exposed throughout the port in places where unaware individuals would be likely to injure themselves. Some equipment could even have built-in self-destruct modes: for example, electronics can heat themselves to the point that they melt key components or start fires. Similarly, pre-established 'kill codes' can be entered and malware injected into equipment. Controlled explosions within the port can be used to destroy equipment and control centres, and then followed by spraying fuel from hoses to burn whatever is left. Following this, deploying copious booby traps throughout the port will cause the invaders to perceive every item they touch as a possible threat; this will slow them directly and induce frustration that degrades their ability to do precision work. Small electronic jammers can be distributed in concealed locations around the port to interfere with communications and navigation. Such devices can intermittently flicker on and off, both to make them hard to localise and to reduce demands on their batteries.

Going beyond the port facility itself, roads and railways can be cratered with explosives, and can have small, low-visibility sharp objects distributed along them to slash tires. Even visible land mines atop road surfaces would take time to redress, while larger devices – akin to the improvised explosive devices that tormented US forces in Iraq and Afghanistan – can be concealed along sides of roads and railroad tracks, detonating when they sense a vehicle's magnetic signature or the vibrations it generates. Roads and tracks can also be obstructed with what appear to be rocks, but which detonate when

Credit: US NHHC NH 107583



USS Begor (APD-127) stands offshore at Hungnam, North Korea on 24 December 1950, as demolition charges wreck the port facilities.

someone tries to remove them. Railway tracks can also be subtly damaged in ways that cause derailment.

Equally extensive destruction can be inflicted on the maritime side, much of which can be achieved through naval mining. Vessels can litter numerous naval mines throughout the port complex and in the approaches to the port. Those naval mines can be designed to hinder mine countermeasures efforts. Minehunting sonar will have difficulty detecting and classifying bottom mines that have irregular mine shapes, shapes that foster self-burial, or shapes resembling cast-off refrigerators. Seeding minefields with a few moored contact mines – the classic 'spiky balls' of First World War vintage – requires a separate minehunting process, further extending timelines. There are also many ways in which to hinder the complementary tactic of minesweeping, in which equipment creates ship-emulating signatures to prematurely detonate mines. For example, some mines can be programmed to detonate only after they have been exposed to ship signatures multiple times, or to have a given probability of detonating each time they are exposed. This not only protracts sweeping processes, but can also lull people with a false sense of security: a detonation-free sweep can be mistaken for a sign that no mines are left, only for transiting ships to then fall victim to them.

Going beyond mining, a simple means of impeding maritime access is by scuttling ships in various chokepoints. Salvage operations to clear those ships could be impeded by littering the ships with explosive booby traps before they sink, and the previously mentioned chorus of jammers would further disrupt them. Before cranes are destroyed, they can be used to drop large concrete or metal obstacles into key channels. These obstacles may be most effective if they are not tall enough to breach the surface, but tall enough to impale or effectively ground ships with moderate drafts. In addition, explosives can be affixed to seawalls and detonated. Concealing the explosives below the waterline and having the detonation occur with a substantial time delay would disrupt attempts to reconstitute the port.

Once the heavily damaged port has fallen, sustained external attacks can impede the considerable work of reconstituting its capacity. Repairing or setting up equipment, defusing booby traps, and other activities require painstaking attention to detail, during which time specialised equipment and personnel are exposed to attack. Personnel and machines engaged in reconstruction are fixed targets, while mine countermeasures assets are generally fragile and move slowly in predictable patterns. Lobbing occasional rockets, mortars, or missiles at the reconstruction effort can cause people to scurry for cover, disrupting their work. Uncrewed vehicles can also strike from multiple domains. By conducting information operations to create frequent false alarms regarding incoming threats, Taiwanese forces can further protract timelines, exacerbate psychological effects that degrade performance, and make the crews less responsive to real alarms. The extent to which such attacks are possible depends on how the rest of the conflict is going: what weapons Taiwan has available at what ranges, and whether outsiders have intervened.

Challenges in undertaking port-destruction operations

There are four key challenges related to such a scorched-earth operation. The first is how to coordinate these efforts so that they do not all interfere with one another or cause human casualties on the Taiwanese side. For example, the cranes need to put obstacles in place before they are destroyed, the arson needs to avoid harming personnel who are placing explosives, naval mines need to be spaced far enough apart to avoid sympathetic detonation, and the malware should be injected into the communications system after it is no longer needed. The destruction needs to take place while the port may be under some degree of fire, and while the PLA may be degrading tactical communications,

Credit: US Navy

US Navy divers undertaking training in mine identification and disposal. In spite of technological advances, the difficult conditions that typify a harbour area would make mine clearance in a destroyed port a hazardous and time-consuming operation.

Credit: US Navy

US Marines undertake a field training exercise in a port environment. The use of Special Forces to seize a port stealthily could restrict the port-denial process to a matter of hours.

or poisoning those communications with false information and orders. The operation may also be interrupted by port capture at any time, so it needs to be designed and coordinated so that it still has a substantial effect even in the event of premature termination.

A second challenge relates to command and control: ensuring that the operation is conducted if, and only if, the port's fall is imminent. The PLA could attempt to infiltrate command channels to prevent the operation, enabling it to seize the port largely intact. Conversely, the PLA could aim to induce Taiwanese forces to damage key ports that it was not intending to capture. Either goal could be achieved through the use of cyberattacks, information operations, or, as was previously referenced, having PLA personnel disguised in Taiwanese uniforms countermand key orders. Taiwanese forces will need to ensure highly reliable, redundant command-and-control mechanisms that are resistant to all of these potential types of PLA tampering. The fact that it is psychologically hard for people to conduct scorched-earth operations in their own country, even when the need to do so is well-justified, also needs to be taken into account. However, unwillingness to do this should not be overstated, given ample historical precedents, including by Chinese and Russian forces during the Second World War.

The third challenge relates to speed. Unlike in the case of Cherbourg or Hungnam, there may not be weeks or even days in which to thoroughly destroy the port. If the PLA uses Special Forces to seize a port stealthily, the process may be measured in hours. Even if the port is captured using ground forces that have already established a beachhead nearby, there will be an understandable reluctance to destroy the port until its capture is assured. Moreover, port-destruction forces may come under fire that impedes their work. The PLA could use anti-personnel weapons, such as guns mounted on small uncrewed aircraft, to hinder efforts to destroy the port without inflicting damage on the facility. Given these considerations, implementation of the operation requires well-exercised plans, prepositioned assets, and enough defensive capabilities to enable the people destroying the port to survive and operate.

Finally, the fourth challenge is that in peacetime, well-exercised port destruction plans should be visible enough to contribute to deterrence, but also not revealed to the point that the PLA can effectively figure out how to stymie such operations. Ostentatiously demonstrating swift port-destruction plans can help to convince the PLA that it will not capture a port intact. Alongside many other efforts to influence China's leadership, this may cause them to defer an invasion indefinitely. Still, the details of what is happening during exercises need to be somewhat obscured, perhaps literally by overhead smoke cover to provide concealment from Chinese intelligence.

Closing thoughts

It is to be hoped that deterrence prevails, bolstered by China's perceptions of Taiwan's port-destruction capabilities. However, hope is not a strategy, and Taiwan can best deter China by achieving robust self-defence capabilities, including the ability to thoroughly destroy its ports before they are captured.

This does not need to entail a large portion of Taiwan's defence budget. Port-destruction capabilities can be acquired at relatively low cost, particularly compared with fighter aircraft and other prestige weapons. Naval mines, booby traps, malware, and other items can be developed indigenously, and none of these is expensive. The main costs are for planning, training, and exercising port-destruction operations wherever they are needed.

If the conflict ends with a Taiwanese victory, friendly nations can send copious assets and personnel to help remediate the damage to the port. Some of the damage can be time-limited by design: for example, mines and booby traps can self-sterilise after a fixed period. Regardless, it could take weeks or months for specific ports to recover to full capacity, greatly damaging Taiwan's economy. On the other hand, that would be far less iniquitous than permanent occupation by PLA forces.

To conclude, a scorched-earth capability to destroy a port would be a valuable addition to Taiwan's defensive capabilities. By preventing the seizure of an intact port, this capability can hinder the PLA's ability to rapidly conquer the island, providing critical time for Taiwanese and outside forces to respond effectively. ■

Notes

1. Harrison, Gordon A, United States Army in World War II: The European Theater of Operations—Cross-Channel Attack, 1951, updated 1993. Washington, DC: Office of the Chief of Military History, Department of the Army, pp.441-442.

2. Mossman, Billy, United States Army in the Korean War: Ebb and Flow November 1950-July 1951, United States Army Center of Military History, 1990, pp. 174-176.

Cyber blindness

Dr Lee Willett

A new white paper argues that government, naval, and industry eyes must be open to the cyber risks to what is known as operational technology.

To generate its operational effects, a high-end naval warship will carry a range of state-of-the-art, automation-focused and information technology (IT)-based weapons and sensors.

A modern aircraft carrier, for example – such as a US Navy Ford class or UK Royal Navy Queen Elizabeth class ships – will embark aircraft such as the 'fifth generation' Lightning II joint strike fighter, which brings its own state-of-the-art weapon and sensor capabilities. The carrier itself will be armed with close-in weapons systems or self-defence torpedoes that are cued to targets by remote sensors, including Electro-Optical/Infra-Red (EO/IR) systems. The ship's own sensors will include Electro-Optical and Infrared capabilities and radars to provide air-search, surface-search, ship navigation, and aircraft landing capability. A data-focused combat management system (CMS) fuses data from the different sensors and distributes information to operators.

Credit: US Navy

An F-35B Lightning II fighter aircraft takes off from the UK Royal Navy (RN) aircraft carrier HMS Queen Elizabeth, while the carrier strike group (CSG) sailed in the South China Sea in 2021. A modern carrier, its air-wing, and its CSG carry a range of operational technology (OT) that must be secured from cyber threats.

The IT underpinning such systems is crucial to their operation, and to the operational effectiveness of the platform. However, it also presents risks to their operational security.

Such IT-based weapons and sensor systems are so critical to a ship's activities and effectiveness – and thus to a navy's operational outputs and its consequent contribution to national security – that significant attention is paid to ensuring the security of such weapons and sensors in the face of growing cybersecurity threats from a greater range of potential adversaries.

However, perhaps equally important – but perhaps not so uniformly recognised and understood – is the cybersecurity threat to other IT-based systems, both onboard ship and ashore, that are essential to the operational use and output of the platform and its weapons and sensors. Collectively, such systems form what is effectively a second IT-based layer, one that enables and underpins the use of ships and their weapons and sensors and one that is central to their effective operational output. This layer is known as operational technology (OT).

OT is another layer that is vulnerable to cyber threats – but the risk here may not be at the forefront of concern to the same extent it is with high-end weapons and sensors, and their host platforms.

Onboard an aircraft carrier – and, indeed, within its Carrier Strike Group – are several core OT systems that could be targeted in cyber-attacks, including against those systems' own infrastructures. These might include: satellite communications-based navigation systems; the ship's power and propulsion set-up; the integrated platform management system; internal and external communications systems; ship safety and recovery systems, such as firefighting or flooding control capabilities; and refuelling/resupply systems including those based on auxiliary ships within the Carrier Strike Group.

Ashore, infrastructure elements within a naval base provide another OT layer that offers an example of how potential cyber-attacks could threaten a ship's operation. Such elements could include dry dock gates, port cranes, or re-supply facilities, for example.

The primary point to bear in mind is that an adversary does not necessarily need to damage or sink a ship to stop it delivering its effect. The adversary simply needs to stop the ship operating in the first place.

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Defining the threat

The UK Government's National Cyber Security Centre (NCSC) defines OT as "Technology that interfaces with the physical world and includes Industrial Control Systems (ICS), Supervisory Control and Data Acquisition (SCADA), and Distributed Control Systems (DCS)." It adds that, in the civilian world for example, OT can include the operation of traffic lights or the provision of energy at the touch of a button. OT, it continued, includes "automatically monitoring and controlling processes and equipment that are too dangerous, too demanding, or too monotonous for manual operation".

Demonstrating the range of OT risks that exist, 'dangerous' systems could include radars or underwater sensors; 'demanding' systems could include ship or port cranes or lifts; and 'monotonous' systems could include onboard heating control systems.

The NCSC notes that traditional cyber security has focused on information security, integrity, and availability, whereas OT focuses more on physical factors relating to safety, reliability, and availability. "Many OT environments form part of the UK's critical national infrastructure, so disruption to services that they control is potentially of concern," the NCSC added.

The NCSC's own work on the issue is designed to help architects and designers procure secure, resilient systems, it continued.

In the military world, navies themselves are focused on improving operational resilience across the board, assessing a range of factors including ship availability, logistics sustainability, personnel capacity, and IT security. Industry experts are thus asking the question of whether securing OT should feature more centrally in discussion and development of ship design and operation concepts, hand-in-hand with increased consideration of securing OT at the infrastructure level.

Tackling the threat

In a jointly produced white paper shared with *Maritime Defence Monitor*, BMT – a naval design, engineering, and management consultancy offering specialised maritime sector solutions, including focus on security and OT cybersecurity – and Fortinet – a specialist cybersecurity company delivering secure OT, through enterprise threat protection across network, datacentre, and cloud-based constructs – argue that losing access to OT system outputs can impact capacity to deliver a mission.

The paper opened by asking the question of whether navies faced the risk of a multi-billion pound aircraft carrier being put out of action because of a cyber-attack on a one-pound sensor. "The example, simple £1 sen-

Credit: BMT, 2024

A BMT illustration, depicting how resilience and innovation can help secure OT in the maritime domain.

sor may be controlling the ship's engines, port cranes or lock gates, or simply keeping the lights on and the environment at the correct temperature," the paper stated.

In setting out the operational context around this question, the paper noted "OT most commonly encompasses the hardware and machines responsible for the physical processes of a business." The paper added that OT systems often use proprietary software, have longer technology lifecycles, and are required to operate autonomously.

Western navies are increasingly focused on digital technologies at sea and digital transformation both at sea and ashore, in order to maintain competitive advantage. For a navy like the RN, the paper said that digital transformation can encompass key developments relating to OT, including:

- Increased use of OT to support system maintenance, engine monitoring, munitions handling, and environmental controls;
- Increased networking and connectivity, such as ship-to-shore communications, remote control of offshore and onboard operations, increased use of cloud-based data applications, and greater integration between OT and IT;
- Increased use of automation and autonomy at a fleet, ship, and shore infrastructure operational level;
- Greater numbers of autonomous vehicles, ranging from very small, single-use ships to very large ships.

The paper noted that the increased use of digitisation, plus the accelerating convergence of OT and IT, have expanded the scope of cyber-attack risk to OT, along with the likelihood of attack success. For organisations like defence ministries, it added that "Delivering secure OT solutions within these business realities will be key to maintaining ... cyber-physical competitive advantage."

"A big risk to digital transformation exists within OT and the ability to exploit and protect these systems and sensors at a speed of relevance to modern mission needs," the paper continued. "To realise the benefits of digital transformation will require security transformation to protect against the evolving cyber threat landscape." Noting that the defence world can learn much about OT cyber security from IT cyber security – by following the same approach of identifying and managing vulnerabilities and risks in the context of business outcomes, but while tailoring the mix of people, process, and technology to manage the different attack possibilities and risks – the paper stated that defence departments and ministries must broaden cybersecurity postures to embrace the need to secure OT.

Reducing OT risk

The paper warned that time is tight in addressing the OT risk.

"To address today's security risks requires targeted and focused interventions, delivered at pace and scale, and informed and prioritised against critical mission outcomes," it stated. Such interventions should be underpinned by continuous development and improvement of OT security capabilities de-risked through experimentation.

In OT security terms, experimentation allows commercial-off-the-shelf (COTS) technology to be rapidly tested, inserted, and focused in the form of an intervention targeted at critical vulnerabilities, but also to provide objective evidence of the technology and organisational changes required to reduce the risk to OT.

The scale and scope of the OT risk is large, the paper argued. Reflecting the NCSC's position, the paper noted that part of the approach to take in reducing OT risk is to promote secure design principles and seamless integration of security products at the point of platform, system, and infrastructure design. "This is as much a cultural as it is a technical problem," the paper said.

Alongside promoting cultural change to feed into longer-term thinking about design priorities, the paper added that focused interventions are required too, to manage risks present today. The paper detailed the focus for interventions across both timeframes, as well as from the strategic-control to more tactical-control levels:

- Gaining understanding of the risks and attack surfaces based on asset criticality. This should include the holistic IT/OT convergence and interfaces. (Fortinet defines an attack surface as the number of possible points where an unauthorized user can access a system, adding that a smaller attack surface is easier to protect);
- Segmenting (where possible) and hardening networks to minimise attack surfaces and impact on system useability, and to manage the severity and duration of successful attacks;
- Building visibility and knowledge of the proprietary, OT-specific protocols allowing system control even down to an individual sensor;
- Reducing risk through access control, and adopting tailored OT signature monitoring and more advanced predictive, proactive, User and Entity Behavioural Analytics (UEBA) detection techniques.

In sum, the paper concluded, defence departments and ministries need to: understand the OT attack surfaces, by identifying and understanding what OT is deployed and applicable; analyse vulnerabilities and threats; and develop mitigation approaches. This can be achieved by following two paths, it said. First, COTS products should be exploited through experimentation to enable rapid test and deployment of OT interventions, in order to provide evidence to underpin the technological and cultural changes required. Second, integrating secure design principles into everyday business processes will assist in reducing risk at source, while also accelerating the benefits of digital transformation in a converging OT/IT landscape.

While the OT cyber security risk is real today and into the future, there are ways to meet this challenge if the risk is recognised, the paper said.

Maritime impact

The cyber risks in the maritime domain are already evident, in both theory and reality.

In March 2021, the container ship MV Ever Given ran aground in the Suez Canal, blocking the canal for six days and impacting the flow of – and costs associated with – mari-

The RN Type 45 destroyer HMS Defender is pictured alongside in Glasgow, Scotland during sea trials in 2013. Ship systems and shore facilities alike are underpinned by OT.

time trade for some while longer. The causes of the incident have not been revealed. However, the example demonstrated the risk to and impact on maritime trade and global economies if a key maritime choke point like Suez was closed off for a while should a ship's propulsion, navigation, or steering systems be subject to an OT-related cyber-attack.

In June 2021, the RN Type 45 Daring class destroyer HMS Defender and the Royal Netherlands Navy De Zeven Provincien class frigate HNLMS Evertsen – both deployed with the RN's HMS Queen Elizabeth CSG on its CSG21 deployment – were operating in the Black Sea when a cyber-attack saw the electronic 'locations' of the two ships 'spoofed' and re-positioned to be just off the Russian naval base at Sevastopol, Crimea. The two ships were in fact moored at Odesa, Ukraine at the time. According to US Naval Institute News, the automatic identification system (AIS) tracking data of the two ships was subject to a cyber-attack. Of course, two NATO warships being positioned just outside Sevastopol could be viewed as provocative – hence the strategic benefit to a NATO adversary of adjusting such AIS tracks.

In a written interview with *Maritime Defence Monitor*, BMT and Fortinet discussed the potential impact of this type of risk for naval and wider maritime operations.

Looking at the RN's situation in particular, Fortinet said "At a navy level, the risk is that already-stretched resources will not be able to protect the UK's interest and commitments around the globe."

BMT underlined the wider naval implications, noting that while the 'fight' systems in the 'float, move, fight' concept of operations for a warship are probably the least vulnerable as the attack surface is more difficult to exploit, the OT-related failure of a small component onboard could lead to an engine or steering problem that would impact the safe operation of the ship. "This is something affecting all maritime domains [commercial and military] as they all share the need to be able to 'float' and 'move' and will often use very similar systems," BMT added.

Regarding particular points of naval operational vulnerability to OT attack, BMT said "The highest vulnerabilities are normally when the platform is most connected (physically and electronically), which normally occurs when the ship is in port." Here, BMT highlighted two areas of focus: first, poorly segmented/partitioned networks, which would increase the number of vulnerabilities an attacker could exploit and would mean the impact of a successful attack could be greater; and second, the need to control access to systems, reducing the risk of attack from inside the system itself.

Credit: US Navy

The US Navy Wasp-class amphibious assault ship USS Bataan transits the Suez Canal in August 2023, astern of several commercial ships. Naval and commercial vessels often use similar OT systems, as they share the 'float' and 'move' requirements.

Fortinet noted that the highest vulnerability can occur when a legacy system is incorporated into a wider network. Legacy systems are a particular challenge in the OT space. "OT systems can be 25 years old and therefore harder to manager," said Fortinet. "This means you lose the layers of security you would have with newer IT and OT systems."

Next steps

Incidents like the Black Sea cyber-attack on the UK Carrier Strike Group ships demonstrate that the risk is real, and that attacks are underway. Navies are thus having to determine how to counter the risk both today and tomorrow.

To BMT, the ways will be different even if the end is the same, managing today's risks by prioritizing critical system vulnerabilities that impact critical business and operational outcomes, while embedding security through design approaches (encompassing people, process, and culture) to manage tomorrow's.

"Once you move from 'if it happens' to 'it is already happening', you can build your cyber security posture to address this," Fortinet added. In practical terms, Fortinet underlined the need for navies to secure cyber security tools in every OT network, starting from the centre and moving outwards. "It is not viable to safeguard all the OT systems in a navy, but you can mitigate the risk they pose," Fortinet said.

BMT painted a picture of the nearer- and longer-term vision for how an OT security environment should look as navies get to grips with the problem. The overall picture, it explained, is one where "security is embedded in the culture to help manage risks associated with the legacy technology."

The culture point is critical, BMT stated. "In the immediate future, the ideal OT security environment within navies would be deeply rooted in a culture of security, where every individual understands and contributes to the safeguarding of OT." "This cultural shift is critical to managing risks associated with legacy systems that are often vulnerable yet integral to naval operations," it said.

While the near-term focus is on critical vulnerabilities in critical systems, the longer-term goal of integrating a security approach into every facet of naval operations will help develop an holistic approach that ensures security considerations are not afterthoughts, but are fundamental components of every operational decision and technological advancement, BMT explained. "In essence, a future-proof OT security environment in navies will be characterised by a pervasive security-conscious culture, continuous prioritisation of critical system vulnerabilities, and a foundational commitment to secure-by-design principles, creating a resilient and adaptive defence against evolving cybersecurity threats," it added.

Tailored Transparency and Security Roadmaps

Mario Eisenhut

Are you prepared for NIS 2?

In December 2022, the EU released the second EU directive on network and information security (NIS 2 directive). Published in the Official Journal L333, Member States must convert the directive into national law by October 2024. As the current NIS Directive had implications to maritime security, this article looks to identify the consequences of the amendment.

Directive (EU) 2022/2555

NIS2 or Directive (EU) 2022/2555 is the second Directive of the European Parliament and of the Council of 14 December 2022 on measures to achieve a high common level of cybersecurity across the Union. It aims to establish measures which ensure a high level of network and information security (NIS) in the EU. The overall objective is to strengthen resilience to cyber threats in critical sectors. NIS2 emphasises the need to implement cross-sectoral security measures.

The EU's NIS 2 Directive on cybersecurity is scheduled to become enforceable across all 27 member states on 18 October 2024. It will bring in stricter requirements for risk management and incident reporting across a wider array of industries. NIS 2 seeks to inaugurate a uniformly high standard of cybersecurity and resilience across the European Union.

In a standard approach, roadmaps will be established encompassing a collection of guidelines, procedures, measures, and strategies aimed at ensuring the security and resilience of a system or organisation. Typical components include risk analysis, security policies, access control, incident response plans, training and awareness, emergency recovery and business continuity planning, as well as compliance and regulation.

Credit: M. Eisenhut

Controlcenter monitoring harbor infrastructure.

The complexity and diversity of maritime operations necessitate a customised approach to developing policies and procedures that effectively address the unique challenges faced in this industry. Tailored transparency and security plans adapted to the specific needs of the particular environment seem to be appropriate to improve network and information security and to enhance resilience to cyber threats, thus ultimately contributing to the safety and efficiency of maritime traffic.

Concrete guidelines and procedures for maritime operations could include clear instructions for ships' cybersecurity, such as securing navigation systems, communication devices, and access controls. Customised clarity and protection strategies are critical for safeguarding maritime facilities and port infrastructure. Implementing these measures is crucial to ensuring the security and reliability of maritime operations and minimising the impact of cyber threats.

Transparency and security roadmaps: Building upon existing instruments …

There are already examples of cybersecurity policies for maritime operations and a close examination of these is appropriate given the comprehensive approach taken in developing them. They include the US National Institute of Standards and Technology (NIST) Cybersecurity Framework Version 1.1, as well as the relevant IMO resolution. The NIST Framework helps companies assess and manage cyber risks, ultimately leading to the creation of a customised 'profile' that identifies and prioritises risk mitigation measures. Specimen framework profiles are publicly available, such as those for maritime bulk liquid transfer, offshore, and passenger ship operations. They provide practical guidelines developed in collaboration with industry representatives. Additionally, guidelines from associations like the Digital Container Shipping Association (DCSA) and recommendations from organisations such

Author

Mario Eisenhut, served in the Navy on destroyers and fast patrol boats before he switched to commercial shipping and became captain. As a security consultant in the realm of maritime security and the protection of critical maritime infrastructure, he contributes to the protection of the seas and safety at sea.

as the International Association of Classification Societies (IACS) offer additional resources for addressing cybersecurity challenges specific to maritime operations. These examples can serve as valuable references for companies looking to enhance their cybersecurity posture and minimise cyber risks in the maritime sector.

Maritime operations involve a wide range of activities, including vessel navigation, cargo handling, port management, and passenger services, each presenting its own security concerns. From protecting sensitive data onboard ships to safeguarding port facilities against physical and cyber threats, policies and procedures must be meticulously crafted to address these diverse challenges.

For instance, ship systems require robust cybersecurity measures to prevent unauthorised access and potential cyber-attacks. Cargo and passenger data must be handled with care to ensure privacy and prevent breaches. Port operation systems, including communication networks and surveillance technologies, must be fortified to defend against external threats and maintain operational continuity.

Clear guidelines for monitoring and enhancing security measures are crucial components of tailored transparency and security roadmaps. Regular assessments and audits help identify vulnerabilities and areas for improvement, enabling proactive risk management and mitigation efforts. Collaboration with industry stakeholders, regulatory authorities, and cybersecurity experts facilitates the development of comprehensive security strategies aligned with best practices and regulatory requirements.

By adopting a tailored approach to transparency and security roadmaps, maritime organisations can effectively safeguard critical infrastructure, protect sensitive data, and ensure the uninterrupted flow of maritime commerce. This proactive stance towards security not only enhances operational resilience but also strengthens the industry's reputation for safety and reliability in an increasingly interconnected world.

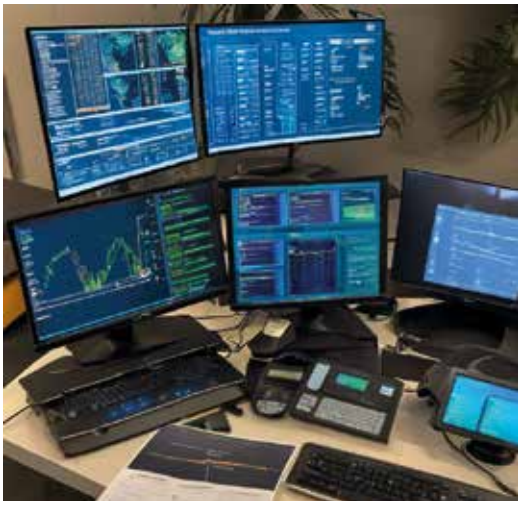
… and extending their scope

Comprehensive **asset management** is vital for securing maritime environments. It involves identifying, classifying, and protecting critical assets such as ship systems, port infrastructure, and IT systems. Access control policies, continuous monitoring, and auditing help identify and mitigate security risks across operational technology (OT) and industrial control systems (ICS), ensuring security and continuity.

Rapid **incident response** is crucial in maritime cybersecurity to address cyber-attacks or system failures swiftly. Skilled incident response teams, clear protocols, and collaboration with regulatory bodies and industry partners ensure timely and coordinated responses, preserving operations' integrity and availability.

Ensuring business continuity in maritime environments is essential amidst unforeseen events like system failures, natural disasters, or cyber-attacks. Robust backup management and secure remote access are key components of this effort. Backup solutions ensure regular backups of critical data and configurations, stored securely on-site and off-site for swift restoration. Secure remote access enables workforce flexibility, ensuring access to critical systems remotely. Technologies like multi-factor authentication (MFA), virtual private networks (VPNs), and SSL encryption ensure data security. Solutions should be scalable to adapt to dynamic operations, enhancing resilience, minimising downtime, and maintaining uninterrupted operations, even in challenging circumstances.

Credit: M. Eisenhut



Multi PC-workspace showing the symphony of data and live feeds.

Vigilant **vulnerability management** is critical for maritime security. Regular scans and tests identify weaknesses in ship systems and port infrastructure. Manual testing supplements automated scans for complex vulnerabilities. Prioritising vulnerabilities based on severity focuses resources effectively. Timely patching of software vulnerabilities mitigates risks. However, patch management remains a challenge due to the distributed nature of maritime operations. Alternative strategies like offline patching may be necessary. Robust updating procedures with smoot patch deployment will enhance resilience against cyber threats.

Multi-factor authentication (MFA) adds layers of protection against unauthorised access in maritime settings, addressing compatibility, resilience, and user awareness challenges. Implementing MFA requires compatibility with existing systems and resilience to harsh conditions. User education is vital for effective MFA usage. By addressing these challenges, MFA enhances maritime cybersecurity, safeguarding sensitive systems and data.

Cybersecurity **training** for maritime personnel is essential to protect against cyber threats. As digitisation increases, personnel

Credit: M. Eisenhut

Real-Time Training showing vigilance in protecting against cyber threats.

Credit: M. Eisenhut

Port Infrastructure showing the role of ports in safeguarding the security of global supply chains.

must recognise and respond to risks effectively. Training should raise awareness of threats like phishing and malware, emphasising potential consequences on operations and data security. It should also focus on detection and response skills, including recognising indicators of attacks and appropriate incident response procedures. Practical scenarios and drills enhance readiness. Training must stay updated with evolving threats. Ultimately, tailored programmes empower personnel to mitigate risks and safeguard maritime infrastructure.

Secure **supply chain management** is essential for reliability and integrity in maritime operations. It involves certifying suppliers through audits and due diligence checks to ensure compliance with security standards. Implementing clear policies and procedures across the supply chain ensures consistency and covers aspects like physical security, cybersecurity, and risk management. Collaboration with partners fosters alignment and accountability. Ensuring traceability and integrity through robust tracking systems is crucial. Vigilance against emerging threats through regular risk assessments and scenario planning is necessary. In summary, secure supply chain management enhances resilience and security, safeguarding against potential risks and disruptions.

Tailored **security policies** for risk analysis in maritime operations are vital for resilience. Understanding unique risk factors, including piracy and cyber threats, is crucial. Policies should cover diverse stakeholders and assets, outlining measures for risk mitigation such as physical security and cybersecurity protocols. Dynamic policies must adapt to evolving threats, requiring regular assessments and updates. Collaboration among stakeholders fosters effective risk management. Ultimately, tailored security policies enhance maritime security and resilience against emerging threats.

Cryptography and encryption technologies are crucial in the maritime industry to safeguard operational technologies (OT) and data integrity. They secure communication channels, preventing unauthorised interception. Encryption scrambles data into unreadable ciphertext, ensuring confidentiality even if intercepted. It is vital for securing data stored on devices and systems, preventing unauthorised access. Additionally, encryption technologies secure access controls and authentication mechanisms, ensuring that only authorised users can access sensitive data. Implementation requires consideration of performance, compatibility, and regulatory compliance. Compliance with standards like IMO guidelines on cybersecurity ensures effective protection against threats. Overall, cryptography and encryption enhance maritime security, mitigating unauthorised access and data breaches.

A wide portfolio of security solutions is vital in the maritime industry to combat cyber threats and address security risks effectively. Adherence to established standards like IMO guidelines and ISPS Code ensures regulatory compliance. Specialised security technologies, such as maritime-focused intrusion detection and prevention systems (IDS/IPS) and vessel tracking systems, address unique challenges. Collaboration with cybersecurity experts and technology vendors ensures tailored solutions. Continuous monitoring, assessment, and improvement are essential for maintaining a strong security posture. Overall, a diverse range of security measures tailored to maritime needs enhances operational resilience and safeguards against evolving threats.

The integration of proven solutions and expertise into maritime security is vital for robust defence against cyber threats. Leveraging technologies like firewalls, intrusion detection and prevention systems (IDS/IPS), and encryption establishes strong defences. Incorporating cybersecurity expertise ensures effective strategy development and compliance. Collaboration with stakeholders fosters knowledge-sharing and collective efforts. Continuous monitoring and improvement through audits enhance security resilience. Overall, this integrated approach strengthens maritime cybersecurity, safeguarding critical systems and data.

Roadmaps offer flexibility

After completing the described roadmap, it is important to emphasise that each individual measure, even if not considered a top priority, still makes a valuable contribution to improving maritime security. Roadmaps have a flexible format for presenting strategic information, so there is no industry standard we should follow. Each of these measures aims to address specific risks and vulnerabilities, thereby increasing resilience to cyber threats. In particular, training and awareness of cybersecurity play a central role. Employees with a solid understanding of risks and security protocols are better equipped to recognise and respond to potential threats. Although training is often neglected, it is important to recognise its significance and ensure it is integrated into the overall strategy for strengthening maritime security. A holistic approach that considers all relevant measures is key to ensuring security in the maritime industry and minimising the impact of cyber threats. By proactively engaging with cybersecurity experts, maritime organisations can enhance their cyber resilience, mitigate risks, and safeguard critical assets against evolving threats in the digital landscape. Collaboration with security experts and governmental institutions is key for the industry's overall cybersecurity posture, ensuring continued operational reliability and safety at sea.

In conclusion, the deliberate implementation of measures, triggered by a robust change management process, will enhance maritime resilience against cyber threats and safeguard the integrity of critical infrastructure. ■

German Armed Forces in the Indo-Pacific

Hans-Uwe Mergener

This year's Indo-Pacific Deployment (IDP) of the Luftwaffe (German Air Force) and Deutsche Marine (German Navy) renews the German intention of wanting to contribute more to the security of the democratic community of values in the region. Both branches of the German Armed Forces will be deployed together for several months in the region between the west coast of America and the east coast of Africa.

The Bundeswehr (German Armed Forces) has been flying the flag in this region for four years. The frigate FGS Bayern took the first step towards a greater German presence with its formal 'foreign training cruise' from August 2021 to February 2022, followed by the Air Force in summer 2022, which practised interoperability with its partners in, or rather over, Australia, Japan, Singapore and South Korea as part of 'Rapid Pacific 2022' with six Eurofighters, four A400Ms and three A330 MRTTs (Multi Role Tanker Transports).

In 2023, the Heer (German Army) continued its cooperation by participating in the exercise 'Talisman Sabre' in Australia - a first for the Bundeswehr. The more than 200-strong unit, mainly drawn from the 31st Parachute Regiment, also included servicemen and women from the Sea Battalion, the German Navy's naval infantry.

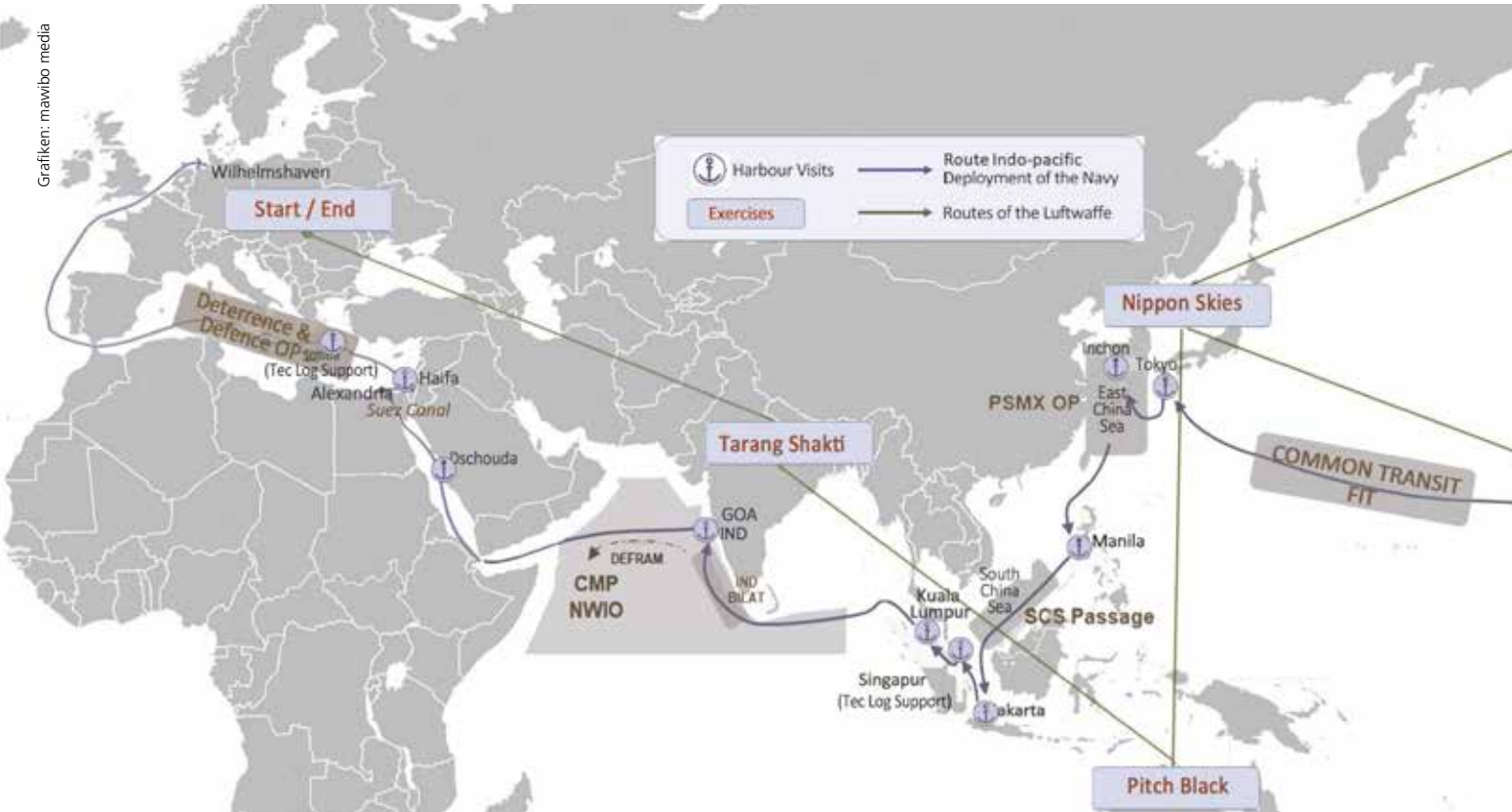
Credit: Bundeswehr/Cora Mohrdieck

Despite the Bundeswehr's stretched resources, the contingent is even larger this year. The focus is on participation in the RIMPAC 2024 manoeuvre, the 29th exercise in the "Rim of the Pacific" exercise series, or RimPac for short. This began in 1971 and has been held every two years since 1974. With around 25,000 participants, 49 ships, six submarines, 200 aircraft, including 40 fighter jets, it is considered the world's largest international naval exercise and takes place in the waters around Hawaii.

The 'strategic' objectives of the exercise are to promote cooperation and trust between the participating nations and to strengthen maritime security in the region. It is organised by the US Navy and brings together up to 750 experts in the exercise planning phase. Participating nations in RIMPAC 2024 are Australia, Belgium, Brunei, Canada, Chile, Colombia, Denmark, Ecuador, France, Germany, India, Indonesia, Israel, Italy, Japan, Malaysia, Mexico, The Netherlands, New Zealand, Peru, Philippines, Singapore, Sri Lanka, South Korea, Thailand, Tonga, the United Kingdom, and the United States of America.

Among the European participants, the presence of Belgium, Italy, the Netherlands and Germany should be emphasised as their par-

Grafiken: mawibo media



ticipation is out of the ordinary. For France, as a Pacific Rim country, participation is virtually a matter of course. The same goes for the globally active United Kingdom, which wants to be a part of it. AUKUS is one of the reasons. As is the case for the Netherlands, which is deploying the frigate HNLMS Tromp, it will be the first participation with a seagoing unit for both Italy and Germany. The Marina Militare is sending the aircraft carrier ITS Cavour, along with an escort ship yet to be determined. The Luftwaffe is also participating in RIMPAC for the first time, with France and Spain also sending their air forces.

Credit: Bundeswehr/Christian Timmig

German frigate Bayern and the destroyer Samidare of the Japan Maritime Self-Defense Force pictured at the Indo-Pacific Deployment 2021 of the German Navy.

Luftwaffe: Pacific Skies 24

Between 14 June and 16 August, the Luftwaffe will also be involved in the Indo-Pacific together with French and Spanish partners. 'Pacific Skies 24' is an air force exercise in which seven partner nations are participating alongside the Luftwaffe: France, Spain and the United Kingdom are European partners; the global partners are Australia, India, Japan and the USA.

As Future Combat Air System (FCAS) nations, Germany, France and Spain expressly want to participate together. The Luftwaffe will deploy 32 aircraft: 12 Tornados, eight Eurofighters, four A400Ms, four A330 MRTTs and four H145M support helicopters. Spain is providing four Eurofighters and two A400Ms; France four Rafales, three A400Ms and three A330 MRTTs.

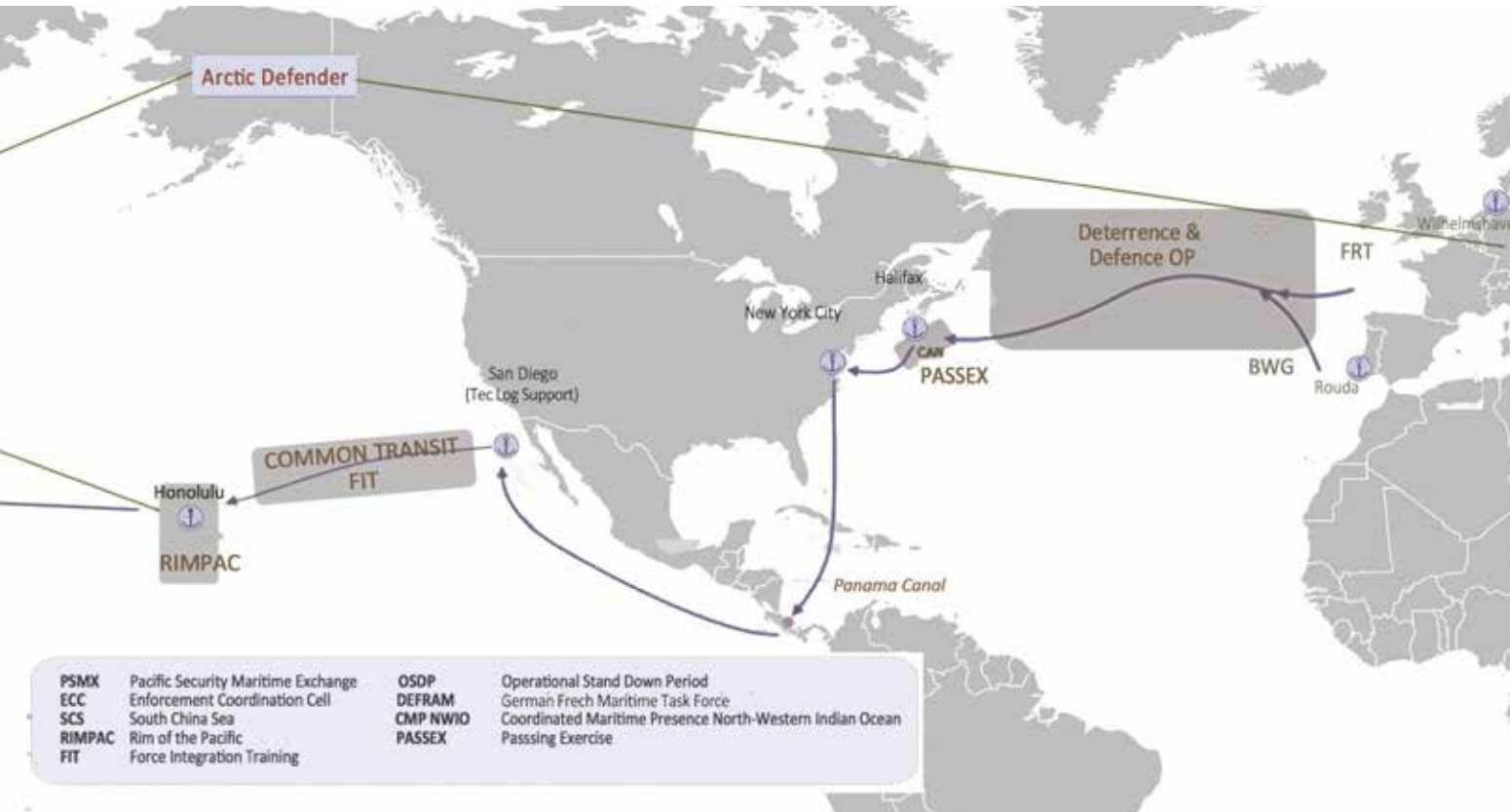
Cooperation between air forces will be practised in five exercises, including 'Arctic Defender' in Alaska, 'Pitch Black' in Australia and RIMPAC. Joint training flights with the Indian Air Force are on the programme as part of 'Tarang Shakti 1'. The Luftwaffe has assumed the lead role in 'Arctic Defender', and is providing three Eurofighters and an A400M for RIMPAC. In addition to the training countries, the programme also includes stop-overs and visits in Canada, Malaysia and New Zealand.

The German Navy

In the eyes of the Chief of German Navy, the Indo-Pacific Deployment is a good example of the Navy's motto "Regionally rooted and globally committed", which he has promoted.

From different locations, namely Rota for the frigate FGS Baden-Württemberg and Wilhelmshaven for the logistics and support vessel FGS Frankfurt am Main, the Navy will start its Indo-Pacific Deployment 2024, or IPD 24 for short, on 7 May. The first stop on the Canadian West Coast will be one of a total of 13 port visits.

The Navy is focusing on five areas for its Indo-Pacific Deployment this year, which it illustrates with the slogan 'Pacific Waves'. Firstly, navigating international shipping routes to maintain freedom of navigation in accordance with the United Nations Convention on the Law of the Sea. Secondly, to contribute to the monitoring of the UN embargo operation against North Korea. Thirdly, the joint participation of the Franco-German Naval Association (DEFRAM) in the European Union's maritime presence in the western Indian Ocean. Fourthly, various naval manoeuvres with partners in the region - including the highlight RIMPAC. And fifthly, the conduct of military-diplomatic port visits along the route to deepen international relations.



Credit: Bundeswehr

During the Indo-Pacific Deployment 2022 Eurofighter of the Luftwaffe participated in the Exercise Pitch Black.

"And I also hope that the Indo-Pacific Deployment will have certain promotional effects," added Admiral Jan C. Kaack at the presentation of this year's Indo-Pacific Deployment on 20 March in Berlin. "Because we can't do all this without people who are passionate about going to sea." Around 200 officer candidates will be embarked.

A showcase for German naval shipbuilding and its suppliers

Due to the geopolitical situation, many Indo-Pacific countries are pursuing more or less ambitious military procurement programmes. German defence companies are also courting customers there. This is not just about ships and boats, but also about components and subsystems, for whose manufacturers opportunities may arise. One of the best advertisements for the efficiency of a defence industry is its use by the 'parent navy'. A live demonstration aboard an actual ship reinforces this advertisement, which is all the more reason to make full use of the opportunities provided by the deployment. During this year's Indo-Pacific Deployment, there will be industrial exhibitions in eight ports where German industrial companies will take the opportunity to provide insights into their products. Around 25 companies will be involved in different groupings depending on marketing expectations.

Harbour Visits of the German Navy	
Halifax, Canada	17.05. – 20.05.
New York, USA	23.05. – 26.05.
San Diego, USA	11.06. – 17.06.
Honolulu, USA	27.06. – 30.06.
Honolulu, USA	30.07. – 03.08.
Tokyo, Japan	20.08. – 26.08.
Inchon, South Korea	06.09. – 09.09.
Manila, Philippines	16.09. – 19.09.
Jakarta, Indonesia	27.09. – 30.09.
Singapur	02.10. – 14.10.
Port Klang, Malaysia	15.10. – 18.10.
Goa, India	26.10. – 29.10.
Dschidda, S.-Arabia	09.11. – 12.11.
Haifa, Israel	17.11. – 20.11.
Alexandria, Egypt	17.11. – 20.11.
Souda, Greece	22.11. – 25.11.
„Frankfurt a. Main" Arrival W'haven	05.12.2024
„Baden-Württemberg" remains in the Mediterranean Sea	

Security policy categorisation

With its Indo-Pacific Guidelines, Germany has formulated its interests in this geopolitically significant region. According to Petra Sigmund, Head of the Department for Asia and the Pacific at the Federal Foreign Office, the voyage of the F 123 class frigate FGS Bayern in 2021/22 has already taken Germany's relations in the region to an entirely new level. At the presentation of this year's trip in Berlin on 20 March, she said: "Our partners were able to see that there is a German understanding and willingness to deal with their challenges." These relationships have become even more important now, in the time of the Russian war of aggression against Ukraine. "For example, Japan, South Korea, Singapore and Australia are actively helping us in this difficult situation in Europe," she said, concluding: "If we want to count on our partners worldwide, especially those from the Indo-Pacific, we must also be able to signal that they can count on us."
In addition to its temporary presences, Germany has also taken further measures to demonstrate its cooperation with its partners in the region in the area of defence policy. In August 2021, Germany joined the Regional Cooperation Agreement on Combating Piracy and Armed Robbery against Ships in Asia (ReCaap). In the context of the Indo-Pacific Deployment of 2021, a liaison officer was established at the Information Fusion Centre in Singapore. At the same time, he is co-accredited to the ASEAN Coordination Centre for Humanitarian Assistance & Disaster Relief (HADR) in ASEAN. A liaison with the US Armed Forces is to be established (envisaged: COMLOGWESTPAC, the Commanding General over the Western Pacific Logistic Group, simultaneously Commander Task Force 73). In addition, liaison officers are to be posted to the Enforcement Coordination Cell in Japan, which monitors compliance with UN sanctions in relation to North Korea, and to US INDOPACOM, the US Indo-Pacific Command. Sending personnel to the headquarters of the US Navy and US Air Force in the Pacific is also being considered.

Goodbye

This year's Indo-Pacific Deployment is more than the name suggests - the Bundeswehr is 'going global'. The motto "regionally rooted - globally committed" – as issued by the Chief German Navy – is even being brought to life across all branches of the armed forces in this case. The German Indo-Pacific Deployment 2024 will be given a European flavour with the participation of the FCAS nations in Pacific Waves on the one hand and the European naval contingents in RIMPAC 2024 on the other.
For the Luftwaffe and Germany's naval forces, however, the global commitment is a major endeavour. Here the IPD2024, there the EU Operation 'Aspides' in the Red Sea or the air policing of the Luftwaffe in the Baltic States, to pick out just two examples of the participation of German Armed Forces in NATO or EU missions.
In the end, the conclusion must be that the planned 212 days of absence for Frankfurt am Main or the record-breaking 10.5 flying hours by Eurofighters from Japan to Pearl Harbor will be time well spent. Not only because of the operational 'lessons learned' but also because of the added value generated. The aim is to open doors for Germany and for Europe across the region and to gain intelligence 'on the ground' in order to obtain an independent picture of the situation. After all, in order to understand other theatres of the world, one has to set feet on the ground. This not only makes it easier to assess the situation yourself. It also minimises the risk of becoming too dependent on the assessments of others. In addition, the experience you have gained helps you to align your own compass.
Last but not least, we had promised to come back on recent occasions. General Ingo Gerhartz, Chief of Luftwaffe, expressed this to the 200 guests on 20 March: "When the German Air Force first visited the region two years ago, I personally often encountered the question: 'Are you coming back?" According to Gerhartz, his answer was: "Yes, we will make it permanent, we will be back".
With this in mind, MDM wishes Loa'a i kahi huaka'i palekana! – in Hawaiian, 'Come home safely'. ■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Enhanced resolve: how the Putin factor has rejuvenated NATO

Peter Felstead

Donald Trump was far from the only US president to admonish NATO for low defence spending to little avail, but the belligerent actions of Russian President Putin have galvanised NATO in a way the Russian leader did not foresee.

On 25 May 2017 Donald Trump attended his first NATO summit in Brussels as US president, with the occasion originally expected to be a celebratory one as the alliance officially opened its new headquarters building.

However, with Trump having previously labelled NATO 'obsolete' during his presidential campaign trail, there was apprehension among the alliance's European leaders over what Trump would likely say in Brussels and, for those who feared a spoiling of the party, Trump did not disappoint. He both chided NATO members for not meeting their financial commitments, claiming that "23 of the 28 member nations are still not paying what they should be paying and what they are supposed to be paying for their defence", and declined to reiterate a US commitment to the alliance's mutual defence pledge under Article 5 of the North Atlantic Treaty.

However, notwithstanding his geopolitical naivety and 'bull in a china shop' lack of diplomacy, Trump had a point. He was also far from being the only US president to express frustration at the low levels of defence spending among NATO's European allies.

The 2% pledge

Spurred by Russia's stealthily successful annexation of Crimea in March 2014, the NATO partners endorsed a Defence Investment Pledge in September of that year that held them to a guideline first agreed in 2006 under which each nation undertook to spend the equivalent of 2% of their respective GDP levels on defence.

The NATO allies also agreed further measures at their 2014 Wales Summit, including the spending of at least 20% of their defence budgets on new equipment; the approval of a Readiness Action Plan, providing a comprehensive package of necessary measures to respond to the changes in the security environment on NATO's borders and further afield; and the establishment of a Very High Readiness Joint Task Force (VJTF) – a new Allied joint force that would be able to deploy within a few days to respond to a crisis, particularly at the periphery of NATO's territory.

However, official NATO figures for 2015 show that, of the then 27 NATO allies, only five – Estonia, Greece, Poland, the United Kingdom and the United States – were meeting or exceeding the 2% guideline at that time. The United States, as usual, was at the top of the list, spending 3.58% of its GDP on defence in 2015.

In 2018, meanwhile, in the year following Trump's harsh words in Brussels – words which he continued to repeat – NATO spending levels were not much improved. Six of NATO's by-then 29 allies in 2018 – Estonia, Greece, Latvia, Poland, the United Kingdom and the United States – were meeting or exceeding the 2% guideline.

Credit: US ANG

Soldiers from the US 3rd Armored Brigade Combat Team, 1st Cavalry Division, and British Army's Royal Lancers during a training exercise in Bemowo Piskie, Poland, on 20 October 2022. Since Russia's full-scale invasion of Ukraine in February 2022 NATO has doubled its battlegroups in Europe from four to eight.

The ultimate spending spur

While NATO spending levels did incrementally improve over the following years, the ultimate catalyst for putting alliance defence spending where it needed to be was not Trump, but Russian President Vladimir Putin, whose wholesale invasion of Ukraine on 24 February 2022 changed everything.

When Putin annexed Crimea in 2014, NATO certainly took notice and had passed consequent resolutions in Wales, yet certain factors appeared to dullen a stronger reaction. For one thing, the annexation had been bloodless, while some argued also that Russia having to maintain its Black Sea Fleet in the Ukrainian port of Sevastopol, as a geopolitical anomaly caused by the break-up of the Soviet Union, presented a legitimate strategic issue for Moscow, notwithstanding the illegality of the annexation.

The Russian invasion of February 2022, however, which brought back the kind of high-intensity conflict that mainland Europe had not seen since 1945, revealed a brazen belligerence by Putin that imparted an unprecedented geopolitical jolt to the very core of the alliance.

Consequently, NATO spending now looks very different. On 14 February 2024, in advance of a meeting in Brussels of NATO defence ministers, NATO Secretary General Jens Stoltenberg welcomed an unprecedented rise in alliance defence spending. Stoltenberg announced that the European allies and Canada had added more than USD 600 billion (EUR 559 billion) in defence spending since the 2% NATO Defence Investment Pledge was made in 2014.

"Last year saw an unprecedented rise of 11% across European Allies and Canada," Stoltenberg said on 14 February. "This year I expect 18 allies to spend 2% of their GDP on defence. That is another record number, and a six-fold increase from 2014, when only three allies met the target.

"In 2024 NATO allies in Europe will invest a combined total of USD 380 billion in defence. For the first time, this amounts to 2% of their combined GDP," Stoltenberg added. "We are making real progress: European Allies are spending more. However, some Allies still have a ways to go because we agreed at the Vilnius Summit [in July 2023] that all allies should invest 2% – and that 2% is a minimum."

Moreover, allies other than the United States are now heading the list of NATO defence spending as a percentage of GDP. While Greece topped the list in 2021 and 2022 with defence spending of 3.7% and 3.86% of GDP respectively – the result of a EUR 2.5 billion deal in January 2021 to buy 18 Rafale fighter aircraft from France (to which six more Rafales were added in March 2022) – the NATO spending table in 2023 was topped by Poland, with estimated NATO figures putting the country's defence spending at 3.92% of GDP.

The uplift in defence spending among the NATO allies since the Ukraine War began has been driven my multiple factors beyond the need to bolster national defences to deter Russia. Most obviously, armoured vehicles and other weapon systems donated by the allies to Ukraine must be backfilled by newly purchased equipment, while the high-intensity warfare in Ukraine has also revealed that the levels of ammunition stocks held by the allies prior to 2022 were far from adequate.

The high level of Polish defence spending, meanwhile, reflects a significant recapitalisation of the Polish armed forces' equipment inventory, including the purchase of major platforms such as main battle tanks (MBTs), air defence systems, artillery systems and combat aircraft.

A rejuvenated alliance

Yet the considerable uplift in NATO defence spending lauded by Stoltenberg is just one of a number of ways that Putin's invasion of Ukraine, along with previous hostile actions against the country, has rejuvenated the alliance.

Ever since 2004, when the three Baltic states joined the alliance, NATO has conducted a rotational Baltic air policing operation to compensate for the fact that Estonia, Latvia and Lithuania do not operate their own fast jet fleets. This was initially conducted out of Šiauliai Air Base in

Credit: USAF/Tech Sgt Jacob Albers

A USAF F-15C Eagle assigned to the 493rd Fighter Squadron, Royal Air Force (RAF) Lakenheath takes off in support of NATO eAP missions with the Polish Air Force at Łask Air Base, Poland, on 15 February 2022.

Credit: NATO

NATO's 75th anniversary celebrations at its headquarters in Brussels on 4 April 2024. Putin's invasion of Ukraine in 2022 ensured that NATO marked its 75th anniversary as a 32-strong alliance.

Lithuania, but in 2014, following Russia's annexation of Crimea, a second air policing presence was established at Ämari Air Base in Estonia under NATO's Assurance Measures to its Eastern allies. NATO also extended these enhanced Air Policing (eAP) measures in 2014 to Romania and Bulgaria using rotational detachments from various allied air forces.

Likewise, when Albania and Croatia joined the alliance in 2009 an air policing mission was set up over the Western Balkans that now protects the airspace of NATO members Albania, Slovenia, North Macedonia and Montenegro – all nations that have no fast jets (Croatia bought 12 Rafales in 2021, which began arriving in February 2024). Slovenia's airspace is now permanently covered by the Hungary and Italian air forces, while the airspace of Albania, Montenegro and North Macedonia are covered jointly by Greece and Italy.

Since 2017, meanwhile, there has been a special air policing arrangement for the airspace of Belgium, the Netherlands and Luxembourg (Benelux) in which the Belgian Air Component and Royal Netherlands Air Force take turns providing fighters for quick-reaction alert duties.

In response to the Russian invasion of Ukraine, NATO has substantially reinforced its eAP operations across the eastern part of the alliance. This involved the deployment of more fighters, surveillance flights and ground-based air defence systems, and included additional alliance fighters sent to Poland just before the invasion occurred in a rotational deployment that remains ongoing.

Meanwhile, Russia's actions in Ukraine have seen a substantial increase in NATO ground forces across the eastern region of the alliance. This enhanced Forward Presence (eFP) was first deployed in 2017, in the wake of Crimea being annexed, 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. However, following Russia's full-scale invasion of Ukraine in 2022 the NATO allies have reinforced those existing battlegroups and established four more multinational battlegroups in Bulgaria, Hungary, Romania and Slovakia. This has brought the total number of multinational battlegroups to eight, effectively doubled the number of troops on the ground and extended NATO's forward presence from the Baltic Sea in the north to the Black Sea in the south. At the 2022 NATO Summit in Madrid the allies additionally agreed to scale up the multinational battlegroups from battalion to brigade size where and when required.

Beyond the already-established VJTF for potential reinforcement of their forward presence, the NATO allies in Madrid agreed a new NATO Force Model, facilitating a broader expansion of high-readiness forces, to number up to 300,000 troops, potentially available to the alliance where and when required.

At their 2023 Vilnius Summit the allies also approved a new generation of regional defence plans. These are designed to significantly improve the coherence of NATO's collective defence planning with allies' national planning of their forces, posture, capabilities, and command and control.

Meanwhile, with an increased focus on readiness, 24 January 2024 saw the initiation of Exercise 'Steadfast Defender': the largest NATO exercise since the last 'Reforger' exercise in 1988, near the end of the Cold War. Running until 31 May, 'Steadfast Defender 24' involves around 90,000 allied personnel and is taking place primarily in Finland, Estonia, Germany, Greece, Hungary, Latvia, Lithuania, Norway, Poland, Romania, Slovakia, Sweden and the United Kingdom. More than 1,100 combat vehicles are being deployed for the manoeuvres, including 166 tanks, 533 infantry fighting vehicles (IFVs) and 417 armoured personnel carriers (APCs), according to a NATO fact sheet. There are also more than 50 naval assets involved, including aircraft carriers, destroyers, frigates and corvettes, and more than 80 air assets, including F-35, F/A-18, Harrier and F-15 combat aircraft as well as helicopters and myriad unmanned aerial vehicles (UAVs).

The exercise is officially based on a fictitious Article 5 scenario "triggered by a fictitious attack against the alliance launched by a near-peer adversary", according to alliance officials.

Neutrality not an option

In long-term military-geopolitical terms, one of the most significant effects of Putin's invasion of Ukraine – and one the Russian leader would certainly have wanted to avoid – is the pushing of formerly neutral Finland and Sweden into the full embrace of the alliance. The two countries handed in official letters of application to join NATO in May 2022, less than three months after Russia invaded Ukraine.

Finland had been a neutral state since the end of the Second World War. Despite having fought the Soviet Union twice – firstly in the Winter War of 1939-1940 and then during the Continuation War of 1941-1944 – Finland had studiously maintained cordial relations with the Soviet Union during the Cold War and subsequently with Russia. In 1994, however, Finland joined NATO's Partnership for Peace programme, joined the EU in 1995 and provided troops for NATO missions in Kosovo and Afghanistan. The country's gradual move toward the NATO fold in subsequent years then became a moot point with Russia's invasion of Ukraine and Finland officially joined NATO on 4 April 2023.

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 far from what Putin was trying to achieve when he ordered the Russian invasion of Ukraine, presumably intending to create in a conquered Ukraine a pro-Moscow 'buffer state' between Russia and NATO.

Summarising the actual outcome of Russia's action when speaking on the eve of Finland's accession, Secretary General Stoltenberg stated, "President Putin went to war against Ukraine with a clear aim to get less NATO. He's getting the exact opposite."

Sweden, meanwhile, had a long history of neutrality dating back to 1812, but had joined NATO's Partnership for Peace construct on 9 May 1994, in the year before the country joined the EU, and had, like Finland, been an active participant in NATO-led missions. While the pros and cons of NATO membership were debated in Sweden for decades, a national opinion poll in October 2014, in the wake of Crimea's annexation, for the first time found more Swedes in favour of NATO membership than against it. However, Russia's 2022 invasion of Ukraine inevitably swung Swedish public and political opinion strongly in favour of NATO membership. Having applied to join the alliance alongside Finland in May 2022, and after ironing out outstanding political issues with NATO members Turkey and Hungary, Sweden officially became a NATO member on 7 March 2024. NATO thus marked its 75th anniversary on 4 April 2024 as a 32-strong alliance.

Meanwhile, even still-neutral Switzerland declared on 10 April 2024 that it has opted to join the European Sky Shield Initiative (ESSI): a German-led project intended to co-ordinate Europe's air and missile defence networks. The ESSI was set up in the wake of European nations witnessing Russian air and missile attacks on Ukraine. Switzerland's joining the ESSI implies that, while the country remains neutral, that would not necessarily remain the case in time of war.

Credit: Office of the President of Russia

Presidents Trump and Putin at the Russian-US Helsinki summit on 16 July 2018. While Putin's invasion of Ukraine in February 2022 has galvanised NATO like never before, Trump could yet undermine those gains.

A potential challenge ahead

It can thus be seen how Putin's belligerent actions in Ukraine have not only galvanised, but indeed expanded NATO in ways that the Russian leader must never have foreseen, given the swift victory he originally expected in 2022. However, a potential threat to the alliance's new-found purpose and cohesion comes not from Putin but from the potential prospect of a second Trump presidential term from 2025.

On 22 April 2024, after a week-long jury selection process, opening statements began in the New York 'hush money' trial, in which Trump has become the first ever former or current US president to be criminally indicted. This is the first of four criminal cases in which Trump faces dozens of charges, yet US opinion polls still have Trump and current US President Joe Biden neck and neck in contending for the next US presidential term.

At NATO headquarters the alliance's European leaders are already scrabbling to come up with a contingency plan for what to do if Trump is re-elected. While Trump has rowed back on his pervious assertions that NATO is obsolete, his apparent fondness for autocratic leaders – in July 2018 he famously sided with Putin over the US intelligence services over questions of Russian interference in the US elections – and his opposition to militarily supporting Ukraine have NATO leaders on tenterhooks as well as Ukrainian President Volodymyr Zelenskyy. Trump has claimed without detail or merit that he could end the Ukraine war "in one day": a plan assumed to involve the ceding of Ukrainian territory that would be anathema to Kiev.

The prevailing irony, therefore, is that, while a Russian leader has galvanised NATO in ways that could never have been foreseen in previous decades, an American one could be the cause of that new-found cohesion ultimately being unravelled. ■

Protecting NATO's East European flank

Robert Czulda

Despite decisions made during the 2023 NATO Summit in Vilnius, Europe's eastern flank remains threatened, and the Russians continue their hostile actions. If the Kremlin achieves its military plans, the situation will become even more challenging.

There is noticeable unease and uncertainty on NATO's East European flank. This arises from several fundamental reasons. Firstly, despite significant losses and minimal strategic accomplishments, the Russians do not intend to end the war in Ukraine and are prepared to continue fighting. The Ukrainians are running out of ammunition, while the Russians have a decisive advantage in the air and in electronic warfare. This is in addition to their superiority in artillery, which is greatly helped by their ammunition availability. According to CNN, Russia produces approximately 250,000 artillery shells per month, almost three times more than the United States and Europe yield for Ukraine. "The Ukrainians are not running out of courage and tenacity. They're running out of ammunition, and we're running out of time to help them," warned CIA director William Burns during a hearing in Congress.

Secondly, Central and Eastern Europe perceives the lack of decisive rearmament among Western allies as alarming. A concern is – should Donald Trump be re-elected as the next US President in November 2024 – that Europe might lose at least part of the US security umbrella. This concern is bolstered by his announced willingness to make concessions to Russia. Thirdly, Central and Eastern Europe is observing with concern the waning interest of Western Europe and raising challenges in the United States with regard to the military support for Ukraine. There are already voices asking whether, in a crisis situation, American politicians will vote to support Eastern Europe? Or, will Germany change its cautious policy and actively support its allies?

Credit: USEUCOM/Jackie Faye Burton

Polish Army Leopard 2PL during Exercise 'Dragon 24' in Poland, part of 'Steadfast Defender 24'.

The region is trying to mobilise the West once again, as Russia will not give up its aggressive ambitions. The lack of Western action is perceived by the Kremlin as weakness, and as an opportunity. "The Kremlin is playing with open cards when it comes to its own goals, both towards Kyiv and – more broadly – the international order in this part of the world," warned Wojciech Konończuk, a political scientist at the Warsaw-based Centre for Eastern Studies (OSW). "Official statements confirming this fact could be quoted at length, but the most striking example may be the words of Dmitry Medvedev – once the personification of Western hope for the liberalisation of Russia – stating that there was and will be no Ukraine.

An good example of current moods in the region can be seen with recent events around Lithuania. In March 2024, Vilnius questioned whether, in the event of a conflict, Poland – its closest ally with significant military potential – would be able to send rapid military assistance due to legal constraints. Polish Prime Minister Donald Tusk avoided giving a clear answer, which is significant in itself. During his visit to Vilnius, he only assured Lithuanians of Polish solidarity. The Polish Ministry of National Defence stated that "There are no regulations prohibiting support for any NATO ally." The uncertainty on the Lithuanian side remains unresolved.

An important topic in the region is the selection of a new NATO Secretary General, who will replace Jens Stoltenberg this year. This is a significant disappointment for Eastern Europe: the region had hoped for a candidate from outside Western Europe, but this seems unlikely to happen. "NATO was supposed to mature to the point where someone from our Eastern Flank would finally lead it," said Polish journalist Jerzy Haszczyński from the Rzeczpospolita daily. "First, we were second-class when it came to sending Western soldiers and equipment to the Eastern Flank. The big war changed that. However, we remained second-class when it comes to leading the Alliance."

Former Dutch Prime Minister Mark Rutte, who did not even seek any support from Central and Eastern Europe states (CEE), is seen as a candidate chosen only because he will not be controversial for Russia.

Author

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

Credit: Polish MoD

Multinational troops during 'Steadfast Defender 24' - NATO's largest military exercise since the Cold War (over 90,000 troops from all 32 NATO Allies participated)

Candidates from the region were Estonian Prime Minister Kaja Kallas and Latvian Foreign Minister Krisjanis Karins. They are decidedly more resolute towards Russia than Rutte, who has support from the United States, United Kingdom, France, and Germany. Presumably, this is why they were not even considered at all by NATO ambassadors in the informal process parallel to consultations with leaders.

However, this choice may be blocked by Hungary. Foreign Minister Péter Szijjártó openly admitted that Budapest would not support Rutte, who has long been a critic of Viktor Orban's government. More opposition from CEE countries to Rutte's candidacy is anticipated. According to Stuart Lau, Correspondent for POLITICO Europe, *"the Baltic countries are unhappy about Rutte's lack of commitment on Dutch defence spending, while Romanian President Klaus Iohannis is displeased with the Netherlands' long-standing resistance to his country's joining the Schengen zone. Last month [February 2024], Iohannis told allies he had decided to challenge Rutte"*.

The Russian threat

Russia is consistently perceived as an existential threat by majority of states located on NATO's Eastern flank (the exceptions are Hungary and, since the end of 2023 Slovakia, while Bulgaria's approach remains mixed). For example, in February 2024, Lithuania – which shares a direct border with Belarus – warned that "Russia is preparing for a long-term confrontation with NATO and has embarked on a major reform of its Armed Forces. Its full implementation will take from at least several years to a decade." The same perception is shared by Romania, which considers Russia a threat to the entire Black Sea region, including Moldova. Bucharest has been concerned

with a scenario in which Russia occupies Ukraine and then moves into Moldova; for context, in 2022, when the Russian offensive against Ukraine collapsed, there was an idea to send American, Polish, and British troops to Moldova – with the consent of the local government. Romania is expected to spend EUR 8 billion on defence in 2024, which is 25% higher than in 2023. Since Russia's military attack on Ukraine, Bucharest has committed to allocate 2.5% of its GDP to defence.

NATO's Eastern flank remains threatened, and the Russians continue their hostile actions. For instance, in February 2024, Poland again experienced significant disruption to GPS. A few days earlier, Estonia reported similar disruption in the Baltic Sea region. Both Lithuania and Latvia reported the same problem. In 2023, Russian Tu-22M3 strategic bombers conducted five flights over the Baltic Sea, compared to none in 2022. Another issue observed in the region is the reported deployment of tactical nuclear weapons by Russia to Belarus. According to unconfirmed reports, in late 2023, Belarus received tactical nuclear bombs that could be carried by Su-24M tactical bombers (Belarus previously withdrew these in 2012). Minsk has also prepared the infrastructure required for intercontinental RS-12M 'Topol' missiles, although it is believed that if such weapons were to appear in Belarus, this would only be under the control of Russian military forces.

Earlier, in December 2022, Belarus received 9K720 Iskander launchers from Russia (with at least two types of missiles: ballistic 9M723 and cruise 9M728). Taking into account the range of Iskander systems (at least 500 km), the threat of tactical nuclear strike from Moscow will cover the western part of Ukraine and Slovakia, Poland, Lithuania, Latvia, Estonia, and partially also the Czech Republic, Hungary, Romania, and Moldova.

Both Russia and Belarus have increased direct military pressure against Poland. Russian aircraft are intercepted by NATO jets on a regular basis. In 2023, NATO fighters were scrambled more than 300 times to intercept Russian military aircraft approaching Alliance airspace, with most intercepts occurring over the Baltic Sea. One of the most recent incidents occurred in March 2024, when two French Mirage 2000-5 aircraft intercepted two Russian Su-30M jets and one An-72 transport aircraft in international waters north of Poland.

Finally, another important aspect of the threat as perceived in the region is the migration pressure artificially created by Russia and its ally Belarus. Warsaw reacted in mid-2023 deploying over a thousand additional soldiers to Podlasie in northeastern Poland, mainly from the 12th and 17th Mechanised Brigades. Additional vehicles, including 'Poprad' wheeled anti-aircraft missile systems and 'Rosomak' wheeled APCs/IFVs, were also deployed. Another 500 police officers, along with horses, dogs, and special units (BOA), were sent to reinforce the Polish Border Guard (SG), which already had 5,000 officers in the region. The SG is increasing the number of weapons at its eastern outposts – patrols are now equipped not only with handguns but also with larger firearms. This was a response to media reports about the deployment of the Wagner Group to Belarus. Even manipulated photos surfaced on the internet, purportedly showing members of the Wagner Group posing near Polish border markers.

Recent activities

An important moment in building security in the region was the NATO Summit in Vilnius in July 2023. Defence plans were adopted for three regions, including the Baltic Sea and Central Europe. NATO plans reportedly also contain details of defence for the so-called Suwałki Gap and the Brzeska Gate. The former is a narrow strip of land between Poland and Lithuania, sandwiched between Russia's Kaliningrad Oblast and Belarus. Its maintenance is crucial for NATO to provide ground support to Lithuania, Latvia, and Estonia. The Brzeska Gate, on the other hand, is a stretch of land about 80 km wide in Poland and Belarus. It is a strategically important area that separates Belarus from Russia's Kaliningrad exclave.

However, the concept of stationing forces in the region, for which the CEE countries were advocating, has not been changed. NATO has maintained its rotational presence of battalion-sized battle groups in Poland, Lithuania, Latvia, Estonia, Slovakia, Hungary, Romania, and Bulgaria, which can be rapidly – at least according to assumptions – expanded to brigade-size forces. A compromise formula for allocating NATO forces with increased readiness to individual CEE countries was adopted in Madrid in June 2022. Those forces are expected to reach 300,000 troops. CEE states are currently engaged in a dialogue with the frame-

Italian aircraft carrier ITS Giuseppe Garibaldi (foreground) and HMS Prince of Wales (background) during Exercise Nordic Response 24, which was a part of 'Steadfast Defender 24'.

Credit: Polish MoD

France is now more active in Central-Eastern Europe than in the past. Recently Paris increased its presence particularly in Latvia and Estonia.

work nations of the NATO battle groups (Germany, Canada, and the United Kingdom) regarding their involvement on the Eastern flank. At the same time, a NATO-Ukraine Education, Analysis, and Training Centre is being established in Bydgoszcz, Poland, following a decision made by NATO member states in February 2024. The centre will focus on collecting experiences from the war in Ukraine and providing support to Kyiv.

In the region, much space in the press is devoted to Germany's difficulties in effectively establishing a brigade in Lithuania (up to 5,000 troops). Germany and Lithuania aim to achieve full operational readiness of a new unit that is to be stationed in Lithuania by 2027 (it is expected to be formed in 2025). For this purpose, extensive infrastructure is to be developed in the village of Rudniki near Vilnius and in Rukla near Kaunas. Currently, Lithuania faces problems in providing adequate infrastructure.

All three Baltic states are increasing their defence expenditures. Estonia reached 2% of its GDP in 2015, while Lithuania and Latvia achieved the same goal in 2018. Estonia plans to spend up to 2.9% on defence in 2024. Latvia and Lithuania are aiming to reach 2.5% by 2025.

At the same time, the media are drawing attention to France's growing position in CEE (especially in Latvia and Estonia), which is a significant element of President Emmanuel Macron's strategy. This is quite surprising, as this region had been neglected by France since 1989. Author Marcin Giełzak, highlighted Macron's assistance to Ukraine: *"If we compare the data known from the German press with what the Ukrainians themselves say, it quickly becomes apparent that the real value of the assistance and commitments provided is about 10 times higher than commonly reported in Germany. It is also important to know that market value does not equate to combat value. Caesar artillery or SCALP-EG missiles are invaluable to Ukraine, as is assistance that is difficult to quantify, such as the involvement of French satellites in providing Ukrainian targets of Russian origin. The key now is for Paris to go further and send a second SAMP/T battery or Mirage-2000 aircraft."*

In January 2024, Lithuania, Latvia, and Estonia have signed an agreement to construct bunkers on the border with Russia and Belarus, forming the so-called Baltic Defence Line. A total of 600 bunkers will be built, each capable of accommodating 10 people along with equipment. The project is worth roughly EUR 60 million. Construction work is set to begin in January 2025. A similar plan is announced by Poland, which, despite the ongoing war for two years, has done nothing to create an effective civil defence. Hundreds of shelters built during the Cold War period remain inactive. It was only in March 2024 that initiatives were launched to support the construction of shelters by local governments. Additionally, the Polish military plans to build fortifications on the border.

NATO's frontline states are increasingly discussing the possibility of mining the border with Russia. Definite voices come, for example, from Estonia. The use of landmines is prohibited under the Ottawa Treaty of 1997. However, there are voices suggesting that the document was signed against a backdrop of completely different international realities, and that minefields would be a significant factor in slowing down any future Russian troop assault. This would be critical, especially for the most vulnerable states that lack strategic depth – Lithuania, Latvia, and Estonia. It is noteworthy that mines are widely used by both Ukrainians and Russians.

Credit: Estonian MoD

In 2024, Estonia is due to commence procurement anti-tank, short-range anti-aircraft and artillery ammunition, as well as various small-calibre ammunition. These procurements total about EUR 1.35 billion for the period of 2024–2027.

Credit: Latvian MoD

The Latvian government approved a plan for the construction of fortifications on the eastern border of the country. The Latvian line will include anti-tank ditches, ammunition stores, and mine-explosive barriers.

What next?

"From many of our European partners, we hear that they should have believed us earlier when we warned about the Russian threat. Now, it is necessary to maintain this attention and understanding that countries with their history with Russia and knowledge should play the role of experts. We must keep our eyes wide open and cannot return to any illusions, to trading, or befriending with the true aggressor", Deputy Speaker and Member of Parliament of Latvia Zanda Kalnina-Lukaševica said in February 2024. However, CEE countries are afraid that the administration of Joe Biden (in case of his re-election) will clandestinely pressure the region to support the idea of starting peace talks with Russia. Regional representatives believe that such peace would mean giving Russia more time to rebuild its potential and further divide European unity. As a result, CEE will become even more vulnerable.

It is therefore no wonder that CEE countries are modernising their armed forces. For example, Estonia will receive an additional 12 Korean K9 self-propelled howitzers (totalling 36). Lithuania, which already has 21 ex-German PzH 2000s, has also purchased 18 French Caesar wheeled howitzers. These three countries will also receive a total of 20 HIMARS launchers. While Estonia and Lithuania procured Polish 'Piorun' short-range portable air-defence launchers, Latvia purchased Swedish RBS-70NG. In June 2022, the defence ministers of Latvia and Estonia signed a Memorandum of Understanding regarding joint procurement of short-range air defence systems, and Lithuania is in talks to increase the number of NASAMS batteries it already possesses.

In mid-March 2024, another batch of three K2GF ('Gap filler') tanks arrived in Poland from South Korea, bringing Poland's total to 31 K2s received, out of a total of 180 ordered, with deliveries planned to run between 2022 and 2025. It is expected that Poland will receive a further 53 K2s in 2024. These are critical deliveries, as Poland continues to fill equipment gaps created by the transfer of over 250 T-72 tanks, 30-60 PT-91s, and 14 Leopard 2A4s to Ukraine. Lithuania, which is now discussing the procurement of an additional 120 Boxer/Vilkas wheeled vehicles, will also receive Leopard 2 tanks. Latvia will receive NSM anti-ship coastal missiles.

A key challenge for the future is the fact that despite losses incurred in the war with Ukraine, Russia consistently pursues plans to increase the capabilities of its armed forces. Defeating Ukraine ("demilitarisation and denazification"), as well as preparing a response to Finland and Sweden joining NATO, are priority goals presented by Russian Defence Minister Sergei Shoigu in December 2023. NATO, primarily the US, is unequivocally referred to as an enemy of Russia.

It seems that in the near future NATO's Eastern flank will face additional Russian military units. The Leningrad Military District, which along with the Moscow Military District will replace the Western Military District, will be the location for the 6th Combined Arms Army. The 14th and 44th Army Corps are being formed along the border with Finland, and the 11th Army Corps will operate in the Kaliningrad Oblast. According to Russian propaganda, this is a reaction to "NATO's efforts to build its military potential near Russia's borders, as well as the expansion of the North Atlantic Alliance to include Finland and Sweden."

The number of Russian armed forces is expected to increase to 1.3 million soldiers (in 2021, it was 900,000). According to official data shared by the Warsaw-based Polish Institute of International Affairs (PISM), Russian defence expenditures increased by 36% in 2023 compared to 2022. Russia allocated 32% of state expenditures to defence, which accounted for approximately 6% of GDP (in 2021, it was 4% of GDP). In 2024-2025, it plans to allocate 6% of GDP for this purpose, which is the highest indicator since the dissolution of the USSR.

"Russia is systematically preparing for a long-term confrontation with NATO member states, as evidenced by the increasing ideological factor and the ongoing militarisation of society, especially among the youth. Therefore, in the coming years, we should not expect a change in Russia's foreign and security policy, which will continue to rely on military strength," predicted Anna Maria Dyner, an analyst focussing on the Russian security policy at PISM. Dyner added, "If Russia succeeds in implementing Shoigu's reform, and military actions in Ukraine do not result in significant losses, the Alliance may face a confrontation with a mass army in the Soviet style, which will be technologically weaker (except for the ability to conduct electronic warfare and long-range strikes), but will possess significant military potential and relatively good training."

Therefore, it is crucial for the entirety of NATO – not just its eastern flank – to actually implement defence plans, as well as increase defence expenditures, aimed at a clear enhancement of combat capabilities. The time for inaction has already ended. According to Jacek Siewiera, Head of the Polish President's National Security Bureau (BBN), "to avoid a war with Russia, the countries of the eastern flank of NATO have 3 years to prepare for confrontation." ■

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Canada's defence industry: exports and partnerships

Bo Leimand

With the long distances involved in reaching the Canadian market, describing the defence sector is a challenging undertaking when it comes to designing a unique marketing strategy. This article examines the commercial prospects that exist in Canada today, given the country's growing interest in the Arctic region, an area where Canada has a lot to offer.

Overall, the Canadian defence industry employs more than 60,000 Canadians and generates over CAD 10 billion in annual revenues, roughly 60% of which come from exports. To provide a closer look at the inner workings of this industry, we will first briefly examine its key facets.

Key players

The following are notable key stakeholders in Canada's defence industry:

- The Standing Committee on National Defence: mandated to review all matters pertaining to Canadian national defence and Canadian Armed Forces;
- The Senate Standing Committee on National Security and Defence: mandated to study issues related to national security, defence and veteran's affairs;
- Global Affairs Canada: responsible for promoting international trade;
- Public Services and Procurement Canada: supports federal departments and agencies in their daily operations as their central purchasing agent;
- Canadian Association of Defence and Security Industries (CADSI): represents over 900 Canadian defence and security companies, also hosts CANSEC;
- Atlantic Canada Aerospace and Defence Association (ACADA): represents the interests of the aerospace, defence, and security industries in the Atlantic Canada regions (New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island);
- The Conference of Defence Associations: represents active and retired members of the Canadian Armed Forces.

Key business segments

Key business segments covered by Canada's major defence industries include: shipbuilding; aerospace; the automotive sector; munitions; electronics; simulation and training; information and communication technologies; textiles; in-service support; satellite and space technologies. On the whole these segments encompass a wide variety of equipment and services, providing a broad industrial capability base.

To help with further growth, the Canadian Government has launched a Key Industrial Capabilities (KICs) initiative, which will help to guide the country's Industrial and Technology Benefits (ITB) offset programme, which is replacing the Industrial Regional Benefits launched in 2009. Initial investigations have helped to define several key areas, including: Arctic and maritime security; protecting the soldier; command and support; cyber security; training systems; and in-service support. According to the ITB offset programme, this means that businesses engaged in the manufacture and delivery of products and services for use in government defence and security applications will be considered.

Credit: Irving Shipbuilding Inc.

The HMCS Harry DeWolf (pictured), the first ship of its class of six Arctic and Offshore Patrol Ships (AOPS) was launched in September 2018. Thus far, four of the class have been delivered, and two commissioned into service.

Obstacles and opportunities

In 2016, the Canadian Chamber of Commerce presented a list of the 'Top 10 Barriers to Competitiveness' for that year. When presenting the list, it was highlighted that in a fiercely competitive world, business needs more than its own skills to win – it also needs supportive public policies. This is not only true for Canada, but other countries face the same issue, and it is not until recently that the situation has changed because of new threats facing the countries. In this context, it might be important to describe the characteristics of the defence market and industries in general.

Governments are essentially the sole clients for companies connected to defence, and are allowed under international trade agreements to give preference to local providers; this makes these industries special. The production and trade in military equipment and services

Credit: Canadian DND

The CF-188 (also referred to as CF-18) has been in service with Canada's Armed Forces since 1982. The Lockheed Martin F-35A was selected to replace it in 2022, beating out Saab's Gripen.

are therefore strongly influenced by governments, usually in ways that strongly encourage the expansion of the home country's defence industry. Many of the most highly industrialised countries have therefore developed, explicitly or implicitly, strategies that promote their defence-related industries, recognising that such innovations will contribute both to sovereignty and to growth.

In short, a nation's defence industrial capability is inextricably linked to government policies and practices. This is also related to security of supply, as even NATO member countries have experienced problems obtaining spare parts or ammunition for a system bought from another NATO member if the country in question disagreed on foreign policy. Lately, this has been quite apparent in terms of equipment support to Ukraine.

Canada's defence industry is integrated with US industry, and reinforced by longstanding bilateral defence production-sharing agreements. Although this special relationship improves access to US defence markets, it also complicates business strategies for Canadian companies considering International Traffic in Arms Regulations (ITAR), which control the trade in goods, services and data related to sensitive military technology.

ITAR is a set of US government regulations applying to export and import of defence-related goods and services on a control list. The control list is meant to safeguard US national security and further foreign policy objectives. Items on the control list may only be shared with US persons or organisations (including their non-US subsidiaries), unless the US Department of State authorises an exemption. Canada has an exemption under ITAR, but must follow the same requirements, including the need to obtain prior approval on retransfer of items on the list to third countries. A recent example of this is the Dutch, Danish, and Norwegian donation of F-16s to Ukraine, all of which required US approval before they could be transferred.

Heavy fines are imposed if the regulations are broken. ITAR can be particularly problematic for dual-use technologies, given that a single ITAR-restricted component automatically leads to any product containing that component also being ITAR-restricted. Moreover, ITAR restrictions have increased cumulatively, with relatively few components de-listed even if the rationale for inclusion no longer applies. ITAR restrictions can even prove a headache for defence planners in NATO member procurement programmes.

Procurement strategy

The Canadian defence procurement strategy has the following three key objectives:

1) Delivering the right equipment to the Canadian Armed Forces and Canadian Coast Guard in a timely manner;
2) Leveraging purchases of defence equipment to create jobs and economic growth in Canada;
3) Streamlining defence procurement processes.

Although these goals set out to streamline procurement and provide economic opportunities for the country, the procurement process in Canada is rather strict, according to discussions with Canadian officers. When the Canadian Armed Forces (CAF) issues a statement of work for a specific piece of equipment, this will form the baseline for the procurement – no more, no less. This means that if a company proposes an addition, or maybe even an improved solution, the company will be declared non-compliant. In some cases, this may mean going with a solution which is not necessarily optimal, but the CAF must live with it.

Credit: USAF/Staff Sgt Madison Scaringe

De Havilland Canada CC-138 'Twin Otter' aircraft from the 440 Transport Squadron, Royal Canadian Armed Forces at Resolute Bay, Nunavut, Canada, on 25 February 2023. Securing the Arctic remains a key priority for Canada.

Exports

Under the Export and Import Permits Act (EIPA), the Canadian Minister of Foreign Affairs can deny exports and brokering permit applications for military goods and technology. This applies if there is a substantial risk that the items would undermine peace and security or could be used to commit or facilitate serious violations of international humanitarian and human rights laws and international conventions.

Canada supports and participates in a range of arms control, export control, and non-proliferation activities, working closely with partners who share Canadian objectives. Canada also participates in the following export control bodies and initiatives: the Arms Trade Treaty; the United Nations Register of Conventional Arms; the Wassenaar Arrangement; the Nuclear Suppliers Group; the Missile Technology Control Regime; the Australia Group; and the Organisation for the Prohibition of Chemical Weapons.

Export controls apply to all foreign destinations. However, due to Canada's close and long-standing military cooperation with the United States, including the 1956 Defence Production Sharing Agreement that underpins the integrated nature of North America's defence industry, Canada and the United States have reciprocal arrangements to ensure permit-free/licence-free movement of most military items between the two countries. Under this agreement the wider North American defence industry is able to cope with almost all demands related to military equipment, and difficult to compete with.

Credit: US Navy/Petty Officer 1st Class Ryan Seelbach

Canadian Army Soldiers, assigned to 4th Artillery Regiment, trained with U.S. Army Soldiers on the AN/MPQ-504 medium-range radar during Exercise ARCTIC EDGE 2022 at Eielson Air Force Base, on 15 March 2022.

Partnerships

International partnerships involving Defence Research and Development Canada (DRDC) are anchored in two multilateral arrangements: the Technical Cooperation Program (TTCP) and the NATO Science and Technology Organization (NATO STO). Through these arrangements, DRDC gains an understanding of the Allies' science and technology programmes and cooperates on a broad range of defence activities to augment defence and security knowledge and resources, avoid unnecessary duplication and jointly identify and close important gaps in technology and knowledge bases.

DRDC also collaborates with Allied countries under several bilateral and multi-lateral arrangements which facilitate information exchange, collaborative projects and exchange of personnel and equipment. In this regard, Canada has privileged relationships with Australia, Germany, France, The Netherlands, Norway, Sweden, the United Kingdom and the United States. Through these relationships, complementary science and technology activities are conducted, and national programmes are harmonised in defence, as well as in public security.

The following areas have been identified where some sort of partnership might be feasible:

- Development programmes/study groups in the NATO Industrial Advisory Group (NIAG);
- NATO programmes like the Airborne Warning and Control System (AWACS) programme and the Alliance Future Surveillance and Control (AFSC) programme;
- The Arctic Area;
- EU-funded programmes;
- National funding;
- The European Space Agency (ESA).

The Canadian Trade Commissioner Service is offering to help Canadian companies by providing financial support, matching them with potential foreign partners, and helping them pursue partnerships and commercialisation opportunities in new markets. One avenue for this has been through the Brussels-based Eureka network, which, among other things, aims to encourage international R&D co-operation. Canada also has a programme called 'Going Global Innovation', which offers funding to support innovators from Canadian organisations seeking foreign partners for the purpose of establishing a collaborative R&D agreement.

Domestic spending looking up

In early 2024, the Canadian Government's spending estimates projected around CAD 1.7 billion (USD 1.3 billion) in defence spending cuts. However, more recently this downward trend in spending appears to have been reversed. On 8 April 2024, the Canadian Government unveiled its new defence policy titled: 'Our North, Strong and Free', in which they pledged CAD 8.1 billion over the next five years, and CAD 73 billion over the next twenty years.

Under these spending plans, the country aims to increase its defence spending as a percentage of GDP from the 2023 level of around 1.29% of GDP, to around 1.76% by 2029/2030. This raft of measures is aimed at moving Canada toward reaching the NATO target of 2% of GDP on defence, which Canada pledged at the 2023 NATO Vilnius Summit. The plan envisions a range of new equipment and capabilities to be procured across multiple domains. In sum, there will no doubt be ample opportunities for the country's industry and their partners to meet many of these requirements. ■

Voices from Industry – Calian Group

Calian Group

In this exclusive interview with Kevin Ford, CEO of Calian Group, we delve into the company's remarkable journey, its pivotal role in supporting the Canadian Armed Forces (CAF) and NATO allies, and its commitment to excellence in defence training. Join us as we uncover the strategies, innovations, and vision driving Calian's success in the dynamic realm of defence and security.

Credit: Calian Group

Kevin Ford, CEO of Calian Group.

1) How does Calian support the CAF and NATO Allies?
We've supported large, complex NATO exercises, providing subject matter experts, scenario developers, and master events lists. Given NATO's increased focus on readiness post-Ukraine invasion, these exercises are crucial, especially for joint and multinational operations. Additionally, we offer individual skills training, covering aerospace, engineering, communications, intelligence, and various specialties. We leverage VR and AR for immersive, realistic training experiences, such as our replenishment-at-sea and JTAC trainers, offering a 360-degree experience with voice recognition and fail-safe mechanisms.

2) For how many years has Calian been providing military training to NATO?
Calian has been providing training to NATO for fifteen years, delivering over 75 large-scale exercises. The training has focused on large, complex exercises for NATO commands. We have been delivering training for the Canadian Armed Forces since 1996, and leverage those years of experience in our NATO work today. As a NATO member, Canada relies on NATO-standard methods and approaches for training development and delivery, allowing us to hit the ground running after establishing ourselves in the NATO market.

3) Which NATO Commands and Training Centres is Calian supporting with training?
Calian has been delivering training for the following commands:

- Joint Warfare Centre (Stavanger, Norway)
- Joint Forces Training Centre (Bydgoszcz, Poland)
- Allied Joint Forces Command (Naples, Italy)
- Joint Forces Command Brunssum
- HQ Eurocorps
- NATO Allied Command Transformation

4) What type of training is delivered by the Calian team across NATO?
We've supported diverse large-scale exercises, including high-intensity operations, counterinsurgency, peace support, wargames, and nuclear deterrence for NATO, totalling over 75 exercises. Our team comprises subject matter experts in various fields like manoeuvre, air defence, aviation, ISR, logistics, civilian policing, and more. Regardless of the training concept, we provide the expertise needed to bring the exercise to life.

5) Calian recently won a contract for a major NATO 360 exercise, what is involved in this contract?
This contract involves supporting the needs of JWC360 for concept development, exercise planning, scenario development and master events list development and a range of other training activities like integrating computer-assisted technologies, role-playing, mentoring and advising. We bring the right subject matter experts with the necessary skills to support whatever JWC needs to deliver on their exercise concept.

6) How does Calian's MaestroEDE training system enable trainers to develop, deliver and evaluate training in a single, simulated environment?
MaestroEDE is Calian's E3D software platform for large-scale military exercises. It streamlines planning, enhances training outcomes, and centralises data with a user-friendly interface. It fosters real-time feedback and collaboration, accommodating participants from any organisation. Additionally, our AI Chatbot automates exercise content generation, reducing human effort and accelerating development for greater agility.

7) How does Calian provide augmented reality (AR) and virtual reality (VR) solutions to deliver realistic, immersive, and configurable training environment?
We utilise AR and VR to offer immersive, interactive training tailored to specific job roles, complete with realistic voice procedures. This approach provides a cost-effective alternative to live training, with reduced risk of injury. Immersive environments allow trainees to learn from mistakes, enhancing the training experience.

8) What can you tell me about Calian's recent contract to supply NATO SHAPE with CBRN specific training for all Alliance military operations?
Calian recently won a contract to supply specialist training with SHAPE HQ for design, development, and execution of three Chemical, Biological, Radiological and Nuclear (CBRN) exercises programmes. Calian's CBRN experts will provide support across the exercise programme and will include program integration with other current NATO training. The training solutions will rely on Calian's proven formula for client success—integrating subject matter experts with deep military experience and industry-leading simulation technologies. Calian uses a blend of technology, modelling, and simulation to design, develop and deliver cost-effective training experiences to meet any objective.

Spain's aerospace prowess

Tim Guest

Making planes since the early days of manned flight, Spain's expertise in the aviation and aerospace sectors has grown over the years, making it one of today's world leaders in these fields, with the country becoming a major supplier of military aircraft, space systems, and equipment.

As a case in point, when the Spanish Ministry of Defence (MoD) sought replacements for the nation's P-3 Orion maritime patrol and CN-235 VIGMA maritime surveillance aircraft (MPA and MSA, respectively), some years ago, despite considering other options, the ministry did not have to look far for its eventual choice. Indigenously-designed and manufactured configurations of Airbus' C295 were just what was needed, with 16 ordered and the first plans now under construction at the company's Seville plant. While a sizeable and impressive EUR 1.695 billion contract, announced in December 2023, represents the latest milestone from within the heart of Spain's significant aerospace sector – more precisely, in this instance, from within the country's Andalusian Aerospace Cluster – and highlights the comprehensive expertise and leading position of Spain on the world aerospace stage.

Credit: Airbus Defence and Space

Fuselage work underway on C295 maritime aircraft at San Pablo Sur, Seville site.

Regions and brief overview

According to a report by the US International Trade Administration (ITA), Spain's aerospace industry, which currently has 51,000 employees, was ranked 5th in Europe and 8th globally in 2022, in terms of turnover. The sector's activities are largely regionally concentrated, mainly around Madrid, the Castilla La Mancha and Castile-León regions, with these three together accounting for some 88% of the sector's activities, followed by Andalusia, the Basque Country, and, to a lesser extent, Catalonia.

The companies spread across these regions, between them have capabilities to meet many civil and military-sector requirements, whether at home, or for export; it is interesting to note, that in 2022, according to the Spanish Government's 'Invest in Spain' business entity, 49% of aeronautics and 75% of space-sector sales were from exports. Those capabilities and expertise cover almost everything from composite materials for aircraft structures, such as wings, stabilisers and flight-control surfaces, down to the specialist adhesives and fastening systems that hold them together, not to mention engines, engine parts and assembly work, all the way to complete military transport aircraft and helicopter manufacture, as well as refuelling airframe conversion. Major players, including Airbus, Boeing, CAE, the European Space Agency (ESA), ITP Aero, Lockheed Martin, Safran, SpaceX, Thales, and many more leading names all have a major presence and facilities in the country.

The sector receives state backing, since it is what the government refers to as a 'strategic industry', which helps maintain the complete design-to-manufacture capability Spain has, delivered by the sector's established original equipment manufacturers (OEMs) and major companies, such as the aforementioned Airbus and ITP Aero, respectively. Yet they couldn't do it without the involvement of the numerous SMEs and start-up partners and suppliers spread across Spain's key aerospace regions.

Engine prowess

Of the more than 720 production centres across the country, engine and gas turbine maker, ITP Aero, is but one example, headquartered in the Basque Country, with facilities across five Spanish regions, including Madrid. It was originally formed as a joint venture between Rolls Royce and Spanish engineering group, SENER, to address requirements for the Eurofighter Typhoon programme, and

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Credit: Tim Guest

Along with other military transport programmes, final assembly of the A400M Atlas military transport plane takes place at Airbus' San Pablo site near Seville.

now claims to be the "ninth-largest aircraft engine and component company in the world". The Eurofighter programme, involving Germany, Italy, Spain and the UK, is just one of several Europe-wide projects with Spanish aerospace industry involvement. As a member of the Eurojet Turbo consortium, which developed the Typhoon and its EJ200 engine, ITP Aero is instrumental in several aspects of the engine, including design, manufacture, assembly and testing; more than 1,200 of the engines have already been supplied to members of the fighter programme.

In mid-2022, Eurojet announced that 48 new EJ200 engines would be delivered to the Spanish Air Force under Project Halcón, aimed at increasing the Air Force's then 70-strong Typhoon fleet stationed on the Canary Islands; ITP, along with its consortium partners, is involved in production of the engine modules, although the Spanish company alone is responsible for final assembly of the engines at its Ajalvir facility – as is the case for all EJ200s destined for the nation's air force. Deliveries began at the start of 2024. The company also provides the maintenance, repair and operations (MRO) support for the engines in service on Spanish Air Force Eurofighters, as well as on some other Typhoons in European and Middle Eastern service. With the aircraft set to eventually replace all the F/A-18 Super Hornets in Spain's inventory in 2030, ITP's work on EJ200 has been a notable step forward from the component parts' manufacturing it has conducted over the years for the Hornets' GE F414 engines.

The dominance of Airbus

When it comes to OEMs, Airbus Defence and Space, as Spain's largest player in the sector, has in-country military aircraft production and final assembly lines (FALs)

Credit: Airbus Defence and Space

Airbus expects the intended anti-submarine NH90 HSPN variant for the Spanish Navy to be made in-country in line with the MoD's Defence Industrial Strategy 2023. Pictured: Spanish Air Force NH90.

Credit: Ejército del Aire y del Espacio

Spain's Mando del Espacio (MESPA) aims to identify and monitor space-based threats, and is based at the Torrejón de Ardoz Air Base.

for both fixed and rotary-wing aircraft such as the Eurofighter, the C295 variants mentioned earlier, the A400M Atlas military transport aircraft, and the latest NH90 helicopters.

The company actually leads many of the nation's aerospace programmes, whether national or with international collaboration, and is also the main supplier of fighter, transport and rotary-winged aircraft to the Spanish Air Force. In the case of NH90, Airbus expects the intended anti-submarine NH90 HSPN variant for the Spanish Navy to be made in-country in line with the MoD's Defence Industrial Strategy 2023, which set out its vision to develop the nation's defence industry in ways to make Spain and its armed forces strategically independent in their capabilities, as well as being leading contributors to overall European defence needs. Spanish aerospace and defence company, Indra, state-owned naval shipbuilder, Navantia and defence electronics specialist, Tecnobit, will all play a role in this major programme under the overall coordination of Airbus, as prime contractor, making it very much a Spanish, family affair. At this time, the company's Albacete plant is already responsible for NH90 front and centre fuselage production for all other variants of the helicopter.

The company's national HQ is located to the south of Madrid, at Getafe, which is also its third-largest site; among many other activities there, it houses the FAL for Spanish Eurofighters and the conversion centre turning A330 airframes into multirole, air-to-air refuelling tankers. Its Seville, San Pablo site handles military transport projects, including final assembly for the aforementioned A400M and C295 aircraft.

The company is also heading up Spanish participation in the EU's European Medium Altitude Long Endurance Remotely Piloted Aircraft Systems (MALE RPAS), or Eurodrone project, which aims to develop what the EU's Permanent Structured Cooperation (PESCO) entity describes as an 'operationally relevant, affordable and sovereign European military capability for the next-generation of MALE RPAS' by 2030. Getafe, where the company already conducts extensive UAV systems design and development, will act as Eurodrone's lead engineering office.

A lively ecosystem

Airbus, however, is not the only major player taking a lead role in Spain's aerospace activities, with many major domestic names, such as Indra, crucial to Spain's strategic objectives. Indra, for its part, among its many major projects, is, along with Airbus and Dassault Aviation, one of the prime collaborators on the European Future Combat Air System (FCAS) project and, in January 2024, announced its 'FCAS Challenge' to involve Spanish SMEs and start-ups in the fighter programme. As well as its participating role in the programme proper, Indra is also Spain's industrial coordinator in the project and has launched this challenge initiative, giving the whole lower-tier, Spanish aerospace ecosystem the opportunity to take part in this major European venture. Spain though Indra, France through Dassault, and Germany through Airbus, are participating in the project in equal parts to develop a new-generation fighter, one that will team with remote operators and be highly connected with other platforms across all domains of any battlespace via the combat cloud.

By bringing together greater Spanish participation at all levels, Indra's challenge will only help further bolster Spain's strategic self-reliance and its domestic industrial aerospace capabilities beyond FCAS. In the meantime, a number of SMEs and start-ups have already received accolades for their FCAS Challenge proposals, including: Beamagine from Catalonia and EM3works from Galicia in the mission-sensor category; Multiverse Computing from the Basque Country and Pixels-Hub from Asturias for signal intelligence work; Madrid's Red Skios in the field of smart communications; and several players from Galicia, Catalonia and Andalusia, partnered to deliver combat cloud expertise.

Spain in space

Let's now take a look at Spain in space, where many Spanish companies offer services and manufactured solutions for a wide range of defence-related and commercial activities, from complete satellites to ground Earth stations and even launch systems. As the main aerospace region and home to many leading

Credit: USMC

PLD Space's Miura-1 is Spain's first recoverable, suborbital launch vehicle. Pictured: 2023 trial launch.

OEMs, Madrid also plays host to various space-related organisations including the country's aeronautics, space and hydrodynamics R&D centre – the National Institute of Aerospace Technology (INTA) – a public research organisation with MoD support and which previously acted as Spain's de facto space agency. In October 2023, amongst its many activities, INTA launched its first cluster of three ANSER (Advanced Nanosatellites System for Earth Observation Research) CubeSats into low earth orbit, as part of its small satellites programme and, in so doing, highlighted Spain's considerable progress in space-related fields; at the other end of the sector are many SMEs and start-ups, of which Catalonia-based, Kreios Space, which focuses on electric propulsion solutions for satellites, is just one example.

Though INTA previously acted as the nation's space agency, that baton was passed to the new Spanish Space Agency, which became operational in April 2023. In 16 March 2023, another new agency, Space Command (MESPA), was created, becoming established on 16 October 2023. MESPA comprises air and space force military personnel, as well as civilian technical advisors from Defence Systems Engineering (ISDEFE), with its purpose to monitor and identify any threats to Spanish territories from space; its initial operational capability is slated for the end of 2024.

Meanwhile, in Catalonia, the Catalan Space Agency was established in 2021, though not without a degree of scepticism from the wider Spanish space community as to whether it was simply another political move to further drive a wedge between the region and the rest of the country. That said, the agency does seem to be making progress, with its third nanosatellite, Minairó, entering orbit in April 2023 aboard a SpaceX Falcon 9 rocket, as part of a 5G communications connectivity experiment. It is also worth noting, that Valencia has also had its own agency, the Val Space Consortium, active in space R&D since 2010, accompanied by a wealth of other space centres across the country, including Boeing's European Centre for Research and Technology and NASA's Madrid Deep Space Communication Complex.

In addition to its own organisations, Spain's space expertise, (developed over seven decades and including early work with NASA in the 1960s on space tracking), is a crucial component to many ESA programmes in which Spain participates as an ESA member; it currently contributes EUR 300 million, annually, to the agency and today is a key provider of high-tech sub-systems for ESA-related space and ground-segment platforms and equipment.

Spain's wider space community also conducts R&D in a number of other areas, including astrobiology, imaging and remote sensing, as well as materials science and propulsion. Its satellite capabilities include complete space vehicles, nano or CubeSats, as per the INTA example above, as well as larger platforms made by Airbus. Other programmes with Spanish space-sector involvement, include the EU's Galileo programme, where the MoD has been supervising the hosting and maintenance of Galileo's ground control segment (GCS) at a secure INTA site at Torrejón de Ardoz for several years.

Copernicus is another EU project, this time for land surface temperature monitoring, where the satellite has been developed by Airbus Space Systems at its Getafe site in Madrid. ESA's European global navigation satellite system (GNSS) programmes also have Spanish involvement. Spain also has ongoing participation with ESA's BepiColombo Mercury planetary orbiter, Europe's first mission to the planet, and also conducted a test launch of PLD Space's Miura-1, recoverable, suborbital launch vehicle in 2023, the first Spanish-built launch vehicle of its kind.

Clearly, from just the above examples, Spain is certainly playing its part filling the void of space. However, in taking its responsibilities seriously, it signed up to the NASA-inspired, non-binding Artemis Accords in 2023, which set out the norms and guidance for activities in space, critical at a time when the domain is becoming increasingly cluttered, as well as militarised.

In relation to Copernicus, probably the most significant player in Spain's space industry is Airbus Space Systems; it is the only prime contractor for such large satellite production in the country, but also applies its material science expertise in carbon fibre composites to construct major parts of both Ariane 6 and Vega-C rockets; it also makes payload sub-systems for several ESA satellite projects. Additionally, and a high-profile example, both currently operational NASA Mars rovers, Curiosity and Perseverance, incorporate communications and meteorological technologies from Airbus.

Final word

While this taster hopefully illustrates that Spain's aerospace ecosystem is world leading in its capabilities. Its many players, both big and small, and their products and expertise, all help to make up this significantly capable Spanish industry and enable it to contribute, to major defence and commercial aerospace projects and programmes both at home and globally. Where it has had weaknesses, such as a past dearth in missile capabilities, this particular area looks set to grow in strength following the 2021 formation of Spanish Missile Systems (SMS), a collaborative effort between Sener Aeroespacial, GMV and Escribano M&E. The company's 2023 contract with the EU for the European Hypersonic Defence Interceptor (EU HYDEF), as consortium lead under the management of the Organisation for Joint Armament Cooperation (OCCAR) in the EUR 100 million programme, is testament to international confidence in Spanish capabilities in this area. EU HYDEF is certainly a programme to watch in an increasingly unstable world. ■

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AD: 29. May • **CD:** 3. June • **PD:** 14. June

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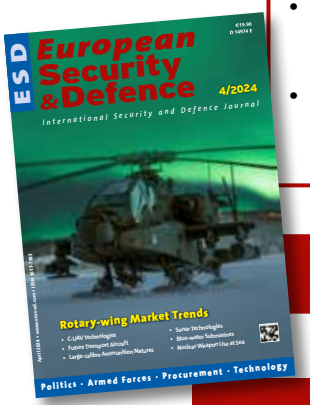

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