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Weighing Ukraine's Kursk offensive

On 6 August 2024, the Armed Forces of Ukraine (AFU) surprised many by staging a surprise incursion into Russia's Kursk oblast, bringing the fight to Russian soil. The stretch of border where the incursion occurred was largely weakly-defended, largely by conscripts and guards from the Russian Border Service. Fairly quickly, the Ukrainian force managed to secure a bridgehead, and by 9 August, had captured the town of Sudzha, along with a number of smaller settlements. On 10 August, a Russian relief force attacked toward Sudzha from the East, and while they initially managing to regain some land, they were pushed back by 16 August. Between 16 and 19 August, Ukraine's advances were considerably slower. On 20 August, the AFU were pushed back from around Belitsa and Bol'shoe Soldatskoe, but made substantial gains in the North flank and smaller gains to the West flank. At the time of writing on 21 August, Ukraine controlled somewhere between 815 km^2 to 1,250 km^2 of territory.

While the numbers of Ukrainian personnel involved in the operation are difficult to estimate accurately, the AFU seems to have assembled an ad-hoc patchwork force from the combat-ready portions of various formations. This is evidenced by the highly diverse range of platforms seen being operated, as well as damaged and destroyed. In terms of Ukraine's vehicle losses, the list includes various higher-end platforms, such as: Challenger 2, PT-91 Twardy, T-64BV, Marder, Bradley, Stryker, BTR-4, as well as larger numbers of lighter platforms such as M113, VAB, Cougar H, MaxxPro, Kozak-2M1, Kozak-7, Senator, among others.

The key question is whether or not this offensive can be considered a success. To a large extent, accurately assessing the success or failure of the operation depends on the intentions, objectives, and strategic logic behind it. With regard to this, on 18 August, President Zelenskyy stated that the goal of the operation was to build a "buffer zone" in Kursk to hinder Russian cross-border attacks. Assessed on those terms, the results appear mixed at best.

By creating a salient within Russia, Ukraine have extended the length of the front line to be defended, and have done so in an area where it is relatively risky to bring up air defence systems. Secondly, the AFU have taken fairly serious losses of capable personnel and high-value equipment, both of which are difficult to replace. Lastly, the offensive has taken up a lot of Ukraine's offensive potential, and the longer the operation lasts, the more Ukraine's defenders on the main front will feel the absence of personnel, vehicles, and ammunition being used in Kursk. Indeed, over the same time period as the Kursk operation, Russian advances have actually accelerated in some sectors of the main front, most notably in the direction of Pokrovsk. Taken together, these factors make Zelenskyy's claim of the goal being to establish a buffer zone seem somewhat dubious.

There have been some definite positive outcomes for Ukraine. For starters, having spent the best part of a year on the defensive, finally being back on the offensive has been a major morale and propaganda boost for the AFU, as well as being highly embarrassing for Putin. Along with causing significant attrition to Russian units sent to deal with them, the AFU also secured an estimated several hundred prisoners, which may be exchanged. According to some reports, Russia was also forced to divert some units from their Kharkiv offensive to stymie Ukraine's progress, along with diverting some aviation, munitions, and reserves to deal with the threat in Kursk.

Yet, taken together, it is difficult to argue that the gains have been worth the cost, not least because the offensive will require ongoing sustainment if the AFU choose to remain in the area. Due to shortages, this sustainment will necessarily have to come at the expense of other units on the main frontline. Indeed, some reports from AFU sources on the main frontline have already stated they are experiencing greater shortages of supplies such as ammunition. As such, the question of why the AFU chose to do this remains open to discussion, and multiple theories have been floated to fill the gap of ignorance.

Some have posited that Ukraine aimed to take as much land as possible, to facilitate more favourable land exchanges at potential upcoming peace talks. Yet overall, Russia retains the initiative on the main frontline, so there would seem little incentive for them to go along with such a proposal.

Another theory has posited that the attack was essentially diversionary, designed to relive pressure on Ukraine's East by drawing away Russian units stationed there. While this seems the most plausible, if true, it does not appear to have succeeded, as seen with Russia's accelerated gains along parts of the main frontline.

Overall, in strategic terms, the nagging feeling is that the AFU now find themselves holding a poisoned chalice. Ahead of them lies the choice of either retreat, or commitment. The former would preserve lives and equipment, but would call the entire purpose of the operation into question, making it look like a blunder. Commitment would continue to exacerbate shortages on the main frontline, in exchange for holding on to questionably useful gains. Neither seems particularly good.

Mark Cazalet

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Cover Photo: A Polish Territorial Defense Force soldier hand launches a FlyEye UAV during the US-led exercise 'Rifle Focus' at Bemowo Piskie Training Area, Poland, on 7 October 2021.
Credit: US Army/Spc Osvaldo Fuentes

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Ukraine's surprise offensive into Kursk region takes war directly to Russia

(pf) By the time Ukraine's surprise offensive into Russia's Kursk Oblast, which began on 6 August 2024, had entered its second week, Ukrainian President Volodymyr Zelenskyy had acknowledged the operation for the first time.

Speaking late on 10 August, Zelenskyy said, "Today, I received several reports from Commander-in-Chief [Colonel General Oleksandr] Syrskyi regarding the front lines, our actions and the push to drive the war onto the aggressor's territory. I thank every unit of our Defense Forces that is making this possible. Ukraine is proving that it truly knows how to restore justice and applies the necessary pressure on the aggressor."

Credit: X account of O Syrskyi

Col Gen Syrskyi, who was appointed as commander-in-chief of the Ukrainian armed forces on 8 February 2024, was quoted on 12 August as saying, "As of now, we control about 1,000 square kilometres of the territory of the Russian Federation. The troops are fulfilling their tasks. Fighting is ongoing actually along the entire front line. The situation is under our control."

Russian authorities, who have admitted that Ukraine controls around 28 settlements in the Kursk Oblast, have already evacuated more than 100,000 civilians from the area and on 12 August continued to do so.

As the Ukrainian incursion into Kursk continues to force the Russian military to draw reinforcements from other areas to stem the offensive – presumably one of the key Ukrainian objectives – it remains to be seen how long the Ukrainian offensive can be sustained. While pro-Ukrainian irregular Russian units have previously mounted raids across the border, the presence of regular enemy forces on Russian territory for the first time since the Second World War is deeply embarrassing for Russian President Vladimir Putin, who will obviously pressure his generals in any way he can to end the situation.

The Ukrainian operation thus becomes even more high risk the longer it continues. As things stand it can be considered a stunning operational victory offering a significant boost to Ukrainian morale; however, if the Ukrainian forces involved suffer heavy casualties in troops and materiel, which they can ill afford to do, any sense of success will be significantly compromised, while the longer the operation continues, the more acute the Ukrainians' logistical problems will become.

In his 10 August briefing, posted on social media, Zelenskyy praised the continued imposition of sanctions on Russia, referenced the latest military aid package received from the United States and alluded to the potential future provision of more long-range capabilities from US allies.

"I'm grateful for the new defence packages for Ukraine," he said. "This week, we received an American package, including missiles for Stingers, ammunition for HIMARS [the M142 High Mobility Artillery Rocket System], and 155 mm artillery shells. We are working to ensure timely logistics so that this aid is felt on the front lines as quickly as possible.

"We are also eagerly awaiting decisions on long-range capabilities from the United States, the United Kingdom, and France – strong decisions that will bring us closer to a just peace," Zelenskyy added.

Meanwhile, the Ukrainian offensive in Kursk has produced some interesting developments. For example, the perceived lack of fighting quality of the 'Akhmat' units loyal to Chechen strongman Ramzan Kadyrov appears to have been borne out, with multiple reports of these units fleeing the battlefield and/or being taken prisoner. Indeed, the presence of Akhmat units in the Kursk Oblast may have been one reason why the Ukrainian planners figured they could prevail there.

Another interesting battlefield development concerns Ukrainian bomb-laden unmanned aerial vehicles (UAVs) appearing to down Russian helicopters over the Kursk region on at least two occasions. A first attack took place against a Russian Mi-28 attack helicopter on 6 August, a source in the Security Service of Ukraine (SBU) told the Kyiv Independent. Footage of the attack appearing on social media the same day did, indeed, show images from a UAV video feed of an Mi-28 being closed upon, although it is unclear if the helicopter was destroyed.

Then, on 9 August, footage was posted of another attack by a bomb-laden UAV on a Russian helicopter, this time an Mi-8 transport helicopter. The footage clearly showed the UAV closing onto the tail rotor of the Mi-8, with reports accompanying the footage claiming the helicopter was destroyed in the attack.

Middle East moves closer to the brink after assassination of Hamas leader in Tehran

(pf) Israel has moved closer to being on the brink of multi-theatre conflict following the assassination of Hamas political leader Ismail Haniyeh in the early hours of 31 July 2024.

That Haniyeh was targeted was not unexpected; in the wake of the Hamas-led terrorist attack on Israel 7 October 2023 Israel vowed it would hunt down all Hamas leaders. However, the nature of the assassination was more surprising: Haniyeh, along

Credit: via ITV News

with one of his bodyguards, was killed in the Iranian capital, Tehran, when what has variously been described as an 'air-launched projectile' struck the house in which he was staying just hours after the Hamas leader had attended the inauguration of Iranian President Masoud Pezeshkian.

The presumed Israeli airstrike thus sent the dual message that the Israel Defense Forces can strike with impunity on Iranian territory and that the government of Israeli Prime Minister Benjamin Netanyahu has no interest in reaching a negotiated end to the war it is pursuing against Hamas in Gaza.

The attack can be also seen in light of the 27 July rocket attack by the military wing of Lebanon-based Islamist group Hezbollah on the Israeli-occupied Golan Heights, which killed 12 children from Israel's Druze community, given that both Hamas and Hezbollah are controlled from and supported by Iran.

While the Israeli government did not comment on the assassination of Haniyeh, it did claim on 30 July to have conducted an "intelligence-based elimination" of senior Hezbollah commander Fuad Shukr in the Lebanese capital, Beirut.

Haniyeh's assassination in Tehran not the first time Israeli forces have targeted their enemies on Iranian soil. In the past, for example, Iranian scientists associated with Iran's nuclear programme have been killed in their own country. Previous assassinations, however, have not been designed to have such a deliberate impact.

In light of the killing a cacophony of calls for retribution came from Iran's political lead-

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ers, who also blamed the United States as a 'facilitator' of Israel's actions.
How the Iranian leadership might actually respond, however, is more difficult to see. Tehran has hardly ever attacked Israel directly; the only time it came in response to the 1 April 2024 Israeli attack on the Iranian consulate in Damascus that killed senior Quds force commander Brigadier General Mohammad Reza Zahedi and other high-ranking members of the Islamic Revolution Guards Corps. On that occasion Iran launched more than 300 bomb-laden unmanned aerial vehicles, cruise missiles and ballistic missiles at Israel, but chose to do so in a manner that was widely telegraphed.
The potential Iranian response to the airstrike on Haniyeh in Tehran is much less likely to be conducted in a similar way.
Hamas, meanwhile, has also stated that Haniyeh's death will not go unanswered.
On 11 August, in light of the escalating regional tensions, the US Department of Defense (DoD) stated that the USS *Abraham Lincoln* Carrier Strike Group had been ordered to accelerate its transit to the Central Command area of responsibility, adding to the capabilities already provided by the USS *Theodore Roosevelt* Carrier Strike Group, and that the guided missile submarine USS *Georgia* had been directed to the region.

First F-16s officially enter the inventory of the Ukrainian Air Force

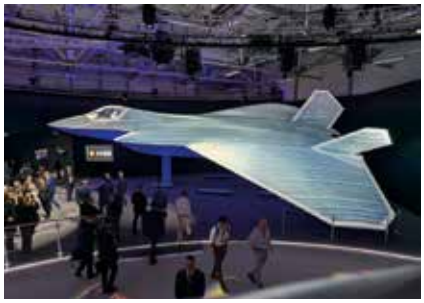
(pf) The first Lockheed Martin F-16 fighters to be donated to Ukraine following Russia's February 2022 invasion have now entered the Ukrainian Air Force inventory and can be worked up for operations.
In a video posted on the X/Twitter account of Ukrainian President Volodymyr Zelenskyy on 4 August 2024, Zelenskyy could be seen addressing a ceremony for Ukrainian Air Force pilots and maintainers at an unknown location with two F-16s behind him sporting Ukrainian insignia.
The video footage also showed two additional F-16s conducting a flypast of the ceremony.
"We are now in a new phase of development for the air force of the armed forces of Ukraine," said Zelenskyy in his address. "We have done a lot to transition the Ukrainian Air Force to a new aviation standard: Western combat aviation. From the beginning of this war, we have been talking with our partners about the need to close the Ukrainian sky from Russian missiles and aircraft.
"We have held hundreds of meetings and negotiations to strengthen the capabilities of our aviation, air defence, and defence forces," Zelenskyy continued. "We often heard the word 'impossible' in response, but we made possible what was our ambition, our defence need, and now it is a reality in our sky: F-16s in Ukraine. We ensured this.
The Ukrainian president then added, "I am proud of all our guys who are skilfully mastering these aircraft and have already started using them for our country. I thank our team for this result. I thank all the partners who are truly helping with the F-16s, and the first countries that accepted our request for aircraft – Denmark, the Netherlands, the United States – and all our partners; we value your support.
"I wish our air force and all our warriors to feel the pride of Ukrainians in our combat aviation and to bring Ukraine the combat results that will bring our victory closer – our just peace for Ukraine."


Credit: X_V Zelenskyy

The first batch of F-16s are understood to have arrived in Ukraine in late July and are likely to have come from Denmark and possibly also the Netherlands.
Speaking at the NATO summit in Washington, DC, on 10 July 2024, US Secretary of State Antony Blinken said F-16s were en route to Ukraine from Denmark and the Netherlands and that those aircraft "will be flying in the skies of Ukraine this summer to make sure that Ukraine can continue to effectively defend itself against the Russian aggression".
Denmark and the Netherlands both committed to donating F-16s to Ukraine on 20 August 2023. Denmark said it would provide 19 aircraft, while Zelenskyy said the Netherlands had committed to providing 42.
Belgium, meanwhile, signed a security agreement with Kyiv on 28 May 2024 that confirmed it would transfer 30 F-16s to Ukraine.
Norway, which decided in 2023 to donate a number of F-16s to Ukraine under the framework of the Air Force Capability Coalition (AFCC) led by Denmark, the Netherlands and the United States, stated on 10 July 2024 that it would donate six aircraft, with deliveries to start in 2024. The Royal Norwegian Air Force phased out its F-16s in 2021 following its adoption of the F-35 Joint Strike Fighter, but sold 32 F-16s to Romania.
The F-16s that Ukraine is receiving are F-16AM/BM variants: single-seat F-16As and twin-seat F-16Bs that have undergone a mid-life upgrade that, among other features, introduced an improved radar – the APG-66(V)2A – that offered the ability to track and engage more targets simultaneously and at greater ranges.
Adoption of the F-35 by the European nations of NATO has meant that the F-16AM/BMs are the only aircraft type available for donation to Ukraine in significant numbers.

GCAP partners unveil new future fighter concept model

(pf) In a dedicated space inside the BAE Systems exhibition area at the Farnborough International Airshow (FIA) on 22 July 2024 the three nations of the Global Combat Air Programme (GCAP) – the UK, Italy and Japan – unveiled a new concept model of their stealthy next-generation combat aircraft.
Although relatively little can be gleaned from this full-scale model, given that it only appears in a form considered fit at this stage for public consumption, the obvious takeaway regarding the design is its size; the concept model as presented is noticeably larger the Royal Air Force's current F-35 and Typhoon fighters – perhaps 1.5 times the size of an F-35.
The three national industry partners leading the GCAP programme – BAE Systems for the UK, Leonardo for Italy and Mitsubishi Heavy Industries (MHI) for Japan – noted in a joint press release that this latest concept model "features a much more evolved design with a wingspan larger than previous concepts to improve the aerodynamics of the future combat aircraft".
Engineers from the three partners are currently working together under a collaboration agreement on the design and development of the future combat aircraft. To do this they are "using a range of innovative digital tools and techniques, including computer-based modelling and virtual reality to evolve the aircraft's design during its concepting phase", the companies stated.
The next-generation combat aircraft – to be known as Tempest in the UK – is being developed under a pacing schedule that intends to see it enter service in 2035.
According to the joint statement by the three industrial partners, it "will be one of the world's most advanced, interoper-



Credit: P Felstead

able, adaptable and connected fighter jets in service, boasting an intelligent weapons system, a software-driven interactive cockpit, integrated sensors and a powerful next-generation radar capable of providing 10,000 times more data than current systems".

The programme "is hugely significant for the security, political and economic prosperity of each nation and through effective knowledge and technology transfer will help to evolve and deliver important sovereign combat air capability in each nation, for generations to come", the partners added.

The governments of the UK, Italy and Japan announced that they would jointly develop and deploy a next-generation fighter in December 2022, following this up with a treaty signed in Japan 12 months later.

"In the 18 months since the launch of the Global Combat Air Programme, we've been working closely with our industrial partners in Italy and Japan under the collaboration agreement, and also with the three governments, to understand and align requirements for a next-generation combat aircraft," Herman Claesen, managing director for Future Combat Air Systems at BAE Systems, was quoted as saying. "The new model, unveiled at Farnborough International Airshow, shows notable progress in the design and concepting of this future fighter jet. We'll continue to test and evolve the design, as we move closer towards the next phase of the programme."

"The pace of the programme is extraordinary, building on a solid foundation and industrial legacy in each country and government-led partnership," added Guglielmo Maviglia, chief Global Combat Air Programme officer for Leonardo. "Since the treaty was signed in December 2023, the programme has seen strong commitment from each partner. Each brings different, but complementary, qualities and requirements. We are now working closely together to exchange knowledge, address common challenges and achieve common goals. The programme is immensely important for Italy, for Leonardo, including our UK-based business, and for wider Italian industry. GCAP represents the future of combat air in a system-of-systems perspective for our generations to come."

Hitoshi Shiraishi, senior fellow for GCAP at Mitsubishi Heavy Industries, stated, "MHI considers any project to be a valuable opportunity to deepen our knowledge. In particular, since GCAP is a three-country joint development programme between Japan, UK and Italy, we expect to obtain better results and deeper knowledge than ever before by combining the different cultures, experiences and knowledge of the three industries involved. I also hope that this GCAP programme, with the broad participation of Japan's defence companies, will foster innovation in the country's industrial sector such as digital transformation, as well as the development of human resources in the field of science and technology."

Ukrainians claim sinking of Russian 'Kilo'-class submarine in Sevastopol

(pf) The Ukrainian armed forces claim to have sunk the Russian Black Sea Fleet 'Kilo'-class submarine *Rostov-on-Don*.

Social media posts by the Ukrainian Armed Forces General Staff on 3 August 2024 say *Rostov-on-Don* was "successfully struck" in the Crimean port of Sevastopol on 2 August and "sank on the spot". Four Russian S-400 surface-to-air missile launchers in Crimea were also claimed to have been significantly damaged.

Credit: Ukr AF Gen Staff

What was used to sink *Rostov-on-Don* was not explicitly mentioned, but it is presumed to have been a missile. The Ukrainian General Staff's Facebook account noted that, prior to the attack that sank it, the boat was significantly damaged by a Ukrainian missile strike on 13 September 2023.

"It was further repaired and tested in the [waters around] Sevastopol harbour," the Ukrainian General Staff stated, adding, "The cost of the submarine is estimated at USD 300 million. The destruction of *Rostov-on-Don* once again proves that there is no safe place for the Russian fleet in Ukrainian territorial waters of the Black Sea."

Rostov-on-Don was an Improved 'Kilo'-class (Project 636) diesel-electric patrol submarine that was commissioned in De-

cember 2014. The boat was 73.8 m long and displaced 3,076 tonnes when dived.
The submarine presented a valuable target to the Ukrainian armed forces due to its ability to launch 3M-14 Kalibr land attack missiles out to ranges of 1,500 km or further (the maximum ranges of Kalibr missile variants have not been firmly established).
Through missile attacks and the employment of bomb-laden MAGURA V5 unmanned surface vessels, the Ukrainian armed forces have sunk several major surface vessels of Russia's Black Sea Fleet, severely curtailing its ability to operate out of Crimea. The second attack on Rostov-on-Don, however, is the Black Sea Fleet's first submarine casualty.

Netherlands and Austria place joint order for nine Embraer C-390s

(pf) During a ceremony at the Farnborough International Airshow (FIA) on 22 July 2024 the Dutch Ministry of Defence signed a contract for the acquisition of nine C-390 Millennium tanker/transport aircraft. The contract relates to a joint purchase in co-operation with Austria that will see five aircraft go to the Royal Netherlands Air Force RNLAF) and four to the Austrian Air Force, with deliveries beginning in 2027.
Acquisition of C-390s will allow both countries to increase their ability to rapidly deploy or evacuate equipment and personnel

Credit: Embraer

worldwide, with Embraer noting in a press release that "the enhanced tactical airlift capacity provided by the C-390 increases operational flexibility and responsiveness, provides logistical support in various missions and operations, and enables a wide range of humanitarian and medical tasks".
The joint purchase will also allow both nations – as well as current and future European operators – to co-operate and benefit from synergies in areas like training, logistics and future growth of the platform.
The C-390 entered service with the Brazilian Air Force in 2019, but five were also ordered by Portugal in 2019 (the first of which was delivered to Portugal in February 2023), while Hungary ordered two in November 2020.
The C-390 is also contending with the Lockheed Martin C-130J for a tanker/transport requirement in Sweden, where the Swedish Air Force has an urgent need to replace its five C-130H Hercules (Tp84) transport aircraft and one KC-130H (Tp84T) tanker, while the Czech Republic announced its intention to buy two of the type in October 2023.
South Korea became the first Asian customer for the C-390 when it ordered three in December 2023.
With air-to-air refuelling equipment installed, in which case the aircraft is designated the KC-390, the Millennium can be configured both as a tanker and as a receiver. While the Dutch aircraft will be configured as both tankers and receivers, Austria's aircraft will just be configured as receivers.
"It is great that we can sign this agreement for both Austria as the Netherlands," added Vice-Admiral Jan Willem Hartman, National Armaments Director of the Netherlands. "This is a good example of collaboration in Europe between countries. The constructive support of Embraer has played a crucial role in the successful realisation of this agreement. We appreciate the contribution of Embraer and look forward to a successful co-operation."
According to Embraer, the current worldwide C-390 fleet has accumulated more than 13,000 flight hours, achieving a mission capable rate of 93% and mission completion rates above 99%.
"The C-390 can carry more payload [26 tonnes] compared to other medium-sized military transport aircraft and flies faster [870 km/h] and farther, being capable of performing a wide range of missions such as transporting and dropping cargo and troops, medical evacuation, search and rescue, firefighting, and humanitarian missions, operating on temporary or unpaved runways," the company states.

Poland signs LOA for 96 AH-64E Apache attack helicopters

Poland has signed a Foreign Military Sales (FMS) letter of offer and acceptance (LOA) for 96 AH-64E Apache attack helicopters as part of the Polish KRUK attack helicopter programme, manufacturer Boeing announced on 13 August 2024.
Poland selected the AH-64E Apache for the Polish armed forces' new attack helicopter fleet in September 2022. The US Defense Security Co-operation Agency announced on 21 August 2023 that the US State Department had approved the FMS to Poland

Credit: Polish MND

covering the 96 AH-64Es. The FMS deal, worth an estimated USD 12 billion (EUR 11.1 billion), also included 18 spare T700-GE 701D powerplants as well as numerous avionics systems and weapons.
The LOA comes a week after the Polish Ministry of National Defence (MND) announced an offset agreement with Boeing. The agreement includes maintenance and support of the Polish fleet of Apaches by the Polish defence industry along with the establishment of training programmes and support for the development of a composite laboratory.
The offset projects aim to enhance the sustainment capabilities of the Polish defence industry, support the creation of highly skilled jobs and facilitate technological advancements, leading to significant economic benefits, according to Boeing.
"Poland's commitment to procure 96 aircraft represents the largest FMS order in the history of Boeing's Vertical Lift division and will not only make Poland our 19th global Apache customer but the largest operator outside of the United States," stated Kathleen Jolivette, Boeing's vice president and general manager for vertical lift programmes.
Boeing noted that it has been building the AH-64 Apache for more than 40 years in Mesa, Arizona, adding that there are currently more than 1,290 Apaches operating worldwide, with sustainment and training support provided by Boeing Global Services.

Austria proceeds with purchase of a dozen UH-60M Black Hawks

(pf) Austria has proceeded with a EUR 715 million contract to buy 12 UH-60M Black Hawk helicopters from Lockheed Martin (Sikorsky) under the US Foreign Military Sales (FMS) construct, with deliveries to begin from 2028.

Credit: US Army

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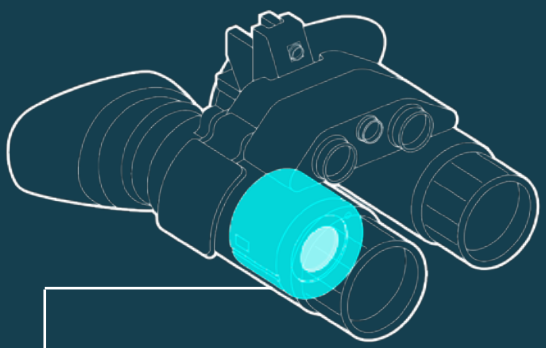

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The 4G+ technology is designed to meet the highest standards and meet the demanding requirements of land forces.

Credit: Boeing

The contract was signed on 30 June 2024, with Austrian Defence Minister Klaudia Tanner quoted in local media reports as saying, "With the purchase of the UH-60M Black Hawk helicopters, we are making significant progress in improving our operational capability. These versatile aircraft make a significant contribution to increasing the safety of our soldiers.

"They will be invaluable to us in a wide range of operational scenarios, particularly in challenging mountainous regions and under extreme weather conditions," Tanner added. "With this investment, we are taking another decisive step to ensure the operational readiness of our armed forces and to sustainably increase safety. We are proud to invest in the future of our Federal Army and to provide soldiers with the best possible resources."

The Austian FMS deal, which was announced as approved by the US Defense Security Cooperation Agency on 29 May 2024, covers 12 UH-60M Black Hawks; 26 T700-GE-701D engines (24 installed and two spares); numerous associated avionics, communications and mission systems; along with spares, technical publications and various aspects of logistics, training and programme support.

Since 2002 the Austrian Air Force has operated nine older S-70A Black Hawks, which have been modernised by the US company Ace Aeronautics, which in February 2019 received a direct commercial sale contract from the Austrian government to add another three similarly upgraded second-hand Black Hawks to the Austrian fleet.

The 12 UH-60Ms just ordered will thus double the size of the Austrian Air Force's Black Hawk fleet. The new aircraft will replace the Austrian Air Force's fleet of 23 Agusta-Bell AB212 helicopters, which, having been in service since 1980, will be phased out by the end of the decade.

Boeing and USAF definitise contract for two rapid-prototype E-7A AEW&C aircraft

(pf) The US Department of the Air Force has successfully negotiated a price agreement with Boeing for the E-7A Wedgetail airborne early warning and control (AEW&C) aircraft rapid prototype programme, the air force announced on 9 August 2024.

Boeing added in a press release the same day that the contract includes lifecycle development, training and support for the US Air Force's (USAF's) E-7A fleet.

The agreement paves the way for the delivery of two operationally representative prototype E-7A platforms.

"The undefinitized contract action has now been definitized, with a total contract value of USD 2,560,846,860 [EUR 2.34 billion]," the Department of the Air Force stated on its website.

"This agreement is a significant win for our warfighters, paving the way for ensuring the air force's ability to provide advanced airborne moving-target indication in the coming years," Assistant Secretary of the Air Force for Acquisition, Technology, and Logistics Andrew Hunter was quoted as saying. "It is also an exemplar of our ability to leverage and support the expertise and investments of our partners and allies to support our common security objectives."

The rapid prototyping programme integrates US-based mission systems into existing E-7 airborne platforms to meet USAF requirements while simultaneously ensuring interoperability with coalition partners already operating the E-7 platform.

The E-7A provides advanced airborne battle management command-and-control and airborne moving-target indication (BMC2/AMTI) capabilities. Its multi-role advanced electronically scanned-array (AESA) radar "will enhance airborne battle management, providing improved situational awareness and enabling long-range kill chains with potential peer adversaries", the Department of the Air Force stated.

Built on the Boeing 737-700 NG airframe, the E-7 AEW&C aircraft offers lower operating and sustainment costs, higher mission readiness rates and unmatched interoperability among a growing global user community, according to Boeing.

Boeing has supplied six E-7As to the Royal Australian Air Force and is currently producing three E-7As for the UK Royal Air Force (with military modifications underway in the UK), while NATO has also selected the type as its preferred AEW&C solution.

Until the E-7A is fielded, the USAF will continue relying on the E-3 Airborne Warning And Control System (AWACS) platform, "as ongoing E-3 modernization efforts meet the 2022 National Defense Strategy intent", the USAF stated. The E-3 will continue with worldwide BMC2/AMTI operations as required by the USAF and the US Department of Defense.

The E-7A rapid prototyping programme is intended to inform a planned production decision in financial year 2026 (FY26). The two operationally representative prototype aircraft are planned to be delivered in FY28.

Sweden proceeds with FMS purchase of another dozen UH-60M Black Hawks

(pf) The Swedish Defence Materiel Administration (FMV) announced on 10 July 2024 that it had proceeded with an order for 12 Lockheed Martin/Sikorsky UH-60M Black Hawk helicopters under the US Foreign Military Sales (FMS) construct.

Credit: USMC

The US Defense Security Cooperation Agency (DSCA) announced that the US State Department had approved the sale on 29 May 2024. The DSCA valued the deal, which includes 30 T700-GE-701D engines (24 installed and six spares) and numerous associated avionics, communications and mission systems, at USD 900 million (EUR 825 million).

The UH-60M Black Hawk, which is designated the Hkp16A in Swedish Air Force (SwAF) service, was first acquired by Sweden in 2011, when 15 examples were ordered for the SwAF. Among their first assignments was conducting medical transport missions during Swedish operations in Afghanistan.

"The procurement of more helicopters is in line with [the supreme commander's] military advice to the government and the Defense Committee's report on strengthened defence capabilities for Sweden as an ally," Michael Stolpen, head of unit at the FMV, was quoted as saying in a press release by the organisation.

The 12 new UH-60Ms are likely to replace at least some of the SwAF's fleet of 13 NH90 tactical troop transport/search-and-rescue (Hkp14A) helicopters and five search-and-rescue/anti-submarine warfare (Hkp14B) helicopters.

Deliveries of the new Black Hawks to Sweden "will be carried out continuously for several years", according to the FMV.

Kelly Ortberg steps into the hot seat as Boeing's new CEO


Credit: Boeing

(pf) Boeing announced on 31 July 2024 that its board of directors had elected Robert K 'Kelly' Ortberg as the company's new president and chief executive officer (CEO), effective from 8 August.

Ortberg, who will also serve on Boeing's board of directors, succeeds Dave Calhoun, who earlier this year announced his intention to retire from the company, having served as president and CEO since January 2020 and as a member of Boeing's board of directors since 2009.

"The Board conducted a thorough and extensive search process over the last several months to select the next CEO of Boeing and Kelly has the right skills and experience to lead Boeing in its next chapter," Steven Mollenkopf, Chair of the Board, was quoted as saying in a Boeing press release. "Kelly is an experienced leader who is deeply respected in the aerospace industry, with a well-earned reputation for building strong teams and running complex engineering and manufacturing companies. We look forward to working with him as he leads Boeing through this consequential period in its long history.

"The Board would also like to thank Dave Calhoun for his strong leadership at Boeing, first as chair and then as CEO, when he stepped in to steer the company through the challenges of recent years," added Mollenkopf.

Those "challenges" have seen Boeing dealing with issues on both the military and civilian side of the business. On 31 July 2024 Boeing recorded second-quarter revenue of USD 16.9 billion (EUR 15.48 billion), generally accepted accounting principle (GAAP) loss per share of USD 2.33 and core loss per share (non-GAAP) of USD 2.90. Boeing stated with the release of those financials that the results "primarily reflect lower commercial delivery volume and losses on fixed-price defense development programs".

For Boeing's Defense, Space & Security business second-quarter revenue was USD 6.0 billion.

"Second-quarter operating margin of 15.2% primarily reflects USD 1.0 billion of losses on certain fixed-price development programs, including a USD 391 million loss on the KC-46A programme largely driven by a slowdown of commercial production and supply chain constraints. Losses recorded on the T-7A, VC-25B and Commercial Crew programs reflect higher estimated engineering and manufacturing costs, as well as technical challenges," Boeing stated.

Core among Boeing's problems on the military side have been issues with the US Air Force's (USAF's) KC-46A Pegasus aerial refuelling tanker, which have led to charges that have already exceeded USD 7 billion on the fixed-price-contract programme.

On the civilian side Boeing has suffered from years of safety issues after two Boeing 737 Max airliners crashed in 2018 and 2019, killing 346 people. Then, on 5 January 2024 a mid-exit door (MED) plug of an Alaska Airlines Boeing 737 Max 9 blew out in mid-flight, forcing an emergency landing.

As a response to that incident Boeing on 30 May submitted a Safety and Quality Plan to the US Federal Aviation Administration (FAA) designed to address what the FAA had called "systemic quality-control issues".

Boeing's renewed focus on safety also led the company to declare on 1 July that it had entered into a definitive agreement to acquire Spirit AeroSystems, which was founded in 2005 when Boeing sold its Wichita division and Oklahoma operations, thus bringing Spirit's Boeing-related work back under direct control.

On the military side, meanwhile, Boeing is betting big on a new 1.1 million square-foot factory to support future combat aircraft programmes on which ground was broken at the turn of the year. Expected to be completed in 2026, the USD 1.8 billion factory, which will nearly double the company's manufacturing footprint at its site near St Louis Lambert International Airport, is intended to revolutionise how military aircraft are designed, built and delivered by Boeing by employing state-of-the-art digital tools and advanced manufacturing techniques.

The most obvious driver for the new facility is the USAF's Next Generation Air Dominance (NGAD) programme. However, while the USAF released a request for proposals for an NGAD engineering and manufacturing development contract in May 2023, with an expected contract award in 2024, that is yet to happen.

As Boeing's new CEO, Ortberg will thus need to ensure the company's Safety and Quality Plan sticks, with a near-religious adherence to quality control, while on the military side overseeing the gaining of new business that offsets the losses caused by Boeing's errant fixed-price contract programmes.

Former Dutch PM Mark Rutte to become new NATO chief from October


Credit: EU

(pf) On 26 June 2024 the North Atlantic Council decided to appoint Dutch Prime Minister Mark Rutte as the next secretary general of NATO, succeeding Jens Stoltenberg. Ambassadors from the alliance's 32 members took the decision at a meeting at NATO headquarters in Brussels.

Rutte will assume his functions as secretary general from 1 October 2024, when Stoltenberg's term expires after 10 years at the helm of the alliance.

The appointment became a formality after his only rival for the post, Romanian President Klaus Iohannis, announced the previous week that he had withdrawn his candidacy, having failed to gain traction.

Rutte, a staunch ally of Ukraine and outspoken critic of Russian President Vladimir Putin, takes the helm of NATO at a challenging time. As well as dealing with the alliance's response to the Russian invasion of Ukraine, NATO also faces the possibility of a second tumultuous period with Donald Trump as the US president. If Trump is elected president in November, then military support for Ukraine is likely to fall much more heavily on NATO's European members

As well as being the longest-serving Dutch prime minister after a 14-year tenure, Rutte is known for cycling to work (he left the prime minister's residence on 2 July, his last day in office, riding a bike), also taught sociology on Thursday mornings at the Johan de Witt College: a secondary school in The Hague.

Stoltenberg said of his successor, "Mark is a true trans-Atlanticist, a strong leader, and a consensus-builder. I wish him every success as we continue to strengthen NATO for the challenges of today and tomorrow. I know I am leaving NATO in good hands."

Poland's future armed forces take shape

Robert Czulda

In recent years, Poland has launched the largest modernisation programme for its armed forces in history. However, not all widely publicised announcements have resulted in binding orders. Impending financial difficulties also raise doubts about these ambitious plans.

In July 2024, Deputy Minister of National Defence Paweł Bejda stated that it was his "dream" for Poland's defence budget to increase to 5% of the country's GDP. According to official statistics, Poland is already spending 4% of its GDP on defence, with 3% from the Ministry of National Defence's budget and 1% from the Armed Forces Support Fund (FWSZ). In 2023, a total of EUR 25.8 billion was allocated to defence, which is 51% more than in 2022. Nevertheless, Tomasz Dmitruk from *Dziennik Zbrojny* notes that this amounts only to 3.26% of GDP, less than the official data. In 2022, real defence spending was 2.39% of GDP. In 2023, EUR 6.7 billion was spent on Technical Modernisation Plan (PMT) expenditures and EUR 1.1 billion on construction investments.

In 2024, approximately 150 contracts are planned to be signed. Among the priorities are JASSM-ER air-launched cruise missiles, AH-64 Apache attack helicopters, multi-role and support helicopters, F-16 aircraft modernisation, additional K2 tanks with ammunition, Pilica air defence systems, unmanned reconnaissance and strike systems, satellite terminals, light reconnaissance transporters under the Kleszcz programme, and light radios. The implementation of air defence programmes such as Wisła, Narew, Mała Narew, and Pilica+ is to be accelerated. A priority is also to build satellite capabilities from scratch; the Satellite Operations Centre is expected to achieve full operational readiness in 2024. The Cyber Defence Forces, which currently number around 6,500 personnel (including civilians), are also being expanded.

Author

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Credit: Polish MoND

According to official data, the Polish Armed Forces now comprise 198,000 soldiers, including 130,000 professional soldiers. Additionally, Poland hosts approximately 16,000 troops from Allied nations.

Regarding the aforementioned FWSZ, it is an additional instrument for financing the armed forces, outside the Ministry of National Defence budget. This fund is managed by Bank Gospodarstwa Krajowego, created by the Homeland Defence Act of March 2022, replacing the Armed Forces Modernization Fund (FMSZ). As noted by Tomasz Dmitruk, the financial plan of the FWSZ is classified, but it is estimated that it was funded to the tune of EUR 7.3 billion in 2023.

Manpower

According to official data, the Polish Armed Forces now comprise 198,000 soldiers, including 130,000 professional soldiers. Additionally, Poland hosts approximately 16,000 troops from Allied nations. The military is currently expanding further, as Poland is creating a sixth division, a decision announced in November 2023. This unit, named the 8th Infantry Division of the Home Army, will have its headquarters in Nowe Miasto nad Pilicą, with its units deployed across four voivodeships (provinces). It will be composed of two mechanised brigades, a motorised brigade, and an armoured brigade. Additionally, the 8th Infantry Division will include an artillery brigade, a logistics regiment, an anti-tank regiment, an anti-aircraft regiment, a command battalion, a reconnaissance battalion, and a chemical battalion.

Despite various challenges, the expansion of the Territorial Defence Forces (WOT) continues, which currently number around 35,000 soldiers. This year, they are expected to reach 20 brigades, including two so-called Border Protection Brigades. Within the operational forces, Poland is still forming a fifth division (the 1st Legion Infantry Division) with four brigades in a controversial move, since existing formations already face equipment and personnel shortages. Forming the 18th Mechanised Division in 2018 was challenging due to the transfer of already existing units.

These actions align with the previous government's plan to create a 300,000-strong armed force. The current government is less enthusiastic about this idea, as are many experts who believe that the army is already

Credit: Polish MoND

One of the main issues facing the Polish Armed Forces is a shortage of manpower. Modernisation efforts require experts who are currently lacking. Additionally, it is unclear where to find new recruits for the units that are being formed.

too large given limitations in appropriate equipment. It also lacks proper command and control (C2) systems, training, material reserves, and logistics. Critics draw an analogy to 1939 when Poland numerically had a large army, but low combat effectiveness.

While the Polish military is now the largest in Europe and the third- largest in NATO (behind the USA and Türkiye) in terms of personnel, it ranks 22nd in terms of spending per soldier. Although Poland invests substantial sums in its armed forces, soldiers face shortages of personal equipment. Many are forced to use worn-out gear, including old uniforms and helmets. Some soldiers even purchase the necessary items themselves, including those serving at the border. To address this, Operation Szpej (Gear) has been initiated. Under this initiative, new uniforms with effective camouflage, new bullet-resistant vests, composite helmets, Grot rifles, VIS 100 pistols, sights, night vision goggles, gas masks, and protective filtration clothing are to be ordered. The first phase is scheduled to be completed by December 2024.

Armoured units

In recent years, Poland has made significant investments in its armoured forces in response to the rising threat from Russia and a decision by the previous government to donate dozens of main battle tanks (MBTs) to Ukraine. Between 250–300 T-72M1/M1Rs, 14 Leopard 2A4s, and up to 80 PT-91 Twardy tanks were given to Ukraine. Poland has ordered 180 South Korean K2 tanks and 366 Abrams tanks (116 ex-USMC M1A1 FEP and 250 new M1A2 SEPv3 tanks, along with 26 M88A2 recovery vehicles and 17 M1074 bridge-layers). Both the Abrams and K2 tanks are intended to become the

Credit: Polish MoND

Polish Krab and Abrams tanks are part of the defence modernisation efforts. Despite official statements, Poland does not allocate 4% of its budget to defence. Significant financial challenges loom on the horizon, which may impact costly modernisation programmes.

country's primary MBTs shortly, since all Soviet-era tanks are to be retired as soon as possible. The Leopard 2 tanks (2A4, 2A5, 2PL—247 in total by 2026) are expected to meet the same fate, albeit much later, and some of these tanks will likely go into reserve. The overall framework agreement covers the acquisition of 1,366 MBTs in total. Despite industrial problems and severe delays, a modernisation programme for the Leopard 2 tanks to the Leopard 2PL standard is ongoing. The current plan is for the last modernised Leopard 2s to be delivered to the army by 2027, seven years after the originally scheduled date.

Regarding the K2 tanks, deliveries are planned to be completed in 2025. The value of the contract, including training and logistics packages, amounts to EUR 3 billion. However, in July 2024, it was revealed that negotiations are underway for a second contract for 180 tanks, expected to be signed in September 2024. Some of these tanks are to be produced in Poland. All M1A1FEPs have already been delivered, while the SEPv3s are to be handed over in 2025–2026. The contract for the SEPv3s is worth approximately EUR 4.66 billion, including training, logistic support, and ammunition.

In reality, the future shape of the Polish armoured units remains a mystery. Apart from uncertainties related to the Leopard 2 tanks, Poland has not yet agreed on the details of its planned local production of K2 tanks from South Korea. The final configuration of the K2PL variant is also unknown. The potential involvement of Poland in the K3 tank project, which is expected to feature a 130 mm gun and an unmanned turret, also remains unclear, though Poland has been invited to participate in this programme. According to initial plans, at least 500 K2PLs are expected to be produced by the Military Automotive Works in Poznań (WZM). Other companies, including the original partner for Hyundai Rotem in Poland, namely H. Cegielski-Poznań (HCP), will also be involved in the process.

Infantry vehicles

A flagship modernisation project intended to shape Poland's future land forces is the Borsuk infantry fighting vehicle (IFV), designed to ultimately replace the ageing BWP-1s (the local name for Soviet-era BMP-1s). Polish mechanised battalions are still equipped with these antiquated vehicles, although some have been donated to Ukraine. The first batch of BMP-1s arrived in Poland in 1974 as a

Credit: RecoMonkey

Borsuk IFV on display at Eurosatory 2024. Seventeen mechanised battalions of the Polish Land Forces (Wojska Lądowe) are expected to receive up to 588 Borsuks in the AIFV configuration by 2035. This means it will take some time before all BWP-1s are retired.

Credit: Polish MoND

The purchase of K9 self-propelled howitzers was a controversial procurement decision in Poland, given that Polish industry had already developed the highly effective Krab SPH. Ultimately, Poland plans to acquire a total of 364 K9A1/A2 howitzers.

replacement for the Polish-Czechoslovak 8×8 wheeled OT-64 Skot APCs. They were never upgraded in Poland and are now decidedly obsolete.

The Borsuk (Badger) was designed and is planned to be manufactured by Huta Stalowa Wola (HSW). It will serve alongside the Rosomak 8×8 wheeled multi-role armoured fighting vehicles (a licence-produced version of Patria's AMV design). Both vehicles are expected to be equipped with the ZSSW-30 (Zdalnie Sterowany System Wieżowy; ENG: remotely controlled turret system), which is jointly produced by WB Electronics and HSW. The main armament of the ZSSW is the Northrop Grumman Mk44 Bushmaster II 30 mm cannon, complemented by a co-axial UKM-2000C 7.62 mm gun and two Rafael Spike-LR2 ATGMs. After years of delays, the first ZSSW-30, mounted on the Rosomak, was test-fired by soldiers from the 21st Podhale Rifles Brigade (18th Mechanised Division) in January 2024. The first batch of Rosomaks with ZSSW-30 was delivered to this unit in December 2023. So far, the Armament Agency has signed a framework agreement for 341 turrets with ZSSW-30 for the Rosomak. An executive agreement worth EUR 396 million was signed for 70 ZSSW-30 turrets for the Rosomak, and the first batch of Rosomaks fitted with the ZSSW-30 is already in operational service.

Seventeen mechanised battalions of the Polish Land Forces (Wojska Lądowe) are expected to receive up to 588 Borsuks in the IFV configuration by 2035. This means it will take some time before all BWP-1s are retired. However, the vehicle is still in the testing phase, and an executive deal has yet to be signed. A framework deal for 1,014 IFVs and an additional 341 specialist variant vehicles was signed between the Armament Agency and PGZ in February 2024. It was recently announced that the first order for Borsuks is to be signed by November 2024 at the latest. The vehicle will be entirely produced in Poland by the local defence industry. Poland also wants to acquire heavier IFVs. While the lighter Borsuk is planned to cooperate with K2/K2PL and Leopard 2A5/2PL tanks, a new heavy IFV is planned to operate alongside M1A1FEP/A2 SEPv3 Abrams tanks.

Regarding the Rosomaks, these vehicles will continue to serve in the Polish Army for a considerable length of time, though decisions regarding a potential mid-life upgrade (MLU) will need to be made eventually. In July 2024, the Armament Agency signed a contract with PGZ for the delivery of 58 Rosomaks with ZSSW-30 turrets. This executive deal is worth EUR 605 million, and deliveries are planned between 2026–2027. These vehicles will not only be armed with the ZSSW-30 but will also receive new engines—replacing the Scania DI12 with the Scania DC13. Negotiations are also ongoing for another batch of 174 Rosomaks with ZSSW-30, with rumours that these turrets might receive different ATGMs to the Spike-LR2. At the same time, deliveries of five M120K Rak company-level 8×8 wheeled self-propelled mortars (based on the Rosomak platform) are ongoing, with completion expected in 2024. According to Defence24, the Polish Armament Agency is also negotiating a contract for 250–400 Rosomak-Ls (a longer variant with several enhancements).

Artillery

As a result of donating some of its indigenously-designed and manufactured (by HSW) Krab 155 mm self-propelled howitzers (SPHs), as well as due to modernisation plans, Poland made the controversial decision to purchase K9 SPHs from South Korea. So far, 72 out of the 218 ordered K9A1s have been delivered. From 2026–2027, 146 K9A2s are expected to arrive. Simultaneously, the Polish Army continues to receive additional Krab howitzers, with a total order of 170. The Polish defence industry hopes for more Krab orders to be placed.

Poland has already received 18 out of 20 M142 HIMARS units and 30 out of 290 modules for the K239 Chunmoo launchers (the latter under the Homar-K project). The latter will be based on the Polish Jelcz chassis and will feature the Polish WB Group Topaz automated fire control and battle management system. A deal worth EUR 4.36 billion was signed in early November 2022 between the Polish Armament Agency and Hanwha Aerospace. Under the current contract, 218 systems are to be delivered, which also includes training and logistics. Poland will also receive "several thousand" missiles of two types: 239 mm (with a range of 80 km) and 290 mm (with a range of 290 km). Deliveries are planned from 2023–2029.

The Homar-K launchers will significantly enhance Poland's artillery capabilities. Current Polish Army artillery systems, such as the Krab 155 mm SPHs and the WR-40 Langusta wheeled MRLs, do not use guided munitions and have a range of only about 40 km (Poland's 9K79 Toc-

zka tactical ballistic missiles were retired in 2005). To fully utilise the K239 Chunmoo's long-range strike capabilities, Poland will need to either develop its own reconnaissance and targeting capabilities or cooperate closely with its allies.

Air/missile defence

In 2023 and 2024, contracts were signed for the delivery of launchers and missiles for PATRIOT air defence systems under Phase II of the Wisła programme (medium range), the Integrated Battle Command System (IBCS), as well as launchers and missiles for the CAMM-ER-based Narew system (medium range). The first two batteries of the Wisła system are expected to achieve initial operational capability (IOC) in 2024. Deliveries of the first two batteries under Phase II are scheduled to occur between late 2026 and early 2027, with completion planned for 2029. IBCS will be used by both Wisła and Narew. In terms of Narew, the Polish defence industry is expected to deliver over 1,000 MBDA CAMM-ER missiles and approximately 138 launchers. This system will intercept various air targets at altitudes up to 20 km and ranges up to 45 km. Poland plans to field 23 batteries (each comprising two battery fire units of three launchers each, for a total of 46 battery fire units) with deliveries scheduled from 2027 to 2035.

In December 2023, Poland received the last batch of the Pilica very short-range air defence (VSHORAD) programme (six systems, each composed of six ZU-23-2 23 mm automatic cannons and Grom/Piorun missiles). In 2022, the Ministry of National Defence (MON) launched a plan to upgrade Pilica to the Pilica+ standard. The existing Pilica systems will be supplemented with launchers for CAMM missiles, extending the maximum engagement range from the present 5.5/6.5 km (respectively depending on whether Grom/Piorun is used) out to 25 km, and the total number of sets will increase from six to 22. Poland is still awaiting deliveries of four Barbara aerostats and 24 early warning P-18PL radars. Additionally, 12 Raytheon LTAMDS Ghosteye radars have been acquired for the PATRIOT system and 22 Polish-made Bystra radars for the Pilica+ system.

Aviation

Poland has received all 12 KAI FA-50 Block 10 (known as KA-50GF in Polish service) light combat training aircraft; this variant was deployed to the 23rd Tactical Airbase in Mińsk Mazowiecki, which has been operating MiG-29s. This is a temporary solution until Poland can introduce the better-armed and equipped FA-50PL into service. This purchase, one of the most controversial among recent orders from South Korea, is expected to enable the Polish Air Force to phase out its Soviet-era MiG-29s and Su-22s. Operationally, the FA-50s will be used for training and to replace F-16C/Ds in some duties, primarily peace-time air-policing. A total of 48 jets are to be procured including the 12 FA-50GF, and 36 FA-50 Block 20 (known as FA-50PL in Polish service). Ultimately, the initial batch of 12 FA-50GF are planned to be upgraded to the FA-50PL standard, featuring an AESA radar, and armed with AIM-9X Sidewinder, and AIM-120 AMRAAM missiles. This is KAI's largest export order ever. Deliveries and modernisation of GFs are expected to be carried out between 2025-2028.

Poland is awaiting the delivery of 36 F-35A aircraft, which were ordered in January 2020 for USD 4.6 billion. Deliveries are planned for 2026–2030. Meanwhile, Poland ordered two used ex-UAE Saab 340 AEW early warning aircraft equipped with PS-890 ERIEYE airborne radars. Although these aircraft are second-hand, they undoubtedly represent a significant capability enhancement as they are the first of their kind to serve in the Polish Air Force. While this is good news, there is some disappointment in Poland, as many hoped the government would procure newer and more advanced systems. Although the Ministry of National Defence assures that this is only an interim solution, many commentators fear that the Saab 340 will be the only aircraft of this class Poland will acquire in the coming years.

Poland is expected to procure more combat jets. According to the previous government's plans, the Polish Air Force aims to establish two additional combat squadrons. There has been speculation that Poland could acquire the Boeing F-15EX Eagle II, but the procurement of F-16C/D Block 72 cannot be ruled out. For its part, Leonardo has been promoting the Eurofighter Typhoon. New F-16s could be used alongside the F-16C/D Block 52+, which will likely be upgraded to Block 72 standard in the coming years. Purchasing additional F-16s would therefore not pose logistical challenges.

Credit: Polish MoND

The first FA-50GF for Poland. Following the contract signing in September 2022, the entire batch of 12 aircraft was delivered in 2023.

Poland has also been modernising with various UAVs. The list includes 24 Bayraktar TB2s. The fourth and final batch was handed over to the 12th UAV Base in Mirosławiec in May 2024. Poland has also been leasing one set of MQ-9A Reapers and has procured at least 168 FlyEye UAVs, with a requirement for 400 by 2035 for the latter.

Regarding rotary-wing aircraft, Poland has received six out of eight ordered S-70i helicopters for the Special Forces, three out of four AW101 aircraft for the Navy (for SAR and ASW duties), and four out of 32 AW149 units for the air cavalry. The AH-64E Apache attack helicopters have not yet been ordered. Poland also plans to purchase 24 new training helicopters.

The Navy

A flagship modernisation project is the Miecznik (Swordfish) programme, which aims to elevate both the Polish Navy and local defence industry. This project involves the construction of frigates based on the British Arrowhead 140 (Type 31) design, which was developed by Babcock and has already been ordered by Indonesia and the Royal Navy. Construction of the first of the three ordered frigates is currently underway, with all deliveries expected to be complete by 2031. The contract, signed in 2021, is the largest order in the history of the Polish defence industry. These frigates are anticipated to become the backbone of the Polish Navy.

Additionally, three out of six Kormoran II minehunters (Project 258) have been delivered. The fourth has already been launched by Remontowa Shipbuilding. The issue of submarines remains unresolved, as Poland currently has only one submarine, commissioned in 1986. Due to a lack of technological and industrial capabilities in this area, Poland must decide to purchase submarines from foreign suppliers.

Credit: PGZ/Babcock

The Polish Navy will receive a boost with the addition of three frigates, based on the British Arrowhead 140 (Type 31) design. These frigates will be equipped with Mk 41 launchers capable of carrying CAMM family missiles, with a total of 32 tubes accommodating up to 128 CAMM/CAMM-ER missiles.

Future challenges

One of the primary challenges facing Poland is financial constraints. The country has adopted overly ambitious modernisation plans, partially driven by internal political calculations and attempts to gain voter popularity. In reality, however, there will not be enough funds to finance all these projects. Delays in some projects and the absence of executive agreements vividly illustrate this issue. Poland must not only find money to purchase specific weaponry but also to implement and maintain it for many years.

"Previous Defence Minister Błaszczak did not secure funding for infrastructure, for instance," noted Deputy Minister Bejda. "These are crucial elements accompanying the orders, which also need to be financed and built." The current government estimates that the previous administration's financial shortfall for ongoing projects amounts to approximately EUR 14 billion.

In June 2024, Poland was listed by the European Commission as one of 12 countries with excessive deficits (over 3% of GDP or public debt exceeding 60% of GDP). The Polish government argues that this is due to increased defence spending. While this is considered a mitigating factor by Brussels, according to EU methodology, military expenditures are accounted for not at the time of payment but at the time of delivery. According to the European Commission's report, Poland's defence spending is expected to double over the next four years.

The government has adopted a deficit reduction plan aiming to lower the deficit to 4.1% of GDP by 2025. This means that Poland will most likely have to cut internal expenditure and revise its defence plans. ■

The changing face of Eastern European armour

Chris Mulvihill

The article aims to cover the nations in Central and Eastern Europe that have begun or are about to begin upgrading or procuring new vehicles for their armoured vehicle fleets. While many of these efforts are a direct consequence of the War in Ukraine, some programmes are the result of timely actions that are beginning to bear fruit.

The strategic situation in Eastern Europe has prompted both renewal and expansion, with several nations procuring new equipment to replace legacy armoured vehicle fleets and increase the number of formations in their land armies. Industry offsets are essentially a standard requirement, with most nations requiring some level of domestic production and development within the purchasing country.

There are also opportunities to benefit from surplus equipment mothballed by Western forces, which could be purchased at reduced rates or even donated entirely. Many of these older-generation vehicles still offer substantial capabilities compared to the archaic fleets still in service in Eastern Europe.

Given the number of programmes emerging from both major and minor NATO powers in Eastern Europe, the 2020s may prove to be as important a decade for rearmament as the 1990s, when the Bundeswehr exported large amounts of excess equipment to Southern Europe.

Credit: Czech MoD

Czech tankers training in a Leopard 2A4 in Germany in October 2022 ahead of the handover the following month. From inception to delivery, the 'Ringtausch' was remarkably efficient at delivering Leopard 2s in exchange for T-72s.

The T-72 is nearing extinction in Eastern Europe

The Leopard 2 has re-emerged as a dominant vehicle in the European tank market, particularly influencing the defence strategies of the Czech Republic, Hungary, and Slovakia. Germany's 'Ringtausch' policy, encouraging Eastern European nations to donate Soviet-era equipment to Ukraine in exchange for surplus German equipment, has been pivotal in reducing the percentage of Soviet-era equipment in Eastern European land armies. Two states utilised the policy to introduce a new tank type, the Leopard 2, into their tank fleet.

The Czech Republic received 14 Leopard 2A4 tanks and one BPz3 Büffel armoured recovery vehicle (ARV) as a gift for donating a number of T-72M1 tanks from their warehouses, with the deal concluded in August 2022. Nearly two years later, on 31 July 2024, the Czech MoD announced that under a second round of Ringtausch, the Czech Armed Forces would receive a further 14 Leopard 2A4 tanks and one BPz3 Büffel ARV, with the tanks slated for delivery by the end of April 2025 and the ARV by the beginning of 2026. For Prague, Ringtausch was a catalyst for the 73rd tank battalion of the Armáda České, with the lifespan of the T-72M4CZ already a subject of internal debate within the Czech Ministry of Defence particularly due to their ambition of establishing a battlegroup that should be fully interoperable with other NATO forces (a view shared in Slovakia). Issues with system obsolescence, particularly the tank's fire-control system, had already become apparent in the late-2010s. The T-72M1 in its basic configuration is still in limited active usage within the tank battalion, being used by the sole reserve tank company, and to some extent in the other three regular tank companies that require substitutes for mothballed T-72M4CZs.

Prague has already commenced a minor programme to revitalise the T-72M4CZ fleet by creating a mid-life upgrade. The upgrade primarily concerns replacing the antiquated fire-control system with a modern analogue, which will boost their gunnery. The first of these tanks are due in 2025, and it is hoped this will allow the T-72 to remain in service into the 2030s, initially serving alongside the Leopard 2A4s before retiring when a successor is procured in the required numbers.

In May 2023, Czech Defence Minister Jana Černochová announced the nation's intention to negotiate for the joint acquisition

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Credit: Czech MoD

The Czech T-72M4CZ is one of the better T-72 upgrades that has been put into service. Every aspect on the iron triangle (firepower, mobility, survivability) was addressed in a comprehensive modernisation. However, obsolescence has severely hampered availability rates for the tank.

with Germany of the Leopard 2A8. The ambition is for a contract of 61 Leopard 2A8s with an option for 16 additional tanks. If achieved, the transformation for the 73rd tank battalion will be profound. From a tank battalion that has 30 T-72M4CZ tanks at its disposal, with a reserve company of 13 T-72M1s, the 73rd will become a battalion with up to 77 Leopard 2A8 tanks and a further 42 Leopard 2A4 tanks, with the latter having the capability of being upgraded to later standards of the Leopard 2. Joining these will be three Büffel ARVs.

Reportedly, there may also be some industrial offsets should the Czech Republic choose to finalise the Leopard 2A8 deal. The Czechs and the Slovaks inherited a large and robust defence industry capable of producing large quantities of licence-produced tanks such as the T-72s in service with the Czech Army's 73rd tank battalion. Given that the Leopard 2A8 negotiations between KNDS Deutschland and Italy fell through, and their German rival Rheinmetall seems to be on a winning streak in Central and Eastern Europe, KNDS Deutschland may be more inclined to move production to the Czech Republic to strengthen their offer.

Slovakia has also been another recipient of Ringtausch Leopard 2A4s, receiving 15 tanks after donating 30 BVP-1s (the Czechoslovakian-produced variant of the BMP-1) to Ukraine. The Slovenské Ozbrojené Sily maintains a fleet of 30 T-72M1s which are unmodernised, unlike their Czech counterparts. Bratislava also inherited a well-developed defence industry, of which domestic modernisations have been offered in the past, including the T-72M2, which featured a new armour package and the usage of the 2A42 30 mm cannon as a secondary armament. These domestic upgrades never went beyond the demonstration phase due to a lack of funding, so the Slovakian 14th tank battalion has seen minimal investments aside from maintenance.

While Prague has already commenced negotiations to procure the Leopard 2A8 and is basing its future plans for the Czech tank forces around such a platform, the Slovaks have yet to begin a formal process to procure a new main battle tank. This is likely to change in the near future, with most countries, and more so those with a direct border with Ukraine, under increased domestic and external pressure to expand their arsenals. Given their similarities with the Czechs in receiving Leopard 2A4s and both nations maintaining close defence ties, there is a significant chance that Bratislava will follow Prague's path of procuring the Leopard 2A8 as their future tank platform.

Hungary is also transitioning its tank force from the T-72 to the Leopard 2. Unlike their northern neighbours, Budapest has not taken advantage of the Ringtausch and instead is benefitting from efforts made in the late-2010s to modernise its antiquated tank battalion.

In 2018, Hungary signed a contract with KNDS Deutschland for 44 Leopard 2A7HU tanks. According to plans presented by the Hungarian Szárazföldi Haderő (Ground Forces), Hungary will be able to field three companies of the Leopard 2A7HU and an additional company for the Leopard 2A4s under the 11th tank battalion based in Tata. Hungary expects the deliveries from KNDS Deutschland to be completed by the end of 2028, with additional support vehicles, including five Wisent 2 armoured engineering vehicles and three Leguan 2 armoured vehicle-launched bridges (AVLBs) also included in the contract.

The Hungarians are thus leading the wave of new Leopard 2 users in Europe, and they could provide lessons to The Czech Republic and Slovakia regarding the challenges in switching from the T-72 to the Leopard 2. Brigadier General Gábor Lőrincz, speaking at an armoured vehicle conference held in Prague in 2023, relayed that investment is not just limited to the purchase of equipment but also critical infrastructure related to transport of these heavy assets. The Hungarians noted that key challenges requiring fur-

Credit: Hungarian MoD

As of July 2024, the Hungarian tank battalion in Tata has 18 Leopard 2A7HUs in service, with deliveries ongoing. The Hungarian Leopard combines elements of the German- and Qatari-specification Leopard 2A7.

Credit: Hungarian MoD

Buying tanks is an expensive effort and it isn't just main battle tanks that are procured. Nations need to buy a plethora of support equipment, including specialised vehicles such as this Leopard 2A7 Driver Training Tank (Fahrschulpanzer).

ther funding include the need for new river fording equipment and the possible need to reinforce key bridges on important national highways and roads. There are also requirements to overhaul tank training ranges to provide an effective and challenging environment that can test the skills of tank crews. Another concern Brigadier General Lőrincz touched upon was that the manpower required to crew the Leopard 2 is 25% greater than that of a T-72, owing to the lack of an autoloader – something the Brigadier General saw as a step backwards in light of domestic recruitment issues.

Despite the commitment to a modern tank battalion centred around the Leopard 2A7, Budapest is already interested in a long-term future tank programme. In December 2023, Budapest inked a EUR 288 million deal with Rheinmetall AG to develop the Panther KF51 EVO, a variant that will build on Rheinmetall's KF51 design first unveiled at Eurosatory 2022. One known stipulation the Hungarians have sought is the use of the Rheinmetall 120 mm L55A1 smoothbore gun over the Rheinmetall 130 mm L51 Future Gun System (FGS) design, although the capability to convert to the 130 mm gun will be retained. This would keep the tank utilising the same standard ammunition as the Hungarian Leopard 2 fleet. It is not yet known if Hungary is interested in investing in the KF51-U development unveiled at Eurosatory 2024 (where it was presented as the 'Concept Uncrewed Turret' (CUT)), which will see an unmanned turret in place of a traditional crewed turret. Overall, this project is part of an extensive partnership between the Hungarians and Rheinmetall.

Marketing Report: EVPÚ Defence

Advanced thermal imaging technology in remote controlled weapon stations

Thermal imaging cameras have become indispensable in modern military operations. These cameras capture infrared radiation within their field of view and utilize the collected data to generate an image, which then enables ground troops to carry out key tasks such as surveillance, reconnaissance, navigation and operating vehicles in low-visibility conditions such as night, smoke or dust.

Thermal imaging technology provides soldiers with enhanced situational awareness and allows them, for example, to identify hidden or camouflaged enemy forces, track movements and avoid ambushes. In complex combat environments, where quick decision-making is vital, the ability to detect threats in real-time significantly improves operational effectiveness and safety. Therefore, thermal imagers form an essential part of the equipment for many types of military vehicles.

EVPU Defence, known in the military sector for its commander and gunner sights, remote-controlled weapon stations and passive protection systems, relies on its own, in-house designed and produced cooled and uncooled thermal imaging cameras. The company focuses on providing customized solutions and offers a wide choice of cameras in its SUMO-U and SUMO-C product ranges. These thermal imagers are usually combined with a day zoom camera and a laser rangefinder in multisensor sights which can be mounted either directly on to the vehicle or, more commonly, integrated into turrets and remote-controlled weapon stations.

In order to offer maximum flexibility towards customer requirements while maintaining high quality standards, EVPÚ Defence has invested heavily in equipment that allows its staff to carry out research as well as assembly and maintenance tasks in special isolated and contamination-free laboratories. This equipment includes, for example, collimators for measuring optical parameters and system

Credit: EVPÚ Defence

rectification, a climate test chamber for temperature and humidity tests, and an active black body for the calibration of electro-optical systems. With its CNC centre, paint shop and rigorous quality control mechanisms, EVPÚ Defence keeps full control over the products from development to final delivery, which enables the company to offer truly customized solutions.

There are a few takeaways from the Hungarian tank programme that present both the advantages and challenges that arise from rebuilding tank fleets around a new platform. Firstly, the Hungarians benefitted from committing to a tank procurement programme before the wave of European rearmament surged after the start of Russia's invasion of Ukraine. While many nations may wish they could travel back in time to do the same, it is once again another case showing that long-term procurement planning is timelier and more cost-effective than short-term rushed and costly programmes – procurement reform may be necessary in many nations in Europe. Another aspect of the Hungarian tank programme worth noting is their ambition to engage with industry on future tank designs, including the partial funding of such programmes.

There is also potential for the three aforementioned countries to set up joint Leopard 2 groups that can utilise each other's training ranges or simulators, as well as jointly procure ammunition and spare parts for their emerging Leopard 2 fleets. This is a major benefit of close partners and neighbours utilising the same type of equipment, but such advantages require good relations and open governments to exploit. The Visegrád Group could be a vehicle for such endeavours.

Credit: Chris Mulvihill

The KF41 Lynx in Hungarian camouflage as presented at Eurosatory 2024.

The Twilight Era of the BMP-1 & 2

The CV90 has seen a revival in orders recently, with both the Czech Republic and Slovakia choosing BAE Systems Hägglunds' CV90 MkIV as their new infantry fighting vehicle (IFV), replacing the BVP-2 (the Czechoslovakian-produced variant of the BMP-2) in both armies. The Czech Republic signed a contract in May 2023 worth USD 2.2 billion for 246 CV90s, including an IFV variant with a 30 mm cannon, as well as command & control, reconnaissance, artillery observation, medical evacuation, armoured recovery, and armoured engineering variants.

Slovakia, meanwhile, signed a contract for their CV90 MkIVs slightly earlier in June 2022 for EUR 1.3 billion. The deal includes 122 CV90 MkIV in IFV configuration armed with a 35 mm cannon (of which 12 will be built in two unique sub-configurations, comprising three for anti-materiel rifle squads and nine for grenade launcher squads), plus an additional 15 command & control, nine reconnaissance, three armoured recovery, and three armoured engineering variants.

Credit: Czech MoD

The Czechs have opted for the CV90 MkIV and is a day and night difference compared to the BVP-2 it will replace. Its procurement is critical in rebuilding the 7th Mechanised Brigade into a NATO-interoperable heavy brigade.

Progress has already been made with the Czech production for the CV90, with imagery emerging in July 2024 of the first Czech-made turrets for the CV90 MkIV produced by Excalibur Army. Czech industry will play a major role in the production of the CV90s, with the main subcontractors being VOP CZ for the final assembly of the vehicles. Others include Meopta, Ray Service, and Retia. Of the seven variants on order, the medical evacuation and artillery observation variants will be developed domestically by VOP CZ. It is estimated that domestic subcontractors will account for up to 40% of the workshare.

The same offsets have been provided to the Slovaks, with ZTS-Špeciál being the main subcontractor responsible for final assembly. Koval Systems will be responsible for producing the turrets domestically for Slovakia, while other domestic subcontractors include Aliter Technologies, EVPÚ, Neways, Rays Services, and Virtual Reality Media.

The Czechs and Slovaks have also signed intergovernmental agreements to cooperate on joint CV90 training and common spare part procurement efforts, seeing as their vehicles are broadly very similar, with only small modifications to suit bespoke requirements in specialised non-IFV variants. For both nations, the CV90 programme will provide valuable expertise and experience with tracked

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armoured vehicle production that has been absent in some cases for decades. In the case of The Czech Republic, the production of armoured vehicles was not a capability lost, with General Dynamics establishing the Pandur II production line. Slovakia, however, has not had the fortune of being involved in armoured vehicle production since the Tatrapan, and for tracked vehicles specifically, it has not had any experience since independence.
Hungary has chosen another path, relying on their preferred armoured vehicle supplier Rheinmetall to build their KF41 Lynx at the Zalaegerszeg plant in Hungary. In a contract awarded in 2020, the deal lists 218 Lynx on order with various associated support systems totalling near EUR 2 billion. While the first 46 IFVs are to be produced in Germany, the rest will be made at the Hungarian plant, with the first Hungarian-made Lynx reported to have been rolled out of the production line in July 2024, becoming the first armoured vehicle produced in Hungary since the Cold War era D-944 armoured personnel carrier (APC). The Hungarians have also had some technical input into the development of the Lynx, including their insistence on manual backup controls for turret rotation and gun elevation, as well as requesting the implementation of the Skyranger 30 turret for mobile air defence formations.
Rheinmetall enticed Hungary to the deal by offering the chance for export deals to countries such as the Czech Republic or Slovakia to be fulfilled by the Hungarian plant, in part or in whole. While the KF41 lost out to the CV90 in both countries, the potential for further exports could keep the production line in Hungary open beyond satisfying the domestic order.

No force is too small for an APC fleet

APCs generally have the lowest average procurement and running costs of the three vehicle classes analysed here, which is why many states that lack a main battle tank or an IFV fleet will often still be able to support a fleet of APCs. While the Czechs and Slovaks are in the process of upgrading current fleets or already in the process of receiving new vehicles, other nations such as North Macedonia have ultimately sacrificed their tank fleet to help free funding to procure new APCs. In part, the advancement of firepower, protection, and situational awareness for APCs now provides the option for some nations to retire their legacy tracked IFVs in place of a wheeled APC at the cost of inferior cross-country mobility and often lower levels of protection. With the exception of Hungary, most of Europe has replaced or is in the process of replacing their legacy 8×8 Soviet BTR fleets.
The Czech Republic's Tatra Defence Vehicles (TDV) are already examining an upgrade based on the Pandur II already in service. Influenced by the Pandur II 6×6 EVO for the Austrian Bundesheer, the upgrade being developed by TDV is known as Pandur II Evo. One of the primary renovations is the integration of a new turret from Elbit, the UT30Mk2. The turret will be equipped with the 30 mm Bushmaster II Mk44 automatic cannon, and a retractable pod integrated onto the turret's right, housing two launchers for Spike-LR/ER anti-tank guided missiles (ATGMs). There are also suggestions the vehicles could be fitted with the Iron Fist active protection system (APS), as per Slovakia's CV90 MkIVs on order. With the Hungarian usage of Rheinmetall's StrikeShield on their Lynx IFVs, both nations illustrate some of the first APS procurements in Eastern Europe, with this type of subsystem previously seen as too expensive for any army outside of the major players to viably procure.
The Slovaks, who currently do not have an 8×8 in service, have been limited to using the tracked BMP-1-derived OT-90 as an APC. To build on this, the Slovaks signed a deal with Patria in August 2022 for 76 AMVxp 8×8 vehicles. These include 60 in their basic APC configuration, with the others including ten medical evacuation vehicles and six in a mobile command post configuration. In line with Patria's past offset offers, the APC will be integrated with the domestic Turra 30 turret from EVPÚ. One of the more interesting aspects of this turret is it utilises the GTS-30/N cannon, which is a local cannon derived from the 2A42 but firing 30×173 mm NATO-standard ammunition. The AMVxp will be produced locally in Slovakia, and the entire contract is planned to be concluded by the end of 2027, with the first vehicle already produced in July 2024.
Both North Macedonia and Slovenia are in the process of examining new 8×8s for their forces. North Macedonia began a government-to-government process in 2022 to procure Stryker APCs. The Stryker deal, which in the foreign military sale documents is estimated to have a value of up to USD 210 million, will likely be the largest military procurement Skopje has signed to date. It may also free up their current BTR-70 and BTR-80 fleet for donation, with Skopje previously setting a precedent by donating their entire T-72A battalion to Ukraine.

Credit: Slovak MoD

The AMVxp for Slovakia reintroduces the wheeled APC vehicle that has been lacking in the Slovak army. It is also in service with Slovakia's large and increasingly well-armed neighbour,. Poland, under the locally-produced variant known as the KTO Rosomak.

The Slovenians, who already operate a small fleet of Patria AMV 8×8s and Pandur I 6×6s, are also exploring the expansion of their APC fleet, with the government in Ljubljana inviting various bids from General Dynamics Land Systems, IVECO Defence Vehicles, and Patria. This comes as a direct result of Slovenia cancelling their participation in the Boxer programme, with cost being the primary reason. The size and potential value of an agreement is not yet known, but it is known that the Slovenes are looking for a battalion-sized order of APCs.

Better late than never

Armoured vehicle fleets across Europe are undergoing a significant evolution driven by the need to modernise outdated equipment and respond to emerging security threats. Nations like The Czech Republic, Slovakia, and Hungary are perhaps leading examples for the smaller countries in Eastern Europe on what paths to take. Through substantial investments in new platforms such as the Leopard 2 and CV90, these modernisation efforts are not only replacing legacy Soviet-era vehicles but also expanding capabilities and enhancing interoperability within NATO while building up new or restoring lost industrial capabilities. Through both funding and order volume, some of these nations are already emerging as contributors towards the development of new vehicles with their technical inputs being adhered to. The 2020s are looking to be a fruitful decade for rearmament in Eastern Europe, and after years of underinvestment, many defence ministries have renewed optimism and importantly more funds to pursue long-overdue modernisation efforts for their armoured vehicle fleets. ■

Credit: North Macedonian MoD

US Army Stryker APC at the Krivolak training range in North Macedonia. The procurement of the Strykers for North Macedonia will see the replacement of both the BTR-70 & 80 fleets and has in part already resulted in the retirement of their T-72A fleet to free funding and manpower.

Boxer enters the ring

Jim Backhouse

Nearly 30 years after the UK first became involved with the Boxer, it is now on the cusp of entering service with the British Army. With more orders in the pipeline, the Boxer programme will be critical to the future of the army and the UK's armoured fighting vehicle (AFV) industry.

By and large, the past two decades have not been kind to the British Army. Faced with an ever more complex strategic situation and economic constraints, it has struggled to articulate a coherent vision for its future organisation. This has been exacerbated by a string of procurement debacles, with one of the most notable being its Ajax family of reconnaissance vehicles.

Against this background, the Army's most recent attempt to procure the Boxer 8×8 AFV is a ray of sunshine in an otherwise gloomy sky. So far, the programme has been able to stick to its schedule even amidst the disruption caused by the COVID-19 pandemic and the War in Ukraine. With UK production lines up and running and initial operational capability (IOC) imminent, the programme has acquired a momentum that looks set to be reinforced by additional orders.

Credit: KNDS Deutschland

The Boxer with RCH 155 mission module was selected for the British Army's MFP in April 2024, but a production contract is yet to be signed.

Backwards and forwards

The UK is no stranger to the Boxer platform, having been intimately involved in its initial development. Recognising a need to replace and consolidate the British Army's AFV fleet, in 1996 the UK joined forces with France and Germany to form what would become the Organisation for Joint Armament Co-operation (OCCAR) international procurement organisation and to develop a family of wheeled AFVs known as the Multi-Role Armoured Vehicle (MRAV). The Eurokonsortium proposal for a family of modular vehicles available in a 6×6 and 8×8 configuration was selected, with its UK contingent Alvis-Vickers developing and manufacturing prototypes before the UK withdrew from the programme in 2003, realising that the MRAV was too heavy to meet emerging requirements for AFVs to be deployable by C-130 transport aircraft.

The British Army flirted with the idea of procuring Boxer again in 2007, when a Boxer competed against two other platforms for the Future Rapid Effect System (FRES) Utility Vehicle programme, despite the fact that the original requirements for the FRES programme had led to the UK abandoning the Boxer in the first place.

It was not until 2016 that the British Army reacquainted itself with Boxer, after the UK government's November 2015 defence review proposed the creation of two rapidly deployable Strike Brigades, in which a Mechanised Infantry Vehicle (MIV) would be required to provide protected mobility to the two mechanised infantry battalions in each brigade.

In what has become a familiar practice with Boxer, the British Army decided to satisfy its MIV requirement by rejoining OCCAR's Boxer programme at the end of March 2018, without holding a competition. This allowed the UK to reassume the rights to build and export the Boxer from the UK that it had sacrificed in 2003.

Yet before a production contract had been signed, the British Army ditched the Strike Brigades in the Future Soldier 25 concept published in November 2021. Instead, 3rd UK Division will hold five mechanised infantry battalions mounted on MIVs, three in the 20th Armoured Brigade Combat Team (ABCT) and two in the 12th ABCT. With the Boxer's core role of providing protected mobility for mechanised infantry unchanged, this reorganisation is unlikely to threaten Boxer or raise questions about its utility.

An (inter)national success story?

Acting on behalf of the UK government, since November 2019 OCCAR has awarded two production contracts to ARTEC, a consortium owned by the German companies Krauss-Maffei Wegmann (KMW), itself now part of the Franco-German KMW + Nexter Defense Systems (KNDS); Rheinmetall Military Vehicles; and Rheinmetall Defence Nederland B.V., a Dutch subsidiary of Rheinmetall. Four main variants of the Boxer have been ordered: Infantry Carrying Vehicles (ICVs), Specialist Carrier Vehicles (SCVs), Command Posts (CPs), and Ambulances.

One element of the Boxer MIV programme that was emphasised in the initial announcement of its selection in March 2018 was that 60% of the manufacturing work and eventually 100% of final assembly was

Credit: Crown copyright 2023

A Boxer MIV prototype undergoing trials at the Milbrook Proving Ground in 2023. This appears to be fitted with either an ICV or SCV mission module.

forecast to be carried out by UK industry.

In a sense, the programme looks able to deliver on these promises. Just over a year after the first production contract was signed, ARTEC confirmed that it would award subcontracts to the UK-based Rheinmetall BAE Systems Land (RBSL) and WFEL (now KNDS UK) to carry out Boxer manufacturing and assembly, integration, and test (AIT) work at their respective facilities in Telford and Stockport, with KNDS UK also tasked with manufacturing 480 drive modules for the first batch of 523 vehicles.

Other UK-based companies are also slated to receive work for Boxer MIV production, including Rolls-Royce, Thales UK, William Cook Engineering, Parker-Hannifin, Mildef, Oxley Group, and Pearson Engineering. Furthermore, Elbit Systems UK was awarded a contract on 9 May 2023 to deliver crew trainers for the Boxer platform as part of the Project Vulcan initiative.

Yet it is important not to forget that both of the main UK subcontractors are now owned by German parent companies, with Rheinmetall commanding a 51% stake in RBSL and KNDS' German branch owning KNDS UK. Moreover, friction created by supply chain issues and a desire to keep the programme on schedule means that most of the second order from April 2022 will be manufactured in Germany, increasing the German workshare from 7% of the initial order to 19% of the total order for 623.

On the positive side however, the Boxer has so far stood out for largely adhering to the schedule outlined at the time of its selection, despite coinciding with the COVID-19 pandemic, which increased procurement times for many electronic components. Production of sub-assemblies had kicked off at KNDS UK by May 2021, while RBSL officially opened its Telford assembly line on 27 March 2023. As expected, the first prototype vehicles were delivered from the German production line to the British Army for trials with the Royal Fusiliers by December 2023. If this continues, the British Army should receive the first production-standard Boxers in the fourth quarter of 2024, leading to initial operational capability (IOC) being achieved in Q4 2025 and keeping the MIV programme on track to reach full operational capability (FOC) in 2032.

Once UK Boxer production enters full swing, the UK government could also seek to capitalise on latent capacity within the production lines by pursuing export opportunities. One such opportunity may present itself in Qatar, where the British Army displayed a Boxer painted in UK and Qatari flags during the March 2024 DIMDEX exhibition, all but confirming that it will be pitched for the Qatari 8×8 AFV procurement programme.

The British Boxer

While much has been disclosed about the status of the UK Boxer programme, comparatively less is known about what the Boxer that is delivered to the British Army will look like. What is clear is that the British Army will be the first operator of the full-spec Boxer A3 drive module. The A3 will be fitted with a more powerful 600 kW (804.6 hp) MTU 8V199 TE21 diesel engine and will have an uprated suspension, modified braking system, and reinforced wheel hubs, allowing it to accommodate a higher gross vehicle weight (GVW) of 38.5 tonnes, although demonstrations have shown that this could grow to 41 tonnes.

Table 1: UK Boxer Contract Awards

Contract Award Date	Contract Value	Quantity Ordered	Quantity Assembled in Germany	Quantity Assembled by KNDS UK	Quantity Assembled by RBSL
4 November 2019	GBP 2.8 billion	5 prototypes + 523 production MIVs (85 ICVs, 200 SCVs, 177 CPs, 61 Ambulances)	5 prototypes + 36 MIVs	225 MIVs (in ICV, SCV, and Ambulance variants)	262 MIVs (in SCV and CP variants)
11 April 2022	Unknown	100 production MIVs (61 ICVs, 35 CPs, 4 Ambulances)	81 MIVs	9 MIVs	10 MIVs
Totals	Unknown	5 prototypes + 623 production MIVs (146 ICVs, 200 SCVs, 212 CPs, 65 Ambulances)	5 prototypes + 117 MIVs	234 MIVs	272 MIVs

Credit: Crown copyright 2022

The British Army demonstrated a representative Boxer BVLB CSB variant (foreground) and an RCH 155 variant (background) at the Salisbury Plain training ground in October 2022.

UK Boxers will also have six instead of four attachment points for mission modules, an uprated central tyre inflation system (CTIS) with a more powerful compressor, reinforced towing eyes, compatibility with an enhanced version of the British Army's Generic Vehicle Architecture (GVA), cameras for the Rheinmetall Trailblazer local situational awareness system, and provision to be fitted with the obligatory boiling vessel (BV).

Four basic mission module variants will be delivered for the MIV programme, with the Ambulance variant having a higher roof. These will be equipped with a Thales UK licence-produced Kongsberg Protector RS4 remote weapon station (RWS) armed with either a 7.62 mm L7A2 or 12.7 mm L1A2 machine gun. Thales UK's Acusonic acoustic shot detection system that has been seen on the Ajax family will also be available as an option for integration into the Boxer MIV. Each variant will have a crew of three comprising a driver, commander, and gunner, with further capacity for eight passengers in the ICV, four in the SCV, five in the CP, and either seven wounded and two stretcher patients, or three walking wounded and three stretcher patients in the Ambulances.

However, there are also planned to be several subvariants of the SCV and CP variants created by fitting them with role-specific mission kits once they have left the production line. A breakdown provided by the MoD in response to a parliamentary question on 9 June 2021 indicates that those ordered in the first batch will be configured as follows:

Variant	Subvariant	Quantity
SCV	Engineer Section Vehicle	60
	Recce/Fire Support Vehicle	62
	Mortar Carrying Vehicle	28
	Equipment Support Repair	50
CP	Command & Control or Command & Control-Utility	123
	Observation Post Vehicle	19
	Beyond Line of Sight Vehicle	24
	Electronic Warfare and SIGINT Vehicle	11

No further information has been provided on what differentiates each of these subvariants, nor has a breakdown been provided for the second batch of 100 Boxer MIVs ordered in April 2022. It is also possible that the projected breakdown may have changed since this response was published.

A Boxer for every occasion

The number of Boxers and the variety of variants in service with the British Army is expected to proliferate in the near future. At the International Armoured Vehicles (IAV) Conference held in January 2024, it was revealed that the British Army intends to order a third batch of at least 100 more Boxers. This new batch would comprise several new combat and combat support variants, which are believed to be part of a broader Boxer Strategic Pipeline (BSP).

The third batch is planned to include a Boxer Repair and Recovery Vehicle (RRV), a Boxer Armoured Mortar (this will differ from the SCV Mortar Carrying Vehicle in that its mortar will be operated mounted rather than dismounted), and a Boxer Vehicle Layer Bridge Close Support Bridging (BVLB CSB). IOC dates of 2029 are projected for the RRV and BVLB CSB, and 2030 for the Armoured Mortar Vehicle. For the RRV, the British Army looks likely to procure FFG's Armoured Recovery Module (ARM), while the decision to award KNDS UK the contract for General Support Bridges under Project TYRO indicates that the Boxer Bridge-Layer module shown by KNDS UK in September 2021 could be a frontrunner for that variant. In terms of the Armoured Mortar Vehicle, RBSL announced in September 2022 that it had test-fired a mortar module containing the Rheinmetall Norway Mortar Weapon System (MWS) with a 120 mm barrel at the Salisbury Plain. However, other solutions are available, including the turreted 120 mm New Mortar (NeMO) from Patria and the Crossbow from Elbit Systems.

Other variants that have been alluded to in the BSP are a carrier for the Serpens weapons-locating radar (IOC 2031), a Counter-Small Aerial Targets variant (IOC 2032), a Mounted Close Combat Overwatch armed with beyond-line-of-sight ATGMs (IOC 2032), and an electronic warfare (EW) variant. For some of these variants, it is debatable whether the Boxer is the optimum platform for the capability they provide. While mounting a valuable asset such as a radar on the Boxer may improve their survivability by making it more complicated for the enemy to identify the specific vehicle carrying the radar, this must be balanced against the cost of using an expensive AFV for a role that could be performed by a less-protected truck or a smaller AFV.

Caption: Crown copyright 2022

A representative of the Boxer RRV variant fitted with the FFG ARM and FEE was also demonstrated at Salisbury Plain in October 2022.

Finally, the Boxer-based Remote Controlled Howitzer 155 (RCH 155) was selected for the army's Mobile Fires Platform (MFP) on 24 April 2024. Once again, to the consternation of other suppliers, the Boxer was chosen without a competition. In another familiar turn, the development of the RCH 155 will be carried out in collaboration with German industry and is planned to enter service before 2030. The UK MoD has not confirmed how many RCH 155s it intends to buy, but previous reporting on the MFP programme implied a requirement for 96 to replace the AS90 tracked 155 mm self-propelled howitzer.

With all of these Boxer variants expected to have a service life of at least 30 years by the UK MoD, and given the scheduled FOC for MIV and IOC dates for many other variants, the Boxer should remain in British Army service until well into the 2060s. In order to maintain their capability, it is likely that they will undergo continuous spiral development and at least one major mid-life upgrade. Few indications have been provided as to what this could involve, although one avenue that the British Army is understood to be considering is the integration of front-end equipment (FEE) onto the MIV fleet. Pearson Engineering has published conceptual images of an FEE interface mounted on a Boxer that could be used to carry combat engineering equipment such as the company's Vector mine plough. OCCAR has also hinted at the possibility of Boxer users coming together to develop a common drive module standard that could incorporate features such as a hybrid-electric drivetrain and artificial intelligence-enabled capabilities.

The elephant in the room

One variant that is conspicuously absent from the British Army's plans is an infantry fighting vehicle (IFV). With the cancellation of the Warrior Capability Sustainment Programme (WSCP) and no plans in place to induct an IFV variant of the Ajax, British mechanised infantry appear to be severely outgunned in comparison to their NATO peers. In response to this gap in capability, some British companies involved in the MIV programme appear to have sought to entice the British Army to buy a turreted IFV version of the Boxer. In July 2021, KNDS UK displayed a Boxer prototype equipped with a Kongsberg RT60 unmanned turret to officials from the British Army and UK MoD. KNDS subsequently developed this version into the Boxer Dragoon, which consisted of an MIV ICV mission module equipped with a lighter version of the RT60. Similarly, Pearson Engineering announced on 13 September 2023 at the DSEI exhibition that it was to play a role in delivering the Samson 30 mm unmanned turret from its parent company Rafael, signalling that could produce the system in the UK for the Boxer programme.

Credit: Lithuanian MoD

Pearson Engineering has the capacity to deliver the Samson 30 unmanned turret (seen here on a Lithuanian Vilkas) for a potential Boxer IFV variant.

Despite these options, the British Army has given no indication that it is interested in pursuing a Boxer IFV. This may be due to concerns regarding the survivability of the Boxer in a more direct combat role. Indeed, British Army representatives have previously pushed back on the idea that Boxer is outgunned by suggesting that it is ultimately more dangerous to fit a platform with weapon systems that encourage the crew to engage targets that are more heavily armed and armoured. In the same vein, the British Army has pointed to the successful employment of infantry anti-tank weapons such as the Javelin ATGM in 'hit-and-run' engagements in Ukraine as evidence that a dismounted anti-tank capability may be preferable. Wheeled IFVs also face greater limitations on their cross-country mobility than tracked vehicles, limiting their tactical flexibility. While KNDS has proposed a tracked Boxer drive module, which was shown at Eurosatory 2024 fitted with the company's Remote Control Turret 30 (RCT30), there are as yet no indications that this is under consideration by the British Army.

A glass half-full?

On the one hand, the Boxer programme could be considered a rare success in the UK's recent AFV procurement. The programme looks poised to deliver on schedule and has helped to resuscitate the UK's declining AFV industry. Looking to the future, the British Army could come to operate the largest and most diverse Boxer fleet in any one military, making Britain well-placed to contribute to its further development and involve its industry in any export opportunities.

Yet it also cannot be forgotten that the British Army could have already been operating the Boxer for more than a decade had it not withdrawn from the MRAV programme in 2003. Worse still, the very success of UK industry in embedding itself into the programme also highlights its decline and dependence on overseas capital and expertise.

There is also the danger that the Boxer's success has encouraged the British Army to adopt it for roles to which it is not well suited, potentially putting some of the acquisition planned in the Boxer BSP at risk if financial pressures start to bite. At the same time though, the army's reticence towards adopting a Boxer IFV could indicate that it is realistic about the platform's limitations and recognises where it must be complemented by other platforms. Only time will tell, but one thing appears almost certain: the Boxer will be a major part of the British Army of the 2030s. ■

Autonomous warriors: British Army seeks to integrate unmanned platforms

Sidney E. Dean

Like other major armed forces, the British Army is systematically seeking to incorporate advanced autonomous unmanned platforms into its formations.

Future Soldier

The British Army operates numerous unmanned systems. Major applications include explosive ordnance disposal (EOD), as well as aspects of intelligence, surveillance, targeting and reconnaissance (ISTAR). The extensive current inventory includes the man-portable Dragon Runner reconnaissance and EOD UGV (in service since 2010), Tarantula-Hawk micro air vehicle for EOD reconnaissance (2010), Thales Watchkeeper WK450 UAV used for ISTAR (2014), and the T7 bomb disposal UGV (2018).

As the Ministry of Defence (MoD) sees it, this is just the beginning. As the then Chief of the Army General Staff, Gen. Sir Mark Carleton-Smith, said in 2018, preparing for the 21st Century battlefield will require a more proactive, threat-based approach to capability planning. This includes "placing some big bets on those technologies that we judge may offer exponential advantage because given the pace of the race, to fall behind today is to cede an almost unquantifiable advantage from which it might be impossible to recover".

The Future Soldier project initiated in March 2021 – which is viewed as the most radical change for the British Army in two decades – aims to prepare the service for the next-generation battlefield. This includes organisational reforms and new operational concepts, but also lays a premium on integration of artificial intelligence (AI), advanced unmanned systems and networking. Robotics and autonomous systems (RAS) – including uncrewed ground vehicles (UGV) and tactical uncrewed aerial vehicles (UAVs) – are considered particularly promising as force multipliers. Human-machine teaming (HMT) is expected to facilitate distributed operations over greater distances, providing smaller-sized units with enhanced combat power. In September 2021, the MoD formally pronounced RAS integration to be an important element of

Credit: USMC

An array of UAVs and UGVs being evaluated by the British Army.

Credit: Crown Copyright 2021

Members of 2YORKS train in Cyprus with a UGV.

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the Future Soldier concept, augmenting current capabilities with a network of new sensors and effectors.

To support these efforts, the MoD has refined the necessary test and evaluation infrastructure, with an emphasis on hands-on experience by combat and combat support forces. In March 2021, the Cyprus-based 2nd Bn, Yorkshire Regt (2YORKS) was selected as the Army's Experimentation Battalion. Reinforced by combat support and combat service support specialists from across the field army, the battalion functions as a Next Generation Combat Team in support of combined arms manoeuvre force development. The unit tests all new and conceptual equipment being offered to the Army, from weapon sights to robots, and evaluates concepts of operation which will optimise the new technology's utility.

As described by the Army, the Experimentation Battalion is at the cutting edge of human-machine integration, defining the architecture for how the service fights on the future battlefield. In 2022, the Army's Experimental and Trials Group (ETG) was activated. 2YORKS forms the ETG's core, augmented by specialist trials and development units.

Credit: Crown Copyright 2022

Troops test the abilities of the Hydra XL 300 to evacuate a simulated casualty.

Army warfighting experiment series

However, the modernisation drive – marked both by procurement and experimentation – predates the Future Soldier initiative. The Urban Experimentation (URBEX) programme – launched in 2009 – was succeeded in 2017 by the Army Warfighter Experiment (AWE) series of annual exercises. AWE is the service's premier innovation programme, focusing on teaming soldiers with AI-enabled machines. It is conducted in close cooperation with industry to identify and evaluate current and emerging technologies for their operational potential.

Each year's AWE is split into three levels. Level A consists of industry proposing equipment they believe is suitable to meeting problems set by the AWE team. Level B constitutes a basic safety testing of the equipment the AWE team decides to include in Level C, the experimentation phase. The Level C integrated assessment – normally conducted in November – follows a year of interaction between the Army and industry partners, and involves an intense field experiment by soldiers utilising the selected kit.

AWE's stated goal is to inform investment decisions and find capabilities suitable for rapid exploitation. Soldier feedback has become an invaluable aspect of the exercises, confirming or refuting a particular system's utility under real world circumstances; this feedback flows directly back to industry, which can adjust otherwise viable technology to better meet operator requirements. According to the MoD, these real-world demonstrations have helped accelerate several uncrewed air and ground systems into the Field Army.

Each year's AWE has a specific focus. The AWE in 2018 ran under the designation Exercise Autonomous Warrior – Land. It focused on HMT, pairing soldiers with AI-enabled and autonomous machines to enhance operational effectiveness. Mission capabilities tested included autonomous last-mile resupply missions across the dangerous final approach to the combat zone; deploying autonomous systems in the ISTAR role to enhance long-range and precision targeting by the manned force; and developing a digital backbone to ensure seamless communication between different systems and platforms.

The AI-based progress made during AWE 2018 flowed into subsequent exercise events. The 2019 and 2020 iterations provided insights into current levels of robotic autonomy, as well as digital connectivity between a broad array of systems and platforms. The 2020 exercise in particular focused on Agile Command, Control and Communication, but covered a broad scope of battlefield headquarters issues ranging from deployable infrastructure, data aggregation and analytics to headquarters resilience and decision support.

In 2021, the MoD announced that AWE was moving to a multi-year format, providing industry partners longer engagement opportunities and more thorough collaboration with the Army, as well as with the Defence Science and Technology Laboratories (Dstl) and Defence Equipment and Support (DE&S), the procurement arm of the Ministry of Defence. The military anticipates that this will lead to development of cutting-edge concepts into demonstrators and then field-ready systems more rapidly than was previously possible.

AWE – Urban Series

The 2022-2024 AWE cycle is focused on urban operations with an eye to optimising brigade, battle group, and sub-echelon units' capabilities in this challenging environment. Each year's experimentation centres around a particular tactical function. These various areas of concentration will be integrated for the final Urban Series experiment to be conducted in late 2024.

The 2022 iteration (AWE 22) was conducted at Portsmouth Naval Base as a proxy urban setting and ran under the headings of 'Sustain' and 'Protect'. 'Sustain' focused on intelligent logistics, medical extraction and vehicle extraction using autonomous systems, while 'Protect' focused on physical and non-physical protection, including counter-UAV (C-UAV) applications. Of the 159 systems originally submitted for consideration by industry, only 20 were ultimately selected for the Level C event conducted in November 2022. Among the more attention-grabbing tests, an electrically-propelled Hydra XL 300 drone demonstrated the ability to airlift simulated casualty payloads of 120 kg over a range of up to 25 km. Smaller drones were used to ferry blood plasma and other medical supplies across the simulated battlefield.

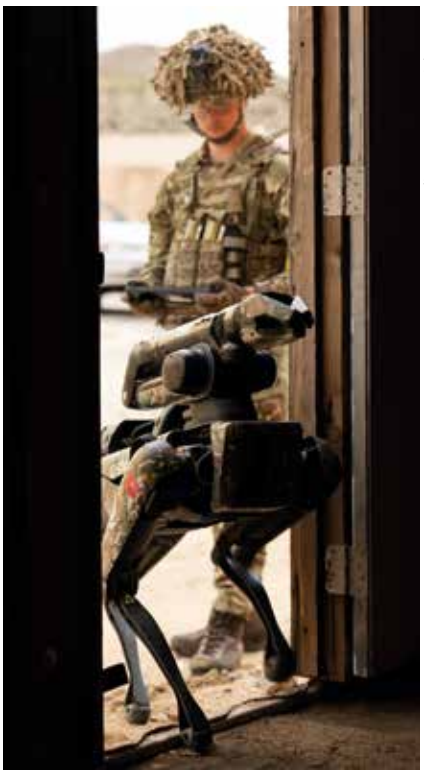
Credit: Crown Copyright 2023

The Hydra 400 heavy lift UAS was evaluated in AWE 2023. Manufacturer Hydra Drones Ltd proposes arming it with three Brimstone missiles.

The following year, AWE 23 tested more than 40 systems by 35 (mostly British) suppliers. The exercise was conducted in November 2023 by 2YORKS on Salisbury Plain, running under the designation AWE Blunt and Dislocate (AWE B and D) and focused on manoeuvre supported by fires and information activities within an urban environment. The Army's stated goal for AWE B and D was to "examine how a future land force can maximise advantage in the 'first battle' by blunting an enemy's advance with organic and long-range firepower, whilst also finding and striking to drive home an early culmination. Concurrently, the experiment [explored] how a future land force can dislocate the enemy throughout his depth, with 'counter kill-chain' at its core."
Systems evaluated ranged from the Black Hornet 4 Nano-UAV for short-range and indoor reconnaissance, to the Hydra XL 400 jet-powered heavy-lift VTOL UAV which was 'armed' with three dummy Brimstone air-to-ground missiles. The XL 400 can be transported in the field on a pick-up truck-sized flatbed and made flight ready within six minutes, providing small units a nearly instantaneous heavy lift (400 kg) transport or strike platform. UGVs were also put through their paces.
AWE 24, also designated AWE Integrate, is focused on command and intelligence hypotheses. It will also bring in industry partners from previous phases of the AWE Urban Series for the cumulative event. The Level C final experiment of AWE 2024 – and of the entire Urban Series – is scheduled for October 2024. Overall the results of the Urban Series are expected to demonstrate future force requirements, and inform the MoD's Strategic Defence Review (SDR) which is scheduled for 2025 as a comprehensive update to the national security and military policy.

Capstone 4

Detachments from Allied nations' test and development units routinely participate in the AWE series. This permits British and partner forces to learn from one another's progress, but – even more importantly – also ensures that technology and operational concepts will be interoperable in the field. This collaboration works in both directions. Some 600 British Army soldiers (alongside Allied forces from six partner nations) participated in the Project Convergence Capstone 4 war-fighting experiment sponsored by the US Army in California in February-March 2024.
The event focused on joint multi-domain operations conducted by US and international partners. Cutting edge technologies were evaluated in realistic scenarios, with a focus on networking systems optimised to accelerate and facilitate the so-called 'sensor-decider-effector-sustainer' kill chain. Approximately half of the British contingent was dispatched by the Army's Experimental and Trials Group. The ETG deployed a Robotics and Autonomous Systems enhanced Battlegroup including engineers, artillery, electronic warfare (EW) assets and UAVs. The unit deployed UGVs and UAVs to support ISR operations. UGVs with mounted machine guns were also included in the exercise, providing fire support for dismounted forces.



Credit: Crown Copyright 2024

2YORKS deploy a remote-controlled dog to check for enemy threats during a training exercise at Razish training complex at Project Convergence Capstone 4.

A "Software-Defined and Data-Centric Force"

AWE aside, evaluation and procurement of new and updated uncrewed systems progresses under various individual programmes. These include:
Robotic Platoon Vehicle (RPV): This is a multiphase experiment to assess the operational benefits of UGVs and facilitate integration of advanced robotics and autonomous systems into platoon-level ground operations. Testing has been performed through integration at the unit level (2YORKS) as well as during the course of the AWE. UGVs are being considered for a broad array of purposes including autonomous and semi-autonomous platoon equipment transport, frontline resupply, casualty evacuation, ISTAR, and weapons platform. Systems tested under the RPV programme include the Multiple-Utility Tactical Transport (MUTT) vehicles developed by GDELS, and various configurations of the swarm-capable Rheinmetall Mission Master SP UGV. The AI-equipped UGVs can follow their unit without being directly controlled, or autonomously navigate difficult terrain to conduct ISTAR or resupply missions. The final seven Mission Master vehicles were ordered in April 2022 for the third and final spiral of the RPV programme. Following the conclusion of the third spiral of the RPV programme, RAS experimentation will continue through

Credit: Crown Copyright 2024

Soldiers from 2YORKS moving from building to building while covered from an autonomous RPV (robotic platoon vehicle) with a mounted machine gun.

the Army's Expeditionary Robotics Centre of Expertise (ERCoE).

ERCoE: Formed in May 2021 by DE&S and the Army, ERCoE is conceived as a central hub for conducting and coordinating key defence robotics and autonomous systems projects. Aside from the RPV programme, these include nano-UAVs, autonomous resupply of forward troops and additional HMT development. ERCoE is managed by the Future Capability Group (FCG) at DE&S. The inclusion of both DE&S and the Army ensures that end-user perspectives are consistently considered during evaluation.

Project Tequila: Lockheed Martin is the systems integrator for this effort to equip small military formations with state-of-the-art ISTAR-capable small UAVs (SUAVs). In 2022, the MoD ordered 159 Indago 4 quadcopters and 105 fixed-wing Stalker VXE30 drones under the Tequila programme. Weighing 2.27 and 20 kg respectively, these AI-driven SUAVs will have significantly improved range and endurance as well as more capable sensors and processors than the UAVs they replace. The MoD expects first units to be operational by late 2024.

Outside of the Tequila framework, the DE&S' Future Capability Group ordered Elbit Magni-X micro-UAVs in January 2023 for delivery to specialist Army units. The procurement serves the Army's HMT initiative. While of shorter endurance than the Indago 4, the Magni-X is swarm capable, enabling cooperative enhance short-range reconnaissance and support combat missions.

Armed SUAVs: In May 2023, the MoD issued a request for information (RfI) regarding options for an armed SUAV for the Army. The objective systems would have a maximum take-off weight (including payload) of 350 grammes and a minimum 20 minutes of flight endurance.

UAS Group: In September 2023, the British Army announced the formation of a new uncrewed aerial systems (UAS) group to be established under the Joint Aviation Command (JAC). As defined by General Sir Patrick Sanders, former Army Chief of General Staff, this move "will bring deep, deep expertise and the coherence that the new defence uncrewed strategy requires" and "provide a focal point for industry around which we intend to develop the next generation of UAS platforms in even closer partnership".

The new aircraft are to feature advancements in autonomy, endurance, and payload capabilities. The enhanced aerial platforms are to provide real-time situational awareness and targeting through ISTAR missions, as well as supporting ground forces through direct delivery of payloads. The UAS Group will also be tasked with: establishing comprehensive training programmes for UAV operators and developing new doctrines to effectively integrate UAVs into military operations; ensuring that UAVs are fully compatible with existing command and communications systems (including at the joint and coalition level); evolving concepts of operations which will expand the boundaries of what UAVs can achieve and contribute to the force.

Hardware is only part of the picture. Sanders stressed the importance of software and data as the drivers of future operational capability, noting that the Army was pursuing more than 25 data projects in close cooperation with industry. Over the next decade, all of the Army's deployable digital systems are to be modernised; this includes command, control, communications and information systems as well as ISTAR capabilities. The Army stresses that networking of systems, soldiers, vehicles and weapons – including network integration with Allied forces – will be a prerequisite for effective future operations. "The army's approach to data will define our ability to adopt artificial intelligence at pace and scale for whole force benefit," he said, adding that the British Army is to be made a "software-defined and data-centric force."

Credit: Crown Copyright 2023

Micro-drones were put to the test during AWE 2023.

UK Defence Drone Strategy

In February 2024, the MoD announced the UK Defence Drone Strategy in order to deliver a unified approach to uncrewed systems not only for the Army but across all three military services. The programme is to run for ten years with a minimum budget of GBP 4.5 billion. The goal is to accelerate fielding of uncrewed land, air and sea systems. According to the MoD, it will enable rapid experimentation, testing and evaluation of uncrewed platforms for all services, coordinated by the UK Strategic Command in cooperation with industry.

Once operational, the systems will be continuously developed and upgraded to stay aligned with the fast-paced advancements in technology and the evolving threat landscape, the MoD said in a February 2024 statement. "Rapidly being able to develop and upgrade uncrewed systems will be key to gaining battlefield advantage and we must seize this opportunity to grow and sustain such skills and capabilities in the UK," said the former Minister for Defence Procurement, James Cartlidge. "Ultimately, this is about learning the lessons from the Ukrainian frontline to procure drones at scale for the UK's Armed Forces." ■

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British Army mobility programmes – a strategy to replace legacy equipment

David Saw

The British Army intends to embark on a number of procurement programmes in the mobility sector, which include the Light Tactical Mobility Platform (LTMP) Light and the LTMP Medium. Subsumed into these efforts is the former General Support Utility Programme (GSUP), which was aimed at finding a replacement for the Land Rover fleet and similar vehicles. Finally, to round off British Army mobility efforts, reference must also be made to the broader Land Mobility Programme (LMP), which covers the replacement of a number of existing protected mobility platforms.

Before discussing the mechanics of these programmes, it is important to place them within the context of the British politics and beyond that, the defence budgetary environment. With the Labour Party's landslide victory on 4 July 2024, John Healey is the new Defence Secretary, while Prime Minister Keir Starmer has reaffirmed his commitment to spending 2.5% of GDP on defence, and commissioned a Strategic Defence Review (SDR) to provide the basis for national defence policy going forward. The SDR is due to be delivered in the first half of 2025, and will look at current and projected future defence procurement programmes to determine whether these fit in with the defence policy of the new Labour government.

In recent years, the previous Conservative government's official position was that there would be an increase in defence expenditure and that more resources would be made available for defence modernisation programmes. Plenty of references were made to the unstable international situation and that Britain could not afford to have weak defences in that environment. That all sounded fine, but in the real world the many glaring weaknesses of the British military have not yet been adequately addressed.

The challenge for the Labour government will be dealing with a sluggish national economy, while enacting progressive social policies and pushing government spending into new areas. While maintaining the previous target of 2.5% of GDP on defence will be welcomed, the reality of the situation is that a little more money will not necessarily solve the problems that the Ministry of Defence (MoD) is faced with. The procurement system is inefficient and error-ridden, financial management within the MoD is poor, and the suggestion is that financial commitments exceed the ability of the MoD to pay for them within existing budgetary limits. Dealing with these properly would require a root and branch reform of the procurement system and indeed the MoD as a whole. This would be a herculean task.

All of which means that many current programmes may have an insecure future, as the Labour government attempts to get to grips with the problems of the MoD and procurement.

Bravo Company, 40 Commando Royal Marines, on exercise in Cyprus with the Canadian American (CAN-AM) 6-wheeled Outlander Warrior vehicle. The British Army has tested and also operated a wide range of ATVs/UTVs, including unmanned systems. This will form the basis for its Light Tactical Mobility Platform (LTMP) efforts.

The light side

The LTMP programme had been spilt into two separate programmes, the first of which was the LTMP Light programme; the MoD released a contract notice for LTMP Light on 25 August 2023. According to the notice, the contract is expected to cover the purchase of a minimum of 156 LTMP Light platforms, either utility terrain vehicles (UTV) and/or all-terrain vehicles (ATV). With the inclusion of through-life support for the chosen platform in the procurement

Credit: Crown Copyright

The Yamaha Grizzly 450 Quad Bike along with the Logic SMT172B trailer was widely used by the British Army in Afghanistan. The Light Tactical Mobility Platform (LTMP) Light seeks to acquire a new ATV for the British Army.

contract, options in the contract could see the LTMP Light programme increased to 311 vehicles. Bidders can only offer one platform in response to the tender.

Performance requirements for the LTMP Light, as given in the contract notice are as follows: minimum ground clearance (fully laden) of 180+ mm, minimum payload capability of 270+ kg, minimum speed of 40 km/h on road when towing a weight of 450 kg; and the LTMP Light vehicle should also be able to be legally driven on UK roads. The initial support period for the selected vehicle will be for five years, although this could be extended for another five years in one-year increments. The estimated programme value was given as GBP 10.4 million, excluding VAT.

The British Army made substantial use of ATVs in Afghanistan, although these should really be referred to as Quad Bikes, with commercial models from Honda and Yamaha being the primary systems acquired. The next phase of acquisitions saw Quad Bikes modified to military requirements by external contractors, then came Quad Bikes built to full military specifications from the start. Trailer systems were also acquired, with light bridging systems also acquired to support the Quad Bikes.

Afghanistan proved that Quad Bikes were very useful operational tools, since they gave units the ability to take the fight to the enemy on long-range patrols and engage from unexpected locations; additionally, they were also very useful for casualty evacuation and for bringing up supplies. Prior to these the British Army had used the Supacat all-terrain mobility platform (ATMP). The Supacat Mk 2 had won the MoD ATMP programme with 36 vehicles entering service in 1988, which was followed in 1996 with a contract for more vehicles and trailers. The ATMP was used in both Gulf Wars, in Kosovo and in Afghanistan, but due to the fact that no measures were taken to support the ATMP fleet, it had to be withdrawn from service.

At this point Supacat were asked whether they could produce more ATMPs or perhaps an improved variant, though they were unable to respond as they were producing other vehicles for the British Army at the time. This led to the issuance of an Urgent Operational Requirement (UOR) for a new ATV, which saw Enhanced Protection Systems awarded a contract for 78 of their Springer vehicles in 2009, with first deliveries made to Afghanistan in 2010. Unfortunately, the Springer was a disappointment and was withdrawn from service in Afghanistan in early 2011, with the vehicle removed from British Army inventory by September 2011.

Since that time, numerous ATV systems have been evaluated by the British Army, including unmanned ground vehicles (UGV). Supacat has gone on to develop the MK III and Mk IV variants of the ATMP and followed that up by developing a hybrid variant (H-ATMP), all of which indicates that there are numerous options to be investigated for LTMP Light.

Moving to medium

The contract notice for the LTMP Medium programme was released on 25 August 2023. The contract value for this programme was given as GBP 80.9 million, covering both the procurement and the through-life support of the selected LTMP Medium vehicle. The initial purchase covers up to 48 LTMP Medium UTVs, which must operate on diesel/AVTUR F-34 fuel, as well as trailers. Contract options could amount to a total of 863 vehicles. The winning bidder must have demonstrable experience of providing through life support for a vehicle fleet.

Outline performance requirements for the LTMP Medium UTV system are as follows: side-by-side configuration (driver and passenger), platform legal to drive on UK roads, minimum speed of 65 km/h when towing at maximum weight, minimum payload capability (personnel, equipment and stores) of 600 kg+, minimum ground clearance (fully loaded) of 180 mm+, trailer weight and payload not to exceed towing capability of the platform or its width. The

Credit: Crown Copyright 2022

Between 2020 and 2023, the British Land Rover fleet declined from 7,595 down to 6,532 vehicles. The out-of-service date for this vehicle fleet is expected to be 2030, meaning that finding a replacement for the Land Rover is rapidly becoming urgent.

Credit: Crown Copyright 2024

A British Army Mastiff vehicle, followed by a Ridgeback vehicle, on the Drawsko Pomorskie Training Area (DPTA), Poland, for Exercise Steadfast Defender 2024. Protected mobility vehicles such as these were required to meet the demands of Iraq and Afghanistan. They are to be replaced under the Land Mobility Programme (LMP).

initial support period for the selected vehicle will be for five years, although this could be extended for another five years in one-year increments.

This article previously mentioned the General Support Utility Programme (GSUP) which was for a 4×4 vehicle, essentially a Land Rover replacement programme. Rugged though it is, the Land Rover has a finite service life and more recently the traditional Land Rover has been replaced in production by a more modern and consumer-focused vehicle. All of which means that the search for a Land Rover replacement had to begin, especially since British Army Land Rover fleet numbers have been declining year-on-year.

According to official figures, in 2020 the British Army had 7,595 Land Rovers in service, and in 2021 numbers had declined to 6,756. The decline continued in 2022 to 6,609 and by 1 April 2023 the fleet number was down to 6,532 meaning that in just over four years 1,063 Land Rovers had been withdrawn from service, some 14% of the total fleet. Assuming that the rate of decline in the Land Rover fleet continues at the present level, there will still be plenty of vehicles around for the foreseeable future. The Land Rover out-of-service date is 2030.

It is worth noting that the old Land Rover is making an important contribution to future UTV systems through Project Lurcher. In April 2023, Babcock were given a contract to convert two Revised Weapons Mounted Installation Kit (RWMIK) Land Rovers and two standard General Service Land Rovers into electric vehicles (EV), in association with partner Electrogenic. After conversion to EV configuration, the British Army Armour Trials and Development Unit (ATDU) went on to trial the vehicles to assess the strengths and weaknesses of EVs in a military environment.

Babcock is also proposing their General Logistics Vehicle (GLV) design, based on the Toyota Land Cruiser 70 to meet British UTV requirements. The Toyota Land Cruiser 70 is actually in use with British Special Forces, as it provides the basis for the Al Thalab long-range patrol vehicle (LRPV), developed by Jankel and the King Abdullah II Design & Development Bureau (KADDB) joint venture, Jordan Light Vehicle Manufacturing (JLVM).

Protected legacy

British Army involvement in the asymmetric conflicts of Iraq and Afghanistan, exposed a significant capability gap in protected mobility vehicles in the face of a rapidly escalating mine and improvised explosive device (IED) threat. This forced the British Army to urgently look to acquire protected mobility that could survive the mine/IED threat. The US military, facing a similar threat, had come up with a new class of vehicle, the mine resistant ambush protected (MRAP) system. A wide variety of MRAP systems in different weight classes became available, with the British Army acquiring some seven different vehicles to meet protected mobility requirements.

The protected mobility fleet included Mastiff, Ridgeback and Wolfhound vehicles, all derivatives of the Force Protection Cougar vehicle, in addition to the Foxhound, the British version of the Force Protection Ocelot, the Husky, a British variant of the International MXT-MV, and the Coyote, a Supacat HMT 600 6×6, and finally the Jackal, a Supacat HMT 400 4×4. As of 2016, the fleet size was: 71 Coyote, 398 Foxhound, 317 Husky, 437 Jackal, 421 Mastiff, 168 Ridgeback and 125 Wolfhound. By 2022, the Husky had been withdrawn from service, leaving the fleet size as follows: 72 Coyote, 398 Foxhound, 431 Jackal, 329 Mastiff, 164 Ridgeback and 88 Wolfhound.

The British Army had decided that it needed to institute a programme to replace legacy protected mobility systems; this resulted in the protected mobility pipeline (PMP), which was itself an outgrowth of a previous procurement effort known as multi role vehicle - protected (MRV-P), which had two elements in the form of the troop carrying vehicle (TCV), which also would also be the basis for a number of variants, with the second element being the future protected battlefield ambulance (FPBFA). To summarise, MRV-P was replaced by the PMP project and this in turn has been replaced by the Land Mobility Programme (LMP) which will rationalise British Army protected mobility fleets and cover the retirement of legacy vehicles currently in service across a range of sectors.

There are four areas covered by the LMP programme: LMP Heavy which will require 500 vehicles in the 20-40,000 kg range, LMP Medium covering 2,000 vehicles in the up to 20,000 kg range, LMP Light covering 2,500 vehicles in the up to 10,000 kg range and LMP Utility with 3,000 vehicles in the up to 7,000 kg range. It should be noted that LMP is separate to the LTMP Medium and LTMP Light programmes.

Four basic families of wheeled armoured vehicles provide the foundation for the LMP, with each vehicle type spawning a number of different variants to fulfil desired mission requirements. The vehicle is treated as a platform into which different mission system packages are integrated to cover the desired roles. The objective is to reduce the number of different vehicle types in service and instead focus on the four separate LMP vehicle families, which will reduce costs and ease the through-life support task.

The aim of all of these programmes is to finally replace legacy vehicles in British Army service and remove vehicles that no longer fit envisaged mission parameters. There is even the suggestion that LMP could cover the replacement for the venerable FV432 Bulldog; as of 1 April 2023, 746 of these vehicles were still in service and the stated out-of-service date is 2030, 67 years after the type first entered service! The problem in all of this is that the British Army has no problem generating new vehicle programmes – the problems come when trying to make these programmes a reality. With the new SDR due in less than a year, it's a difficult time for new vehicle programmes! ■

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Recovering nicely

Shaun Connors

In July 2024, Rheinmetall MAN Military Vehicles (RMMV) hosted a recovery capability focused event at the company's main production facility in Vienna, Austria. While primarily for users and potential users of RMMV's recovery solutions, the final session of the event was set aside for a small group of invited military-specific journalists. Here, the company demonstrated the capabilities of its latest Miller-equipped recovery trucks.

By way of background, RMMV is a 51/49% 2009-created joint venture (JV) between Rheinmetall and truck maker MAN (Maschinenfabrik Augsburg-Nürnberg). The JV originally encompassed all of Rheinmetall's wheeled vehicle portfolio including armoured vehicles such as Boxer and Fuchs, but in 2019 it was restructured and now covers only trucks. MAN is now part of the Volkswagen-owned TRATON Group, along with Scania and Navistar.

RMMV's JV agreement essentially has the company being responsible for all sales to military customers of MAN's commercial product line, this including 'white fleet' (non-combat) vehicles. This bulk of these sales are for militarised medium weight TGM and the heavier-duty TGS, these collectively marketed by RMMV as TG-mil. TG-mil trucks are available with varying degrees of militarisation, this ranging from a relatively basic flat paint finish, rifle racks and a recovery points package through to higher standard electromagnetic compatibility (EMC) and electromagnetic interference (EMI) packages, a reinforced roof with circular hatch, and cold climate preparation. MAN's lighter weight TGL and long haul-optimised TGX ranges can also be offered by RMMV as white fleet solutions, or with limited militarisation. Since 2017 a badge-engineered Volkswagen Crafter (the MAN TGE) has also been available, with a 2024-announced JV with Torsus of the Czech Republic adding a capability enhanced TGE to the portfolio.

RMMV's truck offering is rounded out by the HX range, this a purpose-designed military truck. The HX truck was designed by MAN and is based around MAN's automotive components. The design is considered the spiritual successor of the MAN Kat 1 high mobility trucks of the 1970s.

Credit: Miller Industries

During trials in Australia, a 45M suspend tows a HX77. Note the difference in tyre size between the two; 395/85 R 20 on the HX77, 16.00 R 20 on the 45M

The bulk of RMMV's truck production occurs in Vienna at the former ÖAF-Gräf & Stift AG site. With a legacy tracing back to 1911, the facility now covers 95,000 m², of which 60,000 m² are built up. Over the course of 2024, the sites' 1500 employees (of which >200 are engineers) will manufacture 2200 trucks on two production lines, increasing to 2600 in 2025. The technical capacity of the plant is 4000 trucks per annum, but this would require a two-shift system.

These production figures are quite interesting. The military truck market is far more peak & trough than its commercial equivalent, and using the UK as an example, the 2005 award to the then MAN ERF UK Ltd for the Support Vehicle contract would with around 7500 trucks replace a good 60% of the fleet of the time. However, there will be no serious attempt made to replace these trucks until the end of this decade, showing the often large time-lag between orders.

Commercially, MAN currently produces around 48,000 medium and heavy trucks annually, this giving the company a healthy 13% European market share, albeit a point or two behind rivals Daimler (Mercedes-Benz), DAF and Volvo. While military production, delivery and order figures are generally more difficult to obtain, RMMV's figures give the company well in excess of a 40% European market share for the military segment, that figure increasing to circa 80% for the German home market.

RMMV's Vienna facility produces TGS TG-mil and HX range trucks, but also handles the build of the most complex of MAN's commercial offerings, the type of truck that would cause too much disruption on a modern 'just-in-time' semi-automated automotive production line. Quantities vary, but commercials that include STGO heavy tractor units, multi-axle chassis and other complex 'specials' can account for up to 20% of Vienna's total output, these helping to level out those previously mentioned military troughs. Militarised TGM trucks,

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Credit: Shaun C. Connors

Vienna has two production lines, the main line runs at between eight and 12 trucks per day, while the other which is reserved for the most complex builds produces trucks at no more than one per day

which are generally not militarised to the same levels as TGS, are now manufactured at MAN's facility in Krakow, Poland, with production shifting to MAN's new volume commercial facility following the sale of MAN Truck & Bus Austria and its production facility in Steyr during 2021.

In Vienna, trucks leave the main production line at a rate of between eight and 12 per day (dependent on mix and complexity), the production line deftly melds the labour-intense build of a military or 'special' truck with the best of MAN's volume production know-how. The entire facility in fact echoes this melding, and while the likes of quality control and uniformity of finish is everything one would expect of a premium German-build vehicle, with its vast array of on-site engineering facilities and an engineering-biased (as opposed to assembly-biased) workforce, the impact of supply train glitches and the inevitable peaks and troughs of the military segment can in many cases be reduced by an on-site manufacture/fabrication capability for various component parts when required.

The second production line is reserved only for the most complex of trucks, examples here being the HX81 8×8 heavy equipment transporters (HETs) that are currently in production for Austria and Germany, or the five-axle 45M 10×10 recovery trucks for Norway, these leaving the line at a rate of between half and one truck per day.

The benefits of MAN's involvement in the JV also stretches to in-service support. Users of RMMV's trucks have access to MAN's global support network, this including the novel 'man in a van' approach that operates in Germany and the UK (both of which have sizeable RMMV fleets). While primarily for commercial customers, if needed a technician can travel to any military vehicle with a complete package of diagnostic equipment and essential spare parts. In-theatre support is a further option. Looking ahead, and with MAN being part of TRATON and greater commonality between MAN, Scania and even Navistar inevitable, the global support available for RMMV-supplied trucks will increase accordingly, and potentially to previously 'difficult' markets such as the United States.

The hardware

RMMV's recovery event also allowed for some informed insight into the ever-increasing difficulties of adapting a modern commercial truck such as the TG for military use, or indeed even using components/aggregates of commercial origin in a military-specific truck. While these difficulties are very real, and will only get worse, for certain there will never be a return to the days of a true military-specific truck using military-specific aggregates. For those old enough to remember, as examples of such vehicles, I give the Leyland Martian and the Alvis Stalwart.

Commercial trucks, like cars, are continually evolving, and with every passing year the levels of technology found in a truck increases considerably. This technology can range from something as 'simple' as a more environmentally friendly engine, right through to state-of-the-art electronic systems that start you, steer you, stop you, and do a lot of other things for you. While for the most part these updates are probably a good thing for the truck that delivers stock to your local supermarket, they're definitely not such a good thing on a military truck when a military truck is doing what a military truck is designed for.

Some military users retain a pragmatic approach with regards to technology updates and so on, but others really do require what is essentially a supermarket delivery truck to be battle ready with little more than a coat of green or tan paint, and somewhere to put a rifle. This thought process can either be due to increased political pressures for compliance environmental and/or safety regulation, or it can be that those issuing requirements genuinely do believe that a supermarket delivery truck is pretty much ready and suited to military applications.

Fuel for thought

The term 'simple' is used here in context, but issues can be a simple as fuel type and compliance with emissions. Current-generation diesel engines feature highly complex electronic management and fuel additive systems to make them as fuel efficient as possible, while reducing emissions to an absolute minimum. Perhaps understandably, the military when deployed to theatres such as Afghanistan or Mali, have far more important fuel issues to consider than economy and emissions. It has long been a NATO requirement that for all the right tactical reasons that all 'green' vehicles

Credit: Shaun C. Connors

The task of militarising a commercial truck such as MAN's TGS will only ever get harder and harder. With their next major electronic architecture update, TG cabs will go mainly touchscreen. How will that work in a tactical blackout situation?

are capable of running on aviation/jet fuel (F34/JP8). Jet fuel can contain up to 3000 ppm (parts-per-million) of Sulphur, while in comparison the low-Sulphur diesel most civilians obtain from the pump contains no more than 10 ppm of Sulphur.

Any engine capable of running for extended periods on jet fuel will by design also be tolerant of poor-quality and lower-grade fuels, such as the types of fuels commonly found in the developing world, and where in recent years many NATO-grade/European militaries have found themselves deployed. This is problematic for newer engine designs, given that an electronically-controlled and emissions-compliant (currently EURO 6, with EURO 7 from 2027) engine optimised for low-Sulphur fuel, will simply not tolerate any other type of fuel for extended periods without damage and/or failure.

However, the wholly unrealistic demands for an engine that runs EURO 6 'at home' but at the equivalent of a switch flick adapts seamlessly to F34/JP8 when required, and then back again to EURO 6 and having suffered no damage to the engine and/or fuel system are increasing. The sensible compromise here, which is becoming ever harder to reach, would be an engine rated at EURO 3 standards. The vast majority of EURO 3 engines are capable of running on high-sulphur/dirty fuels for extended periods, and it is a point of note that the reduction in emissions between EURO 3 and 6 is near-miniscule when compared to the drop between EURO 3 and no EURO standard compliance at all. Further supporting that EURO 3 compromise argument, one large container ship transporting disposable plastic goods from China to Europe, over the course of one trip, has a greater emissions footprint than 2000 EURO 3-rated military trucks covering 10,000 km each per annum.

Electronic systems, especially so-called driver aids, are another bane of those tasked with militarising a commercial truck design. While undeniably useful in a peacetime environment, tactically most of these aids become useless. When being seen is not an option, military vehicles have long had a simple blackout switch that, as its name suggests, extinguishes all light sources. In a truck or similar, the driver then slips on night vision goggles. For that same tactical environment the truck driver now needs to be able to neutralise not only lighting, but all audible warnings, while selectively being able to override braking, collision or any other driver or pedestrian/cyclist safety aids the user has opted to have, or been required to have, fitted. At its simplest, when push comes to shove the soldier may actually need to drive over or through an obstacle which assorted safety aids and other systems simply would not permit, or at the very least not without assorted visual and audio warnings.

There is also the added issue of 'hardening' to military standards – EMC, EMI, and even electromagnetic pulse (EMP) – all the cameras and sensors. Waterproofing of these for fording operations is yet another consideration, and that includes salt as well as fresh water. Such are the complexities here that by way of example it is now not economically viable to proof a TG truck for fording beyond commercial norms.

Recurring costs

A key issue with militarising a commercial truck is that this militarisation task is essentially never-ending. Using RMMV's TG-mil as an example here, the current commercial TG is TG Generation 3 (TG3), this introduced in 2020 and now the baseline for all current TG-mil. As with most things commercial and automotive, facelifts or refreshes are a regular occurrence, and in 2022 TG3 received its first planned incremental update. It is receiving another in 2024 for MY25 trucks, and will receive a final one in 2027. For each of these updates, which are usually heavily legislatively-driven, and for the most part related to electronic architecture, militarisation has to be developed, and this is both time-consuming and expensive.

Another issue is timelines. Most commercial customers take deliveries across months, this even for sizeable fleet replacement orders. With the military, deliveries are more often across years, and this in itself creates further challenges. In 2014, taking a joint procurement approach, Norway and Sweden signed a contract with RMMV for TG-mil and HX trucks, for which orders could be placed until 2025, with deliveries following until 2027. A militarisation package that included EMC/EMI to military standards equal to those of an armoured fighting vehicle (AFV) was developed for TG Generation 2 (TG2), and primarily to meet the needs of the Norwegian customer. In fact, such are the costs and to a lesser degree lack of commonality implications of a recurring militarisation development process to these levels, that the Norwegian customer adopted a pragmatic approach and, having received a batch of TG2 TGS, will wait for further TGS deliveries until the full militarisation package is developed for TG3-based TG-mil around the MY25 update. This is scheduled to be the final significant electronic architecture update scheduled for TG3, but is unfortunately not the final scheduled update, which is due in 2027.

The current HX range of tactical trucks are based on TG2 and its electronic architecture, this including much of the TG's instru-

Credit: Shaun C. Connors

Technically the entire MAN portfolio can be fitted with military recovery bodies, but in general nothing smaller than a three-axle truck is. This TGS 8×8 was photographed on trial in Asia.

Credit: Shaun C. Connors

For a cab comparison, side-by-side and both fitted with relatively low-profile 395/85R 20 tyres, on the left is a Swedish Army TGS 8×8 (TG2) and on the right, an Australian Army HX77 8×8.

mentation. To limit regular re-work primarily of electronic architecture, final development of next-generation HX trucks (HX3) was held back by RMMV so that TG3 MY25 updates could be adopted for this. However, even this approach will not eliminate all challenges. Currently, even after TG3's 2022 update, 'real' (physical) switches remain, for driving modes, traction aids and similar. Along with the MY25 electronic architecture update, which will include a selection of advanced driver assistance systems (ADAS), will come considerably more touchscreen technology, this at the expense of most physical switches. While a yet-to-be-developed 'mission mode' switch will in theory enable any fitted ADAS or other undesirable 'aids' to be overridden when required, quite how things will work with a touchscreen in a blackout environment and by a soldier in Arctic clothing (including gloves) remains to be seen.

Then there is the TG3's aforementioned 2027 update. This update is predominantly to comply with new Enhanced Direct Vision requirements, and while enhancing all-round visibility and removing potential blind spots from a truck operating in a busy urban environment is clearly a good idea, how will all that additional glazing (including in the side doors) fare in a military environment?

As previously noted, HX are RMMV's tactical truck offering, and while they utilise MAN's electronic architecture and automotive components, the chassis and cab are purpose-designed for military items. The chassis benefits from not needing to be a one-size-fits-all type design, such as one that is suitable for everything from tipper to curtainsider. The easy-to-repair, eminently practical box-like flat-panelled all-steel cab is curve-free and shows not a trace of ergonomic or aerodynamic styling, the design of which enables the fitting of an integrated steel front bumper and skid plate. In an ex-

cellent example of the 'if it ain't broke why fix it' school of thought, the HX cab, while improved, is not that different to the cab fitted to the original Kat 1 trucks of the 1970s, and the flat split front windscreen remains a rare example of a military exemption being retained. A further benefit of the cabs' flat panels, as opposed to curves, are that they readily accept armour in kit form. For more significant threats, a Rheinmetall-designed and produced armoured swap cab is available, this providing protection levels equal to those of some armoured personnel carriers (APCs).

Another point of contention to mention on the militarisation topic would be the health and usage monitoring system (HUMS). Again, commercially, and even militarily for homeland roles, such systems can be nothing other than useful. There are however a number of challenges to overcome before any military fleet can be fitted with such a system. Least of all, adoption of a HUMS arrangement by any armed force would essentially require a full reset of existing maintenance and general fleet management thought processes and practices. Yet perhaps more importantly, there will be times when any HUMS fitted truck is best to not be transmitting any data (and potentially advertising its location), while the system itself, in addition to being militarised in the areas of EMC/EFI/EMP performance, also needs to be 'hardened' and cyber-secure for when transmission of data is acceptable.

Of course, all of the aforementioned and other similar issues are not exclusive to RMMV. They most definitely apply to any and all commercial truck manufacturers that offer a military product, and to a lesser but still significant extent, to any armoured vehicle produced that uses commercial-off-the-shelf (COTS) components such as engines.

Follow the leader

Before our look at the recovery assets on show at what was predominantly a recovery event, a quick mention of another displayed truck, and one in which the electronic technology may shortly offer the military user a genuinely valuable capability.

Vehicle autonomy is definitely a topic of the moment, but irrespective of some claims made, in the cold light of day, true full vehicle autonomy in any meaningful sense is still a very long way off. For those familiar with the 1990 Arnold Schwarzenegger film 'Total Recall', the Johnny Cab, or similar, will not be giving you a ride anywhere anytime soon. Realistically, we remain firmly in a world where an autonomous vehicle can be halted by a 50 mm deep puddle, for essentially the same reasons it would halt some horses.

However, a couple of steps before full autonomy is so-called leader-follower technology, and RMMV's take on this was explained at the recovery event. With a manned truck at the front leading AI a convoy of trucks can follow one another, with RMMV suggesting that the system could be rolled out in some form by around 2030. There remain challenges of course, and while no autonomous system can currently even effectively 'think' to slightly change a driven line if a route is becoming heavily rutted, and would likely encounter problems should a hill climb be failed, at the rate AI is developing, these and many similar issues that are currently represent the chasm between human and AI capability will almost definitely no longer be.

Recovery

The full RMMV truck portfolio will accept a recovery body, from the lighter TGM TG MIL through to the five-axle HX45M. The majority of recovery trucks, or 'wreckers' to some, are on chassis with three-axles or more, and these are usually chassis with gross vehicle weight/gross combination weight (GVW/GCW) ratings above road-legal limits. Recovery bodies can be sourced from a selection of suppliers, although in recent years RMMV has tended to favour Miller of the United States, and predominantly for rotator configurations.

On show at the recovery event were three HX trucks, an Austrian Army 6×6 42M, an 8×8 44M Heavy Recovery Vehicle in what was believed to be Canadian Enhanced Recovery Capability (ERC) configuration, and a Norwegian Army 45M 10×10 Special Recovery Vehicle.

Recovery truck capability requirements vary considerably from one armed force to another and two trucks to be used to recover loads of essentially the same weights and dimensions can, depending on user, actually end up being specced and looking quite different. The Austrian Army's displayed 42M 6×6 is probably even more user-specific than most.

Packaged and delivered by EMPL of Austria, the 24 medium recovery vehicles (mittleres Bergefahrzeug HX2 (mBgeFzg)) delivered to the Austrian Army in 2022 cost around EUR 1 million each. These 27.6 tonne trucks (78 tonne GCW) are fitted with a rear-mounted Palfinger 41002EH materials handling crane rated at 36 t/m (equating to 3.8 tonnes at 9.5 m of extension). This crane was specified for use with a purpose-designed hydraulic balancing bar/frame rated at 5 tonnes, this for lifting vehicles and the handling of the EMPL swap bodies fitted to the Austrian Army's TGM fleet. The EMPL underlift which extends to 2.17 m is rated at 8 tonnes, this enabling the truck to recover Austrian Army KMW Dingo armoured vehicles. Twin 12 tonne Sepson winches are fitted, these have 60 m of cable and, in addition to recovering bogged down vehicles, can be used to haul disabled vehicles onto a companion recovery trailer. These four-axle trailers were supplied by EMPL in cooperation with DOLL of Germany. To RMMV, the Austrian truck is designated the 42M 6×6 Light Recovery Vehicle.

The 44M 8×8 Heavy Recovery Vehicle and 45M 10×10 Special Recovery Vehicle (RMMV designations) shown at the event were both fitted with Miller recovery bodies, and despite the obvious axle configu-

Credit: Shaun C. Connors

Using the rotator and main winch, a Canadian spec 44M demonstrates the type of controlled recovery of an overturned casualty that is possible with this set-up

Credit: Miller Industries

During Australian Army trials, a 45M. And while technically not necessary when recovering something as 'light' as a Unimog, when suspend towing the rotator sits forward to shift additional weight to the front axles.

ration difference, the recovery packages were almost identical, based around a Miller 1050M rotator and a Rotzler TR200 capstan-type main winch. As a capstan-type winch, the main recovery winch has a constant 25 tonne single line pull for 103 m of cable, this in double line pull configuration easily allowing for recovery of relatively heavy vehicles such as the Boxer 8×8. The Miller rotator is fitted with twin Tarvos TA15 drum winches, these rated at 10 tonnes on the bottom layer and 6.6 tonnes on the top layer. For self-recovery, a single winch can be deployed to the front of the truck.

The rotator set-up is relatively new in the recovery world, originating in the US and making initial market inroads in the mid-1990s. An evolution of sorts of the Holmes-type twin-boom wrecker, a rotator, as its name suggests, has a boom that rotates a full 360 degrees, allowing for a recovery pull in almost any direction. Even without an extending boom option, a standard rotator offers the benefit of height/lift with any recovery pull, and when used in conjunction with the main winch a single vehicle can recover a roll-over casualty in a controlled manner.

The rotator was never designed as a crane, and while technically still not a crane, a vertical lift capability is now part of standard specification, and the rotator is covered by crane legislation within the EU. The Miller 1050M has a 10 m extending boom and user requirements it needed to meet included a 32/21 tonne in/out vertical lift capacity for Australia (45M), and a 16 tonne capacity at 6 m (20 ft) for Norway (45M). The latter was essentially not strictly a recovery task, but to be capable of handling fully laden/kitted out 20 ft ISO containers. Technical lift capacity of the 1050M is 45 tonnes.

The final part of the recovery package fitted to these trucks is an underlift, this rated at a hook load capacity of up to 15 tonnes. Again, this is sufficient for the towed recovery of a Boxer. Maximum extension from the centre of the rearmost axle for the underlift is 4.7 m (44M) or 4.2 m (45M). The 44M has a GVW of 38 tonnes, this increasing to 41 tonnes when an armoured cab is fitted. The 45M has a GVW of 40.8 tonnes, this increasing to 43.8 tonnes when an armoured cab is fitted. GCW for both trucks is 75 tonnes.

The two trucks are as previously noted essentially identical in terms of spec, including automotives based around a MAN 12.4-litre, six-cylinder, EURO 5 rated D26 diesel developing 402.7 kW (540 hp) and coupled to a ZF seven-speed fully automatic transmission. The main automotive differences are drive axles and suspension, the rear tridem of the 45M having hydropneumatic suspension (with a lock-out feature) as opposed to the more conventional longitudinal inverted trapezoidal leaf spring set-up of the 44M. The fifth axle of the 45M contra-steers giving the 11.6 m long vehicle a slightly better turning circle than the 10.9 m long 44M. Tyres, a more important consideration than one might at first imagine, can be 395/85 R 20 or 16.00 R 20. Run-flat inserts and a central tyre inflation system (CTIS) are options.

Customers' differing desires/demands are again clearly highlighted in these recovery trucks which as previously noted have very similar recovery capabilities. Pricing will of course be a key driver for some, with the 44M (with an armoured

Credit: Shaun C. Connors

MAN's commercial 'man in a van' support solution is available to military users if required. Note the smaller 395/85 R 20 tyres on this Norwegian 45M, compared to Australian examples which have 16.00 R 20 tyres.

Credit: RMMV

A 44M destined for New Zealand

cab) coming in at a unit price of around EUR 2 million, about EUR 0.5 million less than the larger 45M.

In terms of mobility, both trucks can ford 1.5 m of water, cross a 1.4 m wide trench, and at GVW climb a gradient of at least 60%, and traverse a 30% side slope. Climatic operational range is -32°C to +49°C. However, its overall weights/dimensions notwithstanding, with comparable tyres the 45M would in most cases be the more mobile of the two trucks. The extra axle is key here, reducing those all-important axle loads for soft ground mobility.

The Australians and the Norwegians both currently operate the HX45M, with a Norwegian truck shown at the RMMV event. Both Australia and Norway opted for a EURO 5 emissions-compliant engine, and despite a non-emissions-compliant option being available. Visually it is very clear the two trucks differ in tyre choice. For mobility, Australia opted for the larger 16.00 R 20 tyres, these when compared to the 395/85 option improving approach, departure and ramp breakover angles, increasing ground clearance and tyre footprint, while reducing overall ground pressure. Norway's 45M as opposed to 44M decision is understood to have been mainly legislatively-driven, and primarily for axle loading compliance when towing a casualty. These loadings were achievable with smaller-diameter (and cheaper) 395/85 R 20 tyres, and these are fitted. Other 'benefits' of 395/85 R 20 tyres opposed to 16.00 R 20 tyres are reduced overall height (when keeping below the EU 4 m regulation is deemed important), and a reduced turning radius (when meeting the EU regulation outer circle 12.5 m radius requirement is deemed important). The 44M Heavy Recovery Vehicle shown at RMMV's event was understood to be in a configuration for Canada. RMMV could not confirm this, but ESD sources suggest that Canada's long-awaited Enhanced Recovery Capability (ERC) has been awarded to the company. Sources also suggest that RMMV ended up being the sole bidder for an already over-complex requirement that was further complicated by the need to comply with the widely-varying road and operating regulations across Canada's ten provinces.

The 44M has also been supplied to New Zealand and Singapore with a Miller-supplied recovery package. Compared to the Canadian 44M, these trucks, which are designated 44M Medium Recovery Vehicle by RMMV, are fitted with a lower-powered 440 hp D20 engine, this again rated at EURO 5. Tyres are 395/85 R 20. With the exception of the Miller 1130 rotator, which has a shorter extension and slightly reduced lifting capacity compared to the Miller 1050M on the Canadian example, in all other recovery equipment areas these and the Canadian truck are essentially the same.

For all the obvious reasons a rotator-type recovery package is now becoming a more common choice than one using a conventional vertical lift crane, and certainly in the commercial sector. The military, traditionally conservative and 'late to the party' (for the right reasons in most cases) for such a capability evolution are now most definitely looking more closely at the rotator as a recovery option.

The first known European military customer of a rotator-type recovery package on a tactical truck was Denmark, which in 2013 ordered 14 RMMV SX45 with a Miller-supplied package. Interestingly, and despite its US origins and very sizeable home market share, the US military has yet to adopt a rotator-based package for any of its tactical truck-based recovery assets, these on the FMTV, HEMTT, MTVR and LVSR. In Europe, RMMV while continuing to offer

Credit: RMMV

In one package costing around EUR 2.5 million, the 45M is technically capable of winch recovering, suspend towing or uprighting all Boxer variants. The rotator is also capable of lifting all mission modules. No single Boxer recovery variant (costing an estimated EUR 10-12 million) would be capable of this.

variously configured recovery packages on TG-mil and HX trucks, is clearly actively promoting the rotator, with Germany and the UK understood to be markets of interest.

Food for thought

For essentially as long as they have been used, when an armoured vehicle is developed for and delivered in any quantity to an armed force, a recovery and/or recovery and repair variant usually follows as either part of a family of variants, or even as a lone specialist variant. Taking the British Army as an example, there were separate Warrior repair and recovery variants, a CVRT recovery variant, a Challenger 2 MBT repair and recovery variant, and most recently there are separate repair and recovery variants of Ajax. However, just because historically 'like recovers like' has been the default assumption, does it mean there it must always be?

The Boxer 8×8 armoured vehicle has been supplied to or is on order with (among others) Australia (211), Germany (550, with more probable), The Netherlands (200), and the UK (623, with more probable). While Boxer's swappable mission module design has allowed for somewhere in the region of 20 mission module configurations to be placed on contract (and well over 30 proposed), as yet no Boxer user has a recovery or even repair/recovery module in production or service. Australia is understood to be developing and considering separate repair and recovery modules, while both Germany and the UK have openly acknowledged the need for a Boxer recovery (and repair) capability.

To meet this need RMMV, is actively promoting the 45M Special Recovery Vehicle as delivered to Australia and Norway, this easily capable of winch recovering, uprighting, and suspend towing a Boxer, the latter possibly with some peacetime limitations on highways. The vertical lift capacity of the rotator also allows for the handling of individual Boxer modules.

Within the region of 13 to 14 tonnes of total payload available (including module structure) there is no possibility of integrating this complete capability into one Boxer module, hence the two-module route Australia is exploring. If one were to outfit a Boxer module with a main winch capable of recovering a bogged Boxer, the available 'payload' left over for a crane would be insufficient for anything near that of the rotator fitted to the 44M/45M. Conversely, fitting a crane of comparable capability, would likewise reduce the winch capacity. Additionally, neither of these options factors in an underlift capability, which would almost certainly not be something that could be fitted to a Boxer.

It is true that the 45M is longer overall than a Boxer and, when fitted with an armoured cab, around 5.3 to 7.3 tonnes heavier (depending on the Boxer configuration), however, mobility is unlikely to be an issue. When fitted with 16.00 R 20 tyres, ground pressure drops as individual axle loads are around 10% lower than those of Boxer in the heavier A2/A3 (mixed) and A3 configurations (as supplied to Australia and the UK respectively), and are just under 5% lower than Boxer in its lightest A1 and A2 configuration (as supplied to Germany, Lithuania and Netherlands). ESD sources report that in an unofficial comparison a 45M successfully followed a Boxer off-road evaluation and demonstration route. Fording, gradeability and climatic operational range are all comparable.

Detractors from the idea of abandoning what has always been regarding a recovery variant might point out that the truck's armoured cab does not provide a level of protection equal to that of Boxer, and that only the crew compartment itself is protected. Both of those statements are true, and while zoned protection for areas such as fuel tanks, air reservoirs, radiators and battery boxes is always an option, by its very nature a recovery operation would generally not be carried out under direct fire. Detractors might also say that a truck adds to any logistic burden as the HX range has no significant component commonality with Boxer. This is also correct, but the Australians, British and German armed forces each operate thousands of RMMV HX trucks. That one fact also mitigates the training and driving argument, as it is probably fair to say that if you are qualified to drive a Boxer, if push ever came to shove, you could almost certainly drive an HX truck.

Yet possibly the clinching argument for the 45M-based solution is that of cost. While obtaining exact pricing information for such things is always difficult, a figure of EUR 2.5 million for an 45M Special Recovery Vehicle is that generally quoted and believed to be reasonably accurate, while the most conservative figure quoted for a Boxer in recovery/repair configuration is around the EUR 10-12 million mark. With a price difference as stark as this, the case for abandoning the long-held tradition of 'like recovers like' appears fairly convincing. ■

Credit: RMMV

An Australian Army 45M with a softskin cab. Note the contra-steer of the rearmost axle, this giving the 45M a slightly smaller turning circle than the 8×8 44M.

Building up: The need for more military bridging systems

Tim Fish

NATO is currently faced with a shortage of military bridging systems. This state of affairs has been brought sharply into focus by the War in Ukraine where rivers and waterways have become dividing lines between Russian and Ukrainian forces. The inability to cross water gaps is one of the major limiting factors in any offensive operation. In Ukraine, Russia lost many bridging systems during its initial offensive in February 2022, in large part due a to lack of awareness of their opponent's capacity to detect and engage forces attempting gap crossings. Despite this, the country still possesses a large inventory. However, the shortage of bridging equipment in NATO member countries' stocks, poses a considerable risk to ground manoeuvre operations. This article looks at the bridging equipment and capabilities in NATO armies.

NATO forces possess a wide range of different sets of bridging equipment. This can be broadly separated into three different categories: Armoured Vehicle-Launched Bridge (AVLB) systems, truck-based bridge systems, as well as ferry and pontoon bridge systems.

AVLBs are usually based on main battle tank (MBT) platforms, and are used for crossing narrower water gaps or obstacles up to 26 m. Because they are using MBT hulls with tracks, these systems can move alongside and within heavy armoured formations, with roughly the same mobility as the MBTs themselves; they are also armoured and are the only systems capable of laying bridges under fire.

The truck-based systems can deliver similar short bridge spans, or modular bridge platforms to cross narrower water gaps; as they are fitted to trucks, these systems are cheaper and can deploy faster on roads. However, truck-based bridge systems cannot be used in dangerous areas as they are too vulnerable under fire, but they are very useful in establishing a larger number of bridges quickly in safe areas to rapidly improve access to and from the front line to allow faster logistics support.

Author

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Credit: US Army

Older AVLBs such as the Biber are being replaced in NATO armies with more capable bridging platforms, with legacy systems often sent to Ukraine to provide a gap-crossing capability.

Ferry and pontoon bridges are used to cross much wider and larger water obstacles. Some ferry systems are based on amphibious vehicles that can work in forward areas to rapidly deliver heavy armour across lakes and rivers to establish a secure position on the opposite bank so that a pontoon bridge can be set up.

Pontoon bridges can be amphibious ferry sections joined together, or floating sections that are delivered by truck, placed into the water and connected together in order to establish a much longer bridge potentially hundreds of metres long.

Falling short

NATO has a shortage of all types of bridging equipment, but in particular there is a lack of ferry and pontoon systems. This is problematic, since the European theatre is full of wide wet gaps that are challenging to cross. Existing civilian bridges and infrastructure could be damaged or destroyed in a conflict or deemed unsafe for heavy armoured vehicles to cross. This means alternatives are needed.

One of the main European amphibious ferry systems is the M3 amphibious rig, which is

Credit: GDELS

At 13.3 m long and 3.35 m wide, the M3 rigs can deploy rapidly and move at 14 km/h in the water, operated by a crew of three including driver, engineer, and other specialists.

supplied by General Dynamics European Land Systems (GDELS). The M3 rig is based on a 4×4 amphibious vehicle fitted with aluminium pontoons on the roof that unfold before entry into the water. The floating rigs can be positioned using two traversable pump jets activated from a controlling station topside and then connected together. Each rig has a crane and four folding ramps that can be laid across the topside to either form a 100 m long bridge (in 15 minutes), or 2–6 rigs can be connected to form a ferry of different sizes.

The M3 has a military load classification (MLC) 85, supporting tracked vehicles up to 85 US tons (77 tonnes) and wheeled vehicles up to 132 US tons (120 tonnes). The M3 was first introduced in 1996 and is used by an Anglo-German Multi-National Bridging Amphibious Engineering Battalion (Amph Engr Bn) 130 based in Minden, Germany, which includes British Army Royal Engineers. The battalion was formed following an agreement between UK and Germany in March 2023 and is part of the Bundeswehr's 1st Panzer Division.

The UK and Germany have plans to replace the existing M3 rigs with new systems under the Next Generation Wide Wet Gap Crossing Capability (NG WWGCC) project run by the British Army in partnership with the Bundeswehr, under a Memorandum of Understanding (MoU) signed by both countries in December 2021. The British Army is expected to procure about 30 platforms with deliveries completed in 2032.

A GDELS spokesperson told ESD: "Today's focus is on fast ferry operations, and here the M3 is worldwide unique. Its newest generation requires a crew of only two instead of three, the electronic system is fully digitalised, and we have introduced other improvements such as an arctic kit for ice-free walkways, new engine and gearbox." The spokesperson added: "The M3 can carry every NATO vehicle including the heaviest versions of the Challenger and Abrams MBTs."

The US Army uses Improved Ribbon Bridges (IRBs), also manufactured by GDELS, which can be integrated with the M3. The IRB is a pontoon bridge system consisting of floating bay sections that are transported by 6×6 bridge transporter vehicles that use a crane to place them in the water. When linked together, the IRB can form a 100 m long bridge in about 30 minutes, providing a gap crossing capability with MLC 80 for tracked vehicles and MLC 96 for wheeled vehicles. The 6.75 m wide sections also allow for two-way traffic. The Netherlands is the most recent operator of the IRB after it placed an order in July 2023, with deliveries due in 2025–26.

The French Army's pontoon bridge system, the Engin de Franchissement de l'Avant (EFA), is built by CEFA and based on a 4×4 amphibious vehicle with attachable inflatable pontoons. The EFA has a payload capacity of 70 tonnes and is operated by a crew of four. The pontoons are inflated before deployment and with two large pontoons on either side of the vehicle, with a further four attached to an extendable bridge section that is deployed at either end of the vehicle. This creates a 34.55 m long bridge or ferry, or four of them can be used to set up a 100 m long bridge within 15 minutes. France has 30 EFAs in service.

New options

CNIM has developed the new Pont Flottant Motorisé Nouvelle Génération (PFM NG) system available as the PFM XP (Expeditionary) or PFM LG (Long) to replace the French Army's existing PFM F1 and F2 pontoon bridge systems. The PFM NG system was first unveiled by CNIM in 2021 and has a rating of MLC90 for tracked vehicles and MLC100 for wheeled vehicles.

The XP is deployed from an 8×8 logistics truck and uses 6.7 m modular floating sections and ramps that are deployed straight into the water using a launching mechanism. In a ferry configuration using four sections, the XP can support MLC90 for tracked vehicles and MLC80 for wheeled vehicles, with lower MLC ratings of 60 and 40 respectively for a shorter ferry configuration comprising two sections.

The PFM LG is deployed from a 6×6 truck and a three-axle semi-trailer that can support 10 m modular floating sections and ramps, which are likewise deployed into the water via a launching system. Each LG unit has an outboard motor for in-water manoeuvring and when sections are fitted together, they can form a 100 m long bridge in 30 minutes or smaller sections that can operate as a ferry. Using four sections, the LG has an MLC 90 for tracked and MLC 80 for wheeled vehicles, with lower MLC ratings of 70 and 60 respectively for the smaller three-section ferry configuration.

In 2015, the DGA contracted CNIM to upgrade ten of its old PFM F1 system to the F2 standard with upgraded ramps and

Credit: CNIM

France needs to replace its older PFM F1 and F2 pontoon bridge systems with a new system capable of supporting heavier armoured vehicles.

modules. However, the new ramps can only sustain loads of MLC40 and the PFM F2 is still limited to payloads up to MLC65. Whilst the French Army has retained a largely wheeled armoured vehicle fleet, which may come under the payload limit, it still has the Leclerc MBT, which is tracked and cannot be transported by the old PFM. This is a problem across NATO as armoured vehicles have become much heavier. Modern and upgraded MBTs and IFVs are larger and weigh considerably more than their predecessors some 30–40 years ago. MBTs now typically weigh well in excess of 60 tonnes, sometimes significantly more. Extreme examples include the British Army's Challenger 2 TES configuration, currently the heaviest in NATO at 74.8 tonnes, with the M1A2 Abrams SEPv3 fitted with the Force Protection (FP) armour kit coming in a close second at 71.6 tonnes.

Revised standards

To meet the challenge of heavier vehicles, NATO has a new minimum MLC of MLC80 to allow for the heaviest of MBTs and Heavy Equipment Transporters (HETs), which carry tanks, to cross bridging systems safely. This will require a massive upgrade or replacement of existing bridging equipment, much of which has an MLC50 or 60. Whilst the MLC standard does not just equate to a vehicle's tonnage (the calculations are somewhat more complex, particularly for longer wheeled vehicles), it does offer guidance for the ability to transport tracked and wheeled vehicles.

Older AVLBs in service such as the German-built Biber and the US M60 AVLB are being retired, with some being donated to the Ukrainian Armed Forces. The Biber is based on the older Leopard 1 MBT and can launch two 11 m long bridge sections to cross a 20 m wide obstacle within three minutes sustaining loads up to 55 tonnes. Meanwhile, the M60 AVLB is based on the M60 MBT and deploys a scissor bridge 18 m long with, rated at MLC60. These are being replaced since they might not be suitable for the majority of contemporary MBTs, including the newer variants of the Leopard 2 and M1A2 Abrams models.

The US Army is introducing the M1074 Joint Assault Bridge (JAB) built by GDLS to replace both the M60 AVLB and M104 Wolverine. It is based on the M1A1 Abrams MBT and can deploy both the legacy 19 m long scissor bridge with MLC 85 and the 18.3 m long MLC 115 Heavy Assault Scissor Bridge (HASC) using a hydraulic bridge launcher system. Deliveries are due to be completed later in 2024. Countries that operate the M1A1 or M1A2 MBTs will want to introduce the JAB to operate alongside its armoured formations and provide them with a gap-crossing capability.

Credit: Leonardo DRS

The US Army's M1074 JAB, being based on the M1 Abrams platform, can support a much heavier payload than the older M60 AVLB and has greater mobility.

In Germany, the Biber is being replaced with the Leguan (Iguana) AVLB, built by KNDS Deutschland, which is notionally based on the Leopard 2 platform (though alternative base platforms can also be used). With a capacity to hold up to 90 tonnes, Leguan can deploy bridges 14 m, 26 m, and 35 m in length. There are 17 countries operating the Leguan, including Germany, Denmark, Spain and The Netherlands. Finland signed a contract in December 2023 worth EUR 23.6 million (USD 26 million) for six Leguans, which will be mounted to the Leopard 2A4 platform by Patria. Delivery is expected in 2026-28 and will add to the Leguan units that were delivered in 2005-08 and 2018–22.

As a way of expanding gap crossing capabilities on more platforms, KNDS has integrated the Leguan onto the 8×8 Boxer armoured personnel carrier (APC). Demonstrations were carried out in 2020–21 on a trial vehicle. GDELS and Rheinmetall are developing the Cobra bridge system, which is also based on the Boxer APC. Cobra can deploy a 15 m long MLC90 bridge using a bridge-launching mechanism from Pearson Engineering that can deploy in two minutes.

New AVLBs with higher MLCs are part of the equation and more will be needed. Yet these AVLBs only represent a part of the total requirement, as this class of bridging vehicle is primarily intended for front line operations and reserved for use with heavy armoured formations. The majority of bridging systems are truck-based and are deployed away from the front line to replace damaged civilian infrastructure, supplement AVLBs and provide additional bridges over gaps to improve the speed of logistics supply – essential in any war.

Truck-based bridging support

Because of its mainly wheeled armoured vehicle fleet, France does not operate an AVLB; instead, the French Army has pro-

Credit: US Army

The Leguan AVLB is popular with armies that operate the Leopard 2 MBT, as it can be based on the Leopard 2 platform, giving it similar mobility characteristics and spare parts commonality with their tank formations.

cured the Système de Pose Rapide de Travures (SPRAT; ENG: rapid span installation system). SPRAT is based on a Scania R580 10×10 truck fitted with two 14 m long bridge units that are 4 m wide and rated at MLC70. Built by CNIM, the SPRAT also includes a 6×6 semi-trailer to host additional bridge spans. Deliveries were completed in 2011–13.

The US Army has the M18 Dry Support Bridge (DSB) based on an Oshkosh M1078 10×10 truck able to deploy a 40 m long bridge using an A-frame with s mechanical beam and rail system to deploy bridging sections. The DSB is manufactured by WFEL, a UK subsidiary of KNDS. The US Army has over 100 in its inventory and in January 2024, the UK ordered an undisclosed number of DSB units for GBP 150 million. Other operators include Australia, Germany, South Korea, Switzerland, and Türkiye, where they are based on different logistics trucks.

GDELS offers the Python, a light aluminium dry gap bridging system capable of deploying a 13 m long bridge rated at MLC50. The Python can use an 8×8 truck or a Piranha family 8×8 as the host platform. In June 2023, Georgia placed an order for four Python bridging systems from GDELS, with deliveries expected in 2025.

Credit: US Army

Using a Palletised Load System, the M1078 DSB can install a bridge over gaps up to 46 m in about 90 minutes.

In partnership with Rheinmetall, GDELS has launched the Anaconda tactical bridging system, which has bridging units able to span a 22 m wide gap mounted on an HX2 8×8 truck. The intention is to make it cheaper and easier to increase bridging inventories by integrating bridging systems onto a family of trucks that are more common in service. This reduces the need for support and training as a large number NATO countries already use the HX truck series.

Challenges ahead

A look ahead, as well as an update of inventories, shows the need for more integration of bridging equipment across NATO. This means procuring more, similar equipment able to be used by all NATO members, which could mean that even if NATO armies do not possess much heavy armour, they should still procure MLC80 systems in order for Allied armies to be able to use their bridges.

Another way of increasing interoperability is by developing a Universal Floating Bridge Adaptor (UFBA). Plans for a UFBA were announced as part of NATO's Gap Crossing High Visibility Project, initiated in February 2023. The intention is to produce an adaptor that can allow all of NATO's floating bridging equipment to be integrated. However, this effort is still in the pre-concept phase. ■

Ajax – problems solved and lessons learned?

David Saw

As of early August 2024, with the British Army reporting the completion of its first firing-on-the-move trial on Ajax, the overall outlook for the British Army's long-troubled programme appears more optimistic. As a high-profile programme, Ajax has served as a posterchild for the MoD's procurement woes over the last few years. However, Ajax is far from the only British MoD programme which has faced serious issues. Increasingly, the focus has shifted to the MoD's procurement practice as a whole, with the lessons of Ajax catalysing calls for reform of Britain's procurement system.

Even the most fervent supporter of the Ajax programme will admit that the programme is running late and has encountered all sorts of difficulties. However, it is not the only procurement programme that finds itself being criticised for not delivering what was expected, when it was expected. Year-on-year, the British Ministry of Defence (MoD) finds itself having to defend its procurement process, its ability to manage projects and its ability to utilise its budgetary resources to maximum effect.

The prevailing opinion is that the UK's present procurement system is not fit for purpose, and most are perfectly happy to criticise the procurement system as the default setting. In July 2023, the House of Commons Defence Committee published a report entitled 'It is broke — and it's time to fix it: The UK's defence procurement system'. The report used the Ajax programme as one of its case studies evidencing a dysfunctional procurement system, along with the Type 26 frigate and E-7A Wedgetail programmes.

Credit: USMC

An Ajax vehicle of the Household Cavalry conducts a live fire of its 40 mm CTA cannon as part of an extreme weather testing programme in Lapland, Sweden, where temperatures dropped to -30°C. The capability to fire the gun system on the move was successfully demonstrated.

Road to the Ajax programme

The starting point for an analysis of the Ajax programme has to begin with previous efforts by the MoD and the British Army to modernise their armoured vehicle assets. The road to Ajax begins in 1985 with the Future Family of Light Armoured Vehicles (FFLAV) study aimed at defining a successor to the FV430 and CVR(T) vehicle fleets, which led to the Tactical Reconnaissance Armoured Vehicle Equipment Requirement (TRACER). In 1992, Britain initiated a joint programme with the US to meet the TRACER requirement with the intention to acquire 355 vehicles. The programme was overambitious in technology terms and eventually the US decided to end its involvement; consequently, the MoD cancelled its programme in 2001 after spending GBP 131 million.

Then came the Future Rapid Effects System (FRES), which would replace the FV430, CVR(T) and Saxon vehicle fleets. FRES entered concept development in 2001, and would enter the assessment phase in 2004 with the envisaged in-service date being 2009. FRES was ambitious, since 3,000 vehicles were to be acquired in three variants: Heavy, Utility and Reconnaissance. The utility vehicle (FRES UV) was to be the first FRES vehicle to enter service, but the programme began to fall apart as the envisaged in-service date slipped to 2012 and then 2015. In 2008, FRES UV was de facto cancelled after some GBP 133 million had been spent.

Out of the wreckage of FRES, the FRES Specialist Vehicle (SV) emerged. This was to be a programme covering around 1,200 vehicles in five blocks, the first of which covered 589 vehicles in three variants: Scout, Protected Mobility, and Equipment Support. This would later evolve into the Ajax programme and two main bidders emerged to meet the requirement: General Dynamics with the ASCOD and BAE Systems with the CV90. In 2010, General Dynamics Land Systems UK (GDLS-UK) was awarded the demonstration contract for the programme.

According to the 'Report of the Armoured Cavalry Programme (Ajax) Lessons Learned Review' quoted by the Defence Committee, the programme originally covered the delivery of 245 Ajax reconnaissance vehicles, 93 Ares protected mobility vehicles, 112 Athena command and control vehicles,

Credit: Crown Copyright 2023

Royal Lancers Ajax armoured vehicle on Salisbury Plain during Exercise Iron Titan, FOC (Full Operating Capability) for Ajax is scheduled to be achieved between October 2028 and September 2029. Ajax became one of the most controversial British defence programmes of recent years.

52 Argus engineer reconnaissance vehicles, 50 Apollo equipment repair vehicles and 38 Atlas recovery vehicles. By purchasing an armoured vehicle 'off-the-shelf,' ASCOD had been purchased by Spain and Austria, so it was hoped to de-risk the programme. In September 2014, GDLS-UK was awarded a contract for 589 vehicles; it would later emerge that this was a 'fixed price' contract, meaning that costs over the agreed programme contract value, that would amount to GBP 5.52 billion, would be the responsibility of the contractor. This was the most important and expensive British Army armoured vehicle contract for some 30 years. Also, ASCOD would be assembled in the UK (in Wales), whereas BAE Systems' CV90 offer had been based on production in Sweden. The programme timetable at the time was that the Main Gate 2 business case for Ajax was approved in June 2014 (before the procurement contract was officially awarded), with the Initial Operational Capability (IOC) date for Ajax set for July 2020, with initial vehicle deliveries commencing in 2017.

Things fall apart again

With the procurement contract signed, the timescale to deliver the initial vehicles was short and consequently, problems started to emerge. Understandably the British Army wanted the best vehicle that they could possibly get, and although the base vehicle was 'off-the-shelf,' the plan was to integrate advanced sensors and systems into the vehicle. The danger in this approach was being seduced by the possibilities of technology, often ignoring what was available now for something far better that might be available in the future. This had happened before with TRACER and it was now happening again!

What would happen with Ajax was that there were changes, far too many changes. Across the six variants, some 1,200 new capability requirements were added – something which would inevitably impact delivery timescales. In an effort to resolve the issues hampering the programme, the MoD and its procurement arm, Defence Equipment & Support (DE&S), and the contractor agreed to a 'contract reset.' This saw the Ajax programme reorganised into five 'Capability Drops,' ranging from Drop 0 to Drop 4, with Drop 4 being the full specification vehicle, and vehicles built to earlier standards all due be upgraded to Drop 4 level.

After the contract reset, the IOC remained the same, but originally the IOC would have required the delivery of 45 vehicles; after reset the number was down to 27. According to the 2023 Defence Committee report: "The IOC date was nonetheless missed. In addition, from around 2014 onwards, concerns began to be expressed about potential safety issues relating to noise." Rumours about noise would become more visible in 2017, but it would only become a publicly visible issue much later.

The Defence Science and Technology Laboratory (Dstl) informed DE&S that the safety case for Ajax was unsound in April 2018, and in September 2018 DE&S issued a safety notice citing high levels of vibration, but trials continued. In January 2020, Dstl informed DE&S that the noise and vibration calculator being used in the Ajax programme was underestimating the actual levels of noise and vibration. Then in November 2020, the Minister for Defence Procurement was told that the Ajax trials programme had been suspended due to excessive noise and vibration. The trials programme would restart in February 2021.

In a further sign of a procurement system in trouble, in March 2021, with the publication of the 2021 Integrated Review (IR) and subsequent Command Paper, the MoD announced the cancellation of the Warrior Capability Sustainment Programme (WCSP). This left the UK's obsolescent Warrior infantry fighting vehicles (IFVs) without badly-needed upgrades, facing a planned retirement of the fleet by 2025 with no apparent successor. In November 2023, the MoD signed a contract to upgrade the UK's Warriors with rearview cameras, and unidentified British Army personnel have

Credit: Crown Copyright 2016

An image from 2016 when General Dynamics announced that they would build the Ajax family in a factory near Merthyr Tydfil in South Wales. Less than two years after the contract announcement, problems were mounting for Ajax, but information on these problems was not reaching the higher echelons at the MoD.

Ajax on exercise on Salisbury Plain. The controversy surrounding Ajax was so extreme that in May 2022 the Secretary of State for Defence appointed Clive Sheldon KC to conduct a review of the Ajax programme. The Sheldon Review entitled 'Report of the Armoured Cavalry Programme (Ajax) Lessons Learned Review' was published in May 2023.

stated that the vehicle is likely to continue service to the end of the 2020s. A successor IFV programme has yet to be announced.

In the middle of all this, in March 2021, the Defence Committee would issue a report titled: 'Obsolescent and outgunned: the British Army's armoured vehicle capability'. They noted that: "The Ajax programme, which is now also seriously delayed, is yet another example of chronic mismanagement by the Ministry of Defence and its shaky procurement apparatus." In June 2021, DE&S issued a stop notice for the Ajax trials programme. According to the Defence Committee report on procurement of July 2023: "As of 9 December 2021, 310 individuals were exposed to noise and vibration from Ajax vehicles. Four individuals were medically discharged from Service, and eleven were recommended for long-term restrictions on noise exposure (thereby limiting their military duties)."

Given that the MoD, DE&S and the British Army have a duty of care for personnel working on the Ajax trials programme, and the noise/vibration issue was a known problem and safety risk, it is astounding that corrective measures were not taken sooner, or the trials programme suspended until safety concerns could be fully satisfied. Ajax trials resumed in May 2022 after corrective measures had been taken, nearly a year after trials were halted.

By this point, the controversy surrounding the Ajax programme was immense. In response, Secretary of State for Defence Ben Wallace appointed Clive Sheldon KC to conduct a review (known as the Sheldon Review) of the Ajax programme in May 2022, later published as 'Report of the Armoured Cavalry Programme (Ajax) Lessons Learned Review' in May 2023. The Defence Committee procurement report noted that: "In March 2023, the Government announced a new IOC date for Ajax of between July and December 2025, with FOC (Full Operating Capability) scheduled to be achieved between October 2028 and September 2029, both years later than originally envisaged."

Adding to the litany of procurement mishaps, in December 2023 the MoD cancelled major elements of the Morpheus tactical communications programme central to the Land Environment Tactical Communications and Information Systems (LETacCIS) strategy of the MoD. The existing Bowman system will be updated to fill the gap caused by the Morpheus cancellation; Bowman was originally supposed to be withdrawn from service in 2026 and this was changed to between 2031 and 2035. Morpheus was supposed to provide key communications capabilities for the Ajax programme, but will an updated Bowman system be able to deliver the necessary capabilities?

Recovering confidence?

In 2007, the House of Commons Defence Committee in a report on the FRES programme stated the following: "This is a sorry story of indecision, constantly changing requirements and delay." Today, nearly 17 years later, they would probably say much the same about the Ajax programme. Why is it so difficult for the MoD, DE&S and the British Army to run an armoured vehicle programme? While Britain has been grinding its way through FFLAV, VERDI 1 & 2, Tracer, MRAV, FRES UV/SV, WCSP, Ajax, Boxer, and Challenger 2 LEP/Challenger 3, among others, France has introduced four entirely new armoured vehicles into service in the form of the VBCI, Jaguar, Griffon, and Serval, and has begun receiving their upgraded Leclerc XLR tanks, all within much shorter timescales. Is there something that the Direction générale de l'armement (DGA) in France knows that the MoD and DE&S do not?

Thus far, this author has referenced numerous official reports on the dire state of the

An Ajax vehicle undergoing cold weather trials at Tame Ranges in Sweden in February 2019.

UK MoD's procurement system, but these all beg the question of who is responsible and who is accountable? It is very easy to blame at all sorts of people in the MoD, DE&S, the military and in government. Yet what is most disturbing is that there seems to be no real systemic accountability. Was anybody held accountable for the failure to deal with safety issues during the Ajax test programme? While all of this is going on, the British Army finds itself operating aged and/or underperforming equipment, while it waits on the promised arrival of new systems that will eventually replace legacy equipment.

This brings us to the Sheldon Review of May 2023 – if one read it with the expectation of a blistering critique of the procurement system as is, and a call for its rapid replacement by something new and better, one would be disappointed. The review stated: "The Review makes a total of 24 recommendations. These do not aim to achieve a wholesale re-configuration for the delivery of major programmes. None is a magic bullet. Rather, they represent relatively small improvements, which cumulatively should help the MoD avoid similar problems in future."

As regards the 24 recommendations, the review groups them as follows: "Of these: four are aimed at improving the working relationship between DE&S and Dstl; five are aimed at improving the support and information provided to the SRO [Senior Responsible Owner]", who specifically provides direction for a project or programme. They do this by taking ownership of the business case and objectives, successful delivery and benefits on behalf of the organisation. Five Sheldon recommendations are aimed at improving the processes for holding to account and assurance; and eight are aimed at improving information flows and escalation. What Sheldon is suggesting is eminently sensible and achievable. The report tried to be fair, noting how COVID from early 2020 to mid-2021 severely disrupted work on the programme.

Regarding the safety issue, Sheldon comments as follows: *"The SRO, DLE (Director Land Equipment at DE&S) and Chief of Materiel (Land) were first aware in general terms of the noise and vibration concern from late spring or summer 2020. Neither they nor the Army's Director Capability ("DCap") understood that noise or vibration posed a significant risk to the programme over and above other safety hazards identified, or that crews may potentially have been harmed in trials as a result of noise and vibration, until autumn 2020. Concerns about harm to crews in the trials were not raised in writing with DCap, and it was only in autumn 2020 that he became aware that crews had reportedly been injured by noise and vibration in the ATDU trials. The Minister for Defence Procurement was only informed on 13 November 2020."*

Credit: Crown Copyright 2023

Exercise Iron Titan on Salisbury Plain in September 2023. On the left is an Ares troop carrying vehicle, with the Ajax reconnaissance variant on the right. The Ajax family consists of six different variants, with 589 vehicles on order, of which the Ajax reconnaissance variant is the most numerous.

Given that safety concerns from excessive vibration had been expressed by Dstl in their quarterly reports as far back as 2014, the length of time for the SRO and DCap to become aware of the issue is concerning. In this vein, Sheldon continued: "Reporting was at times lacking, or unclear, or overly optimistic. That led to senior personnel and Ministers being surprised to discover in late 2020 and early 2021 that the programme was at much greater risk than they had appreciated." By June 2021, expenditure on the Ajax programme amounted to GBP 3.17 billion (including tax).

It should be noted that not all variants in the Ajax family have been equally problematic – in July 2020, the Household Cavalry Regiment announced that it had received the first six vehicles of the Ares armoured personnel carrier variant, making it the first the MoD accepted delivery of. By January 2024, the figure had increased to 44 Ajax family vehicles delivered (at Capability Drop 1 standard), with the variant split as follows: 17 Ajax, 14 Ares, 5 Athena, 2 Atlas, 4 Apollo, and 2 Argus. While it has been a long road, at present the outlook for the programme admittedly looks considerably better than even a year prior. Thus far in 2024, the Ajax reconnaissance variant has completed cold weather trials in Sweden, and a firing-on-the-move exercise in the UK, among others. Furthermore, in response to a question by Labour MP Luke Akehurst to Maria Eagle, the new Minister for Defence Procurement, concerning progress on Ajax entering service, Eagle responded: "The Armoured Cavalry Programme (Ajax) is due to achieve Initial Operating Capability by December 2025 as planned."

It would be nice to think that post-Sheldon Review, there is a real trend towards reforming and revitalising the procurement system. Hopefully that is, or perhaps might become, true. Fundamentally the issue is that modern defence equipment is so complicated and expensive, therefore specifying it, acquiring it and managing a programme to bring it into service requires specialist skills. These include engineering skills to understand the technical aspects, commercial experience to understand the industrial/business aspects, legal knowledge and experience to craft contracts that are legally sound, and a solid understanding of real-world operational requirements. Also essential are people with real programme management skills, and in this respect, effective SROs must be from the top end of the talent pool!

There are a multitude of lessons to be learned from the Ajax programme and from the many and varied procurement failures that have blighted the British defence sector. Yet these failures will have been for naught unless the UK's defence institutions learn from and absorb these lessons. In this regard, there is a weight of expectation for reforms to be proposed in the next Strategic Defence Review (SDR), due in 2025.

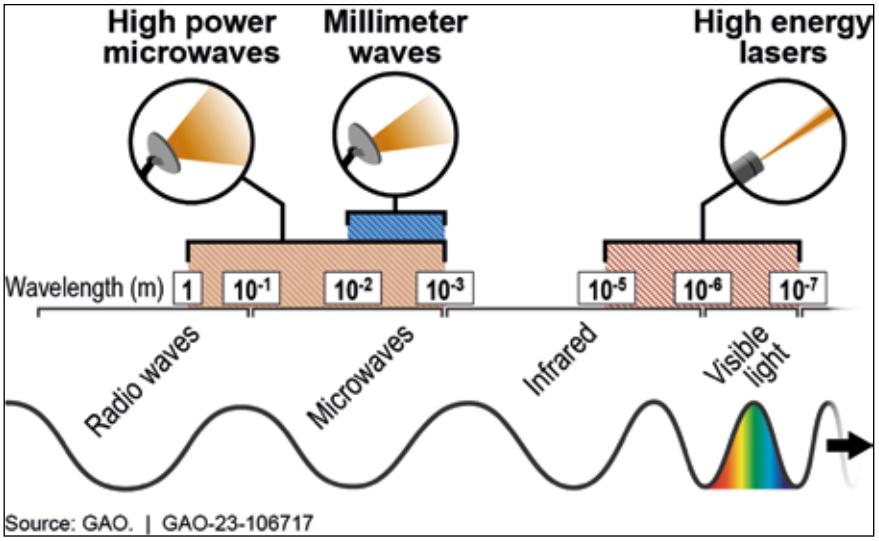
Highway to HEL

Alix Valenti

HELMA-P, HELIOS, HELCAP, SSL-TM, ODIN, these acronyms represent just a sample of the multiple ongoing High Energy Laser (HEL) programmes in France and the US. Many other programmes – such as, DragonFire in the UK – are progressing worldwide, albeit at varying paces, in a bid to outpace potential opponents on the road to HELs.

HEL weapons' popularity is driven by the numerous advantages they seem to offer. From the ease of target tracking and engagement, to the very appealing ratio of low engagement cost to magazine depth. Several navies see these weapons as a critical capability for future naval warfare. Yet HEL programmes' varying levels of progress worldwide also indicate that several challenges persist, be it at the physics level, the organisational level or both, and nowhere is this more evident than in the US Navy (USN).

So the question remains: are HELs a battlefield revolution, or simply an evolution in layered defence?



Credit: US GAO

As the diagram illustrates, the various types of DEW use different portions of the electromagnetic (EM) spectrum to deliver various effects on target.

HEL 101

HELs are one of three primary types of Directed Energy Weapons (DEWs) in mainstream development, which also include High-Power Microwaves (HPMs) and Millimetre Wave Weapons (MWWs). The latter are very similar to HPMs, but operate at higher frequencies, and with a narrower beam. Each type of weapon leverages different regions of the electromagnetic (EM) spectrum to produce various effects. Other types and sub-types of DEWs exist, such as particle beams and Masers, but these are not yet known to be part of mainstream DEW research and development efforts.

In the naval domain, preference has overwhelmingly gone toward HEL programmes for two reasons.

Firstly, concentrated light beams such as HELs, as opposed to dispersed beams as with HPMs and MWWs, allows its user to either counter targets at greater extended – albeit still within line of sight (LoS) – ranges, or pierce a wider variety of materials. This range can be further extended by raising the level of energy used to power a HEL, which increases the weapon's range and intensity. It should be noted that increasing the power of HPMs and MWWs would also increase their effective ranges.

Second, as Arnault Gagnepain, responsible for CILAS' laser division, told ESD: "[HEL's concentrated light beam] means these weapons are generally simple and easy to integrate onboard because there is no dispersion cone, and therefore no interference with other equipment." The same cannot be said about HPMs and MWWs. Accordingly, expectations for HEL weapons are high at the operational level.

The bright side of HEL – Operational benefits

As noted in the Annex of the Congressional Research Services (CRS) report, 'Department of Defense Directed Energy Weapons: Background and Issues for Congress', published in August 2023, HEL weapons are expected to present four main advantages over conventional alternatives.

Firstly: short engagement times. The time-on-target of a HEL weapon is almost instant, meaning that compared to traditional ammunition, there is no need to factor in ballistics to calculate an intercept course. In practice, this should also translate into the possibility of engaging multiple targets within short timeframes since there is no need to reload or do another set of calculations.

A second significant advantage of HEL weapons is their expected ability to counter manoeuvring or agile targets. Since these weapons function by maintaining their beam on their targets, they are designed to follow them until the threat is neutralised (incapacitated or destroyed). In a January 2024 article published in Physics Today titled, 'The new laser weapons', Thomas Karr and James Trebes explain that a 300 kW HEL can defeat an aluminium-shelled target in about 2.5 seconds and a plastic one in less than a second.

Third, HELs' light beams make them highly precise weapons. "The weapon will hit what the operator aims at," Gagnepain explained, consequently eliminating not only ballistics concerns but also significantly reducing collateral damage risks.

Finally, using a light beam with adjustable intensity allows armed forces to have scalable effects in one weapon system. From non-lethal effects such as dazzling of optronic sensors, to limited damage such as burning out optical sensors, to complete neutralisation of the target, HEL weapons promise the ideal scalable response.

Credit: Crown Copyright

A false-colour shot of the DragonFire conducting an engagement at night. HELs tend to use the infrared (IR) band, and so in reality, HEL beams are typically invisible to the naked eye.

Consequently, the US armed forces, as well as other armed forces around the world, are working on HEL development programmes to counter a wide range of threats, from Uncrewed Aerial Vehicles (UAVs) and potentially Uncrewed Surface Vehicles (USV) to ballistic and hypersonic missile defence. However, these programmes' timelines and ambition levels vary significantly as armed forces grapple with HEL weapons' well-documented limitations in very different ways.

European temperance – French and British HEL

For all their expected operational advantages, HEL weapons also present a number of limitations. These limitations have been well documented by several decades of ongoing HEL development programmes, particularly in the US.

One of the main limitations of HELs, at least to date, is their range. This is primarily because, inherently, a light beam can only operate within LoS ranges. Beyond this, these systems are susceptible to atmospheric conditions, because HELs function on the infrared end of the EM wavelength spectrum. Consequently, as noted in the CRS report: "Substances in the atmosphere – particularly water vapour, but also sand, dust, salt particles, smoke, and other air pollution – absorb and scatter light, and atmospheric turbulence can defocus a laser beam."

Shipboard systems is particular may have to contend with the problem of water vapor, which also absorbs the light, more than their land-based counterparts. However, as these systems develop, navies will be able to find solutions to mitigate these effects – the CRS report, for instance, mentions the possibility of designing the laser to emit light at a wavelength less affected by water vapour – but the overall performance will continue to be reduced. The report also mentions the use of adaptive optics to make continuous rapid adjustments to the beam in response to atmospheric disturbances, preserving the beam's power in a wider range of conditions.

Another critical limitation to date is Size, Weight and Power (SWaP). For a HEL weapon to successfully disable and/or neutralise large and potentially hardened targets, more power is required to emit a stronger light beam. Yet more power will inevitably impact the size and weight of the system itself and, in turn, its footprint – real estate and power demands – on the host platform.

These well-known limitations explain why, to date, European programmes such as the French HELMA-P and the British DragonFire, are primarily focused on beams in the >100kW class, for the neutralisation of smaller targets such as UAVs, rockets, and improvised explosive devices (IEDs).

Speaking with ESD about the HELMA-P, Gagnepain explained that currently, the system consists of three blocks of approximately 1m3 each: the laser generator with all the electrical installations, the cooling system, and the turret – which is admittedly even smaller than 1m3. It draws power and cooling directly from the ship's systems.

"In practice, this means that our system is very easily integrated onboard any ship, from corvettes up to aircraft carriers," Gagnepain noted. Once it has received the target designation from a ship's Command and Control (C2) system, it can autonomously track, engage, and neutralise threats - always with a man-in-the-loop.

At present, the system is dedicated to countering small- and micro-UAVs. Anything beyond this would require far more power and would, inevitably, result in significant power surges that not all ships can sustain – or at least, not when all other systems are a go. "But we are working very closely with the French Navy and other armed services to continue scaling up our system so that it can tackle bigger, more hardened targets," Gagnepain concluded. This would, for instance, include USVs, missiles, and potentially (eventually) using lasers against satellites.

The HELMA-P was successfully demonstrated to the French procurement agency (Direction Générale de l'Armement; DGA) in June 2023 when it was installed and operated from the Horizon class frigate Forbin (D620). The first systems are scheduled for delivery by mid-2025, and though Gagnepain could not comment

Credit: DGA

France's DGA, CILAS and the French Navy successfully conducted the first series of tests of HELMA-P from a French Navy's Horizon class frigate Forbin, in June 2023.

Credit: Dstl

The UK's DragonFire HEL offers the prospect of effective VSHORAD capabilities at a fraction of the cost per shot of conventional alternatives.

on whether the French Navy would receive any, he mentioned that "there is enough for all services to begin with." CILAS is working on this with Ariane Group and is ready to scale up production.

In the UK, the DragonFire programme is also moving forward, with the MoD recently announcing its renewed commitment to fielding the weapon before the 2030s. The DragonFire is a 50 kW class HEL demonstrator developed by an MBDA-led consortium, including Leonardo (responsible for the beam director) and Qinetiq (responsible for the laser source), that will likely be fitted to both land and naval platforms.

Similarly to the HELMA-P, the DragonFire demonstrator comprises three separate units: a C2 cabin, a thermal plant and a laser effector container. The size of these units remains unknown, though it appears to have a slightly larger footprint – as a demonstrator – than the French system. According to a related MoD press release, the DragonFire demonstrator was successfully tested in the MoD's Hebrides Range in late 2023, demonstrating its ability "to track moving air and sea targets with very high accuracy at range."

No precise delivery dates have been announced yet, though the MoD has stated its intention to move the operationalisation date forward from the initial 2030s. To date, there are also no definite plans as to which ships will be fitted with these weapons, but the Royal Navy's (RN's) Type 45 destroyers and the Type 26 frigates have been floated as likely candidates.

So, both European programmes are progressing at pace and moving to start fielding >100 kW class HEL weapons over the short- (FR) and medium- (UK) terms. This indicates a desire to start operationalising HELs as soon as possible as a complementary weapon system, part of a layered defence. It will also contribute to developing CONOPS progressively.

Go big or go home – USN HEL dilemmas

Across the Atlantic, the HEL landscape is somewhat different, and the many years – and millions of dollars spent – on ongoing development have attracted significant criticism. During the Surface Navy Association event in DC in January 2024, Read Admiral Fred Pyle, USN director of surface warfare requirements, made the headlines by stating: "I am not content with the pace of directed energy weapons. We must deliver on the promise this technology gives us."

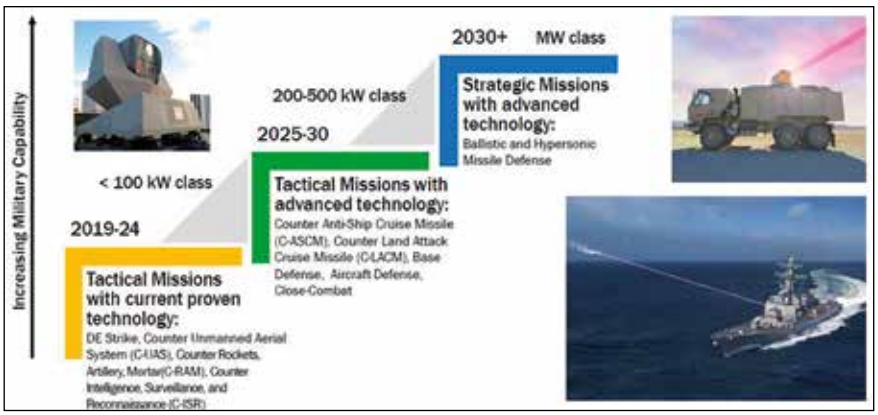
The USN's lack of steady progress in fielding HEL weapons to its many surface ships best exemplifies the limitations related to these weapons programmes. These are well documented in a US Government Accountability Office (GAO) report, 'Directed Energy Weapons – DoD Should Focus on Transition Planning', published in April 2023, and are perhaps best summarised by the sentence: "For decades, DoD has prioritized investing in early-stage research and development of technologies." This has resulted in a lack of foresight and, consequently, difficulties competing for funds against well-established acquisition programmes.

This has, in turn, resulted in representatives within the defence industrial base raising concerns about investing in developing HEL technologies without a clear government commitment. The main issue at stake, as the GAO report notes, is the inability to leverage commercial products due to the lack of commercial applications for DEWs or critical technologies. This inevitably results in high development costs for industry partners.

By contrast, the DragonFire consortium in the UK has been communicating that it is leveraging COTS to move forward and will subsequently work to ruggedise the material or find alternatives – thus moving the programme along.

Lack of foresight in the transition efforts has also resulted in a lack of DoD stable funding for DE weapons programmes and strengthening of the industrial base. This issue is evident across multiple defence sectors worldwide. It was exemplified in a paper published in the MIT Technology Review on 30 July 2024, "How the US and its allies can rebuild economic security". Basing their analysis on drone manufacturing – another

Credit: US DoD/Dr Jim Trebes



The US DoD's directed energy roadmap, showing notional dates for the development of HELs of varying power classes. Source: Dr. Jim Trebes, "Advancing High Energy Laser Weapon Capabilities: What is OUSD (R&E) Doing?," presentation at the Institute for Defense and Government Advancement (IDGA), 21 October 2020.

Credit: Lockheed Martin

Artist's impression of the HELIOS HEL aboard an Arleigh Burke class destroyer.

'hot' technology at the moment – Edlyn V. Levine & Fiona Murray explained that many European countries have led their manufacturing base slide East, much to the detriment of their capacity to produce critical capabilities.

Another issue is the USN's process for developing and transitioning HEL technologies. Based on a partnership between the Navy science and technology community and the Program Executive Office (PEO), Integrated Warfare Systems, this partnership has only informally recorded data on weapon usage for the development community. Combined with the fact that tactics and concepts of operation (CONOPS) for these weapons are still being developed, a lack of formal records about development iterations between developers and users could significantly slow industrialisation and adoption.

Many of these issues are primarily rooted in the fact that the USN is seeking to achieve higher-powered HELs, but is failing to successfully integrate the demonstrators onboard ships. Simultaneously, industrial capacity is lacking to ramp up production activities on those systems that did prove useful. Consequently, to date, the USN has experienced four HEL programmes with limited reach and, at times, impact.

The Solid State Laser Technology Maturation (SSL-TM) culminated in installing the 150 kW class Laser Weapons System Demonstrator (LWSD) on USS Portland in 2019, and the programme was due to close in 2024. The Optical Dazzling Interceptor, Navy (ODIN), designed to dazzle UAVs with a 60 kW class laser, has only been deployed on seven *Arleigh Burke* Flight IIA destroyers. The High-Energy Laser with Integrated Optical-dazzler and Surveillance (HELIOS), another 60 kW class laser, albeit intended for both dazzling and interception – with potential for growth to 120kW – was installed on an *Arleigh Burke* class destroyer, the USS Preble, in 2022 and conducted sea trials in 2023, but is planned to undergo continued testing till 2028.

Finally, the High Energy Laser Counter ASCM (anti-ship cruise missile) Project (HELCAP), intended to reach power levels of 300 kW, will undergo experimentation until 2028 and has not yet been installed on any ship. Consequently, questions about the feasibility of such large power and cooling demands remain largely unknown.

Highway to HEL

HEL weapons may hold a lot of promise, but the limitations they are still facing mean that the most sensible path forward is that of incremental evolution. As the French and the British programme demonstrate, working to operationalise smaller HELs onto more platforms, using them as part of a layered defence approach, offers more time for adaptation – for industry, the armed forces, and their platforms.

A further notable example would be Israeli Company Rafael's Iron Beam HEL, a 100 kW class weapon which is intended to complement Israel's air and missile defence system at the lower tier. It may be the closest of all those mentioned to operational deployment, with the manufacturer anticipating its fielding by the Israeli Defence Forces (IDF) toward the end of 2025.

The USN, as well as the other US service branches, may have its eyes on bigger systems that are expected to provide a silver bullet to the ballistic missile threat – an expectation that has yet to prove correct – but in the meantime it has failed to properly field existing technologies. As such, not only are CONOPS not advancing, but the country's industrial base is not ready to address its Navy's demands. "Today we are working on the deployment of laser weapons, while also preparing for the future as we look into giving them more power and integrating them on more platforms," Gagnepain concluded. Perhaps this 'slowly but surely' approach is indeed the most assured highway to HEL. ■

Credit: Rafael

Rafael's Iron Beam HEL may be the closest of its competitors to being operationally fielded.

NMH contenders keep bids alive as uncertainty clouds the requirement

Peter Felstead

The UK's ongoing strategic defence review has thrown another obstacle in the path of the country's New Medium Helicopter requirement – and possibly one it will not get beyond.

July 2024's Farnborough International Airshow (FIA) would normally have seen the remaining contenders for the UK's New Medium Helicopter (NMH) requirement – Airbus Helicopters, Leonardo UK and Lockheed Martin UK/Sikorsky – assertively outlining the strength of their bids. In the event, however, there was little such activity following the coming to power in early July of a new Labour government that soon declared it would conduct a strategic defence review, which is due to report in 2025.

The NMH requirement

When the NMH programme was first announced by the UK Ministry of Defence (MoD) in March 2021, the ministry announced that it would procure up to 44 aircraft in a contract worth GBP 0.9-1.2 billion (EUR 1-1.4 billion) that "intends to rationalise existing multiple rotary-wing requirements into one platform type, maximising commonality in order to improve efficiency and operational flexibility".

The programme was intended to cover four distinct rotary-wing requirements. As well as replacing the fleet of 23 Royal Air Force (RAF) Puma HC2s operated by No 33 and No 230 squadrons out of RAF Benson in Oxfordshire from 2025, the programme was also intended to replace five Bell 212s serving with the Army Air Corps' (AAC's) No 667 Squadron in Brunei, three Griffin HAR2s operated by the RAF's No 84 Squadron out of RAF Akrotiri on Cyprus (tasked with search and rescue), and six special-forces-roled AS365 N3 Dauphin IIs operated by the AAC's No 658 Squadron from the Special Air Service (SAS) barracks at Credenhill in Herefordshire.

Beyond procuring aircraft, the NMH contract was also to "include the provision of training capabilities and a maintenance/spares package as well as design organisation scope", according

Credit: Crown Copyright

An RAF Puma HC2 pictured over Cyprus on 31 March 2023, when the type took over from the Griffin HA2s at RAF Akrotiri. If the UK's NMH programme becomes a casualty of the ongoing UK strategic defence review, the Puma HC2 fleet may well have to soldier on for a few more years.

Credit: Airbus

Airbus Helicopters has bid the H175M for the NMH programme, but in November 2023 the UK MoD published a notification of intent to procure six Airbus H145s to serve British forces operating in Brunei and Cyprus, accounting for part of the original NMH requirement.

Credit: Leonardo

Leonardo UK, which is bidding the AW149 for the NMH requirement, continues to push the heritage of its Yeovil site being 'the home of British helicopters' from the days of UK manufacturer Westland.

to the MoD. The relatively ambitious in-service date for the new helicopters was given as 2025, suggesting that an already-existing airframe was likely to be chosen.

Thus far, only Airbus Helicopters has secured a slice of the NMH pie, after the MoD published on 13 November 2023 a notification of intent to procure six Airbus Helicopters H145 aircraft, along with three years of support services, to serve British forces operating in Brunei and Cyprus. On 18 April 2024 the UK MoD's Defence Equipment & Support organisation announced it had awarded Airbus a GBP 122 million (EUR 142.6 million) contract for the six H145s.

While Airbus is actually bidding the H175M – a military variant of the Airbus H175 civilian type – for NMH, selection of the H145 for the Brunei and Cyprus roles made sense from a logistical and training perspective, as three of the type are already operated under the UK armed forces' contractor-operated Military Flying Training System regime, where the H145s are known as Jupiter HT1s.

The ordering of the H145s means that aviation support to UK defence facilities in Brunei and Cyprus, where Puma HC2s took over from the three Griffin HAR2s on 31 March 2023, has been extracted from the NMH requirement.

A false sign of progress

The NMH programme then seemed to make progress on 27 February 2024 when the MoD issued an invitation to negotiate (ITN) for the requirement, with responses to the ITN due to be received by 30 August 2024, but following the general election and announced strategic defence review, the NMH programme now seems to have all but fallen into abeyance.

Speaking to ESD at FIA 2024 on 23 July, an Airbus spokesman said of the NMH situation, "As far as I know, there's no one way or the other as to whether it will continue or not. Meanwhile, we assume it will continue and we work towards putting our bid together."

Meanwhile, Leonardo UK, which is bidding the AW149 for the NMH

Credit: US Army

Lockheed Martin UK is offering the UH-60M Black Hawk from its US parent company's Sikorsky business for the NMH requirement. If the programme ultimately doesn't happen, Lockheed Martin can nevertheless look to a number of recent successful sales of the UH-60M into Europe.

requirement, continues to push its credentials as the only downselected NMH contender that is currently manufacturing helicopters in the UK. In a general briefing at Farnborough on 22 July covering Leonardo's current activities, Adam Clarke, managing director of the company's helicopters business in the UK, said of Leonardo's NMH bid, *"We believe that we are in a strong position. For more than five years we've been laser focused on the delivery of this platform to the UK armed forces, ensuring it will be able to quickly go into service with the operator. Importantly, while we are confident in the platform and its capabilities, we're equally competent in our economic value proposition to the UK."*

Clarke noted, "We will be providing UK built platforms with substantial design work conducted onshore, securing high quality jobs and skills and ensuring long-term social value for the UK taxpayer," adding, "While competitors are offering some level of UK assembly, Leonardo is the only company downselected in the competition that actually has the skills and infrastructure onshore today."

The third and final NMH contender, Lockheed Martin UK, has bid the UH-60M Black Hawk from its US parent company's Sikorsky business. However, rumours prior to FIA 2024 suggested that, having recently secured plenty of firm UH-60M orders from elsewhere – eight from Croatia, 12 from Sweden and 12 from Austria in July alone – Lockheed Martin was growing weary of the long-drawn-out NMH programme. Asked about this at FIA 2024, Eric Schreiber, director of international sales for Sikorsky, told ESD, "We're waiting for the Strategic Defence Review to come out, and we're trying to be responsive. These procurements take a long time; some of the deals we've secured this year have been 10 years in the making." He did not specifically deny that Lockheed Martin had withdrawn from the NMH contest.

How many helicopters?

As ESD talked to the three companies bidding for NMH at FIA 2024, it appeared to be clear that there was some sensitivity over the remaining numbers. When Leonardo's Clarke was asked about how many aircraft are covered by the remaining NMH programme following the Brunei and Cyprus requirement being addressed by six Airbus H145s, for example, he replied that he is "not allowed to get into any details on the quantities within NMH", adding that this was "one of the controlled requirements that I can't talk about".

Although the UK MoD originally stated in March 2021 that it would procure "up to 44 aircraft", ESD understands that there was never a definite number of aircraft in the requirement and that it was up to the bidding companies to present solutions based on the available funding. It has been put to ESD that the budget of up to GBP 1.2 billion, which included VAT, was never enough to procure 44 aircraft, while the fact that modern helicopters are more reliable and cost-effective than legacy types would always have meant fewer airframes would be procured.

Further to this, ESD understands that the entire premise for the NMH requirement may well have been based on former defence secretary Ben Wallace, who was in post from July 2019 until August 2023, looking to avoid multiple UK rotary-wing replacement requirements all converging on the same timescale, rather than purely any dire need for new medium helicopters.

Soldiering on

While the RAF's Pumas have, indeed, been in service for more than 50 years, 24 of an original fleet of 53 aircraft underwent a mid-life upgrade, the contract for which was signed in September 2009, with the RAF returning this modernised fleet of Puma HC2s to operational service in 2015. Published UK MoD data states that the RAF had a total of 18 Pumas in its inventory in 2023, of which 13 were in active service.

Sources from Airbus, which inherited the position of original equipment manufacturer of the Puma from Aerospatiale/Eurocopter, have suggested that the remaining Puma HC2s could be kept in service until the mid-2030s. If the NMH programme does ultimately become a casualty of the UK's ongoing strategic defence review, then this 'Plan B' could effectively see Airbus Helicopters, in a way, secure another slice of the NMH pie, albeit only by maintaining helicopters already in service.

As Europe heats up, momentum builds for joint ISR aircraft acquisition

Charles Rampling

Russia's recent military aggression has created many problems for European leaders, and not all of them come from the most obvious direction to the East. The other growing challenge for NATO involves the vast North.

Credit: GA-ASI

MQ-9B SkyGuardian in flight in 2017. The UAV underwent cold weather validation in 2023 to prove its suitability for extreme temperatures in the Arctic region.

The Arctic is becoming a venue for geopolitical, economic, diplomatic and potentially military disputes as never before. The warming planet is melting sea ice, permitting more ocean transit and more access to fishing stocks, seabed minerals and other resources, which Russia seeks to exploit.

Several Nordic and northern powers within NATO are therefore assessing acquisition of new multi-mission aircraft that can cope with the great distances, low temperatures and high latitudes involved in Arctic operations.

The inhospitable conditions over the polar oceans, in the air and on the ground (pack ice for example), are tough on airframes and even tougher on crews in the event an aircraft ditches after an accident or combat. For these and other reasons, the latest wave of aerial intelligence, surveillance, and reconnaissance (ISR) programmes has sought to augment ageing fleets of manned, multi-engined patrol aircraft with uncrewed aerial vehicles (UAVs).

Joint focus on mutually-supported ISR

One aircraft that received significant attention at the 2024 Farnborough International Airshow in the United Kingdom was the Protector RG MK 1, flown by the Royal Air Force. Also known as the MQ-9B SkyGuardian, from General Atomics Aeronautical Systems Inc. (GA-ASI).

In July 2024, the RAF announced the MQ-9B International Cooperation Support Partnership (MICSP), aimed at pooling resources for operators. This initiative knits together nations that already fly these aircraft or seem on track to acquiring it: the UK, Belgium and Canada are 'members,' with Denmark, Germany, Greece, Lithuania, Norway, Qatar and Sweden as 'observers.'

The presence of so many northern or Nordic nations in this group suggests many see the appeal of joint training and support for their current or pending national fleets. Unlike the earlier MQ-9A Reaper, GA-ASI has claimed that the MQ-9B was designed specifically to take off and fly in virtually any weather, including extremely cold conditions.

The newer aircraft was also specifically designed to be certifiable to operate in civil airspace, which can be problematic for older drones, and to use proliferated low Earth orbit (LEO) satellites to provide the communications and control needed to operate all the way up to the North Pole. Legacy satellite constellations meant that previous generations of drones could not get a controlling radio link above or below a certain latitude.

Of the nations in the MICSP, the UK, Canada and Belgium are known to have formal MQ-9B programmes, and Denmark appears poised to move soon, having announced in January 2024 its intent to acquire long-range UAVs for Arctic operations. Norway made a similar announcement in April 2024, though press reports indicate a consideration of Northrop Grumman's MQ-4C Triton is also underway.

Troubled programme

The MQ-4C Triton is a higher-altitude jet-powered UAV operated by the US Navy. It is closely related to the troubled RQ-4 Global Hawk, which enjoyed limited success and is being decommissioned by its launch customer, the US Air Force (USAF). The Triton situation is not much better for the US Navy, with recent reports placing per unit cost at USD 513 million now, with USD 618 million envisaged after the Navy cut its purchase from 70 to only 27. Complicating things further for Triton, the high-altitude aircraft was designed in an era with much more expensive and limited satellite coverage. The modern space intelligence ecosystem arguably makes such high altitude platforms redundant.

A decision by Oslo to acquire Triton would seem questionable, disregarding potential economies of scale around the MICSP and loading the Norwegian defence budget with an exquisite platform at six times the cost of a single MQ-9B. Some members of the MICSP consortium, such as the UK and Germany, have already assessed the related RQ-4 and encountered problems, most notably one report referred to Germany's RQ-4E 'Euro Hawk' experiment "an unmitigated disaster."

International sales could theoretically limit the surging Triton costs, providing relief for both the US Navy and the manufacturer – although history suggests otherwise. It could also reduce the number of assets available for Norway in the short term: the possibility of buying more aircraft, permitting more operations, much greater flexibility, and regional/NATO interoperability, would appear to give MQ-9B the edge.

Whatever the Nordic and northern governments choose, the political movement toward increased armament and readiness across Europe appears to be gaining momentum, as allied nations prepare not only to deter Russia on the continent but the in the high North as well. ■

Is 2024 the decisive year for Ukraine?

Sam Cranny-Evans

It will be difficult to identify true turning points in the Ukraine war. Instead, we should look to understand the trajectory of the war from multiple perspectives. This piece examines the current situation in Ukraine, and what things may begin to look like going forward.

Social media-fuelled optimism

Viewed through the camera of a drone, or one of the social media accounts that claims to track Russian losses in the war, it appears as though Ukraine is on course to win the war. In multiple videos, defeated Russian soldiers seem to give up and beg the drone operator for mercy before they are dispatched. In others, small vehicles weighed down with entire sections of Russian soldiers are engaged with first person view (FPV) drones, leaving the viewer to imagine the consequences. The Russians rarely seem to have had any form of defence; occasionally they fight back using rifles, shotguns or by swinging at the drone as it approaches. Rarely, it seems, are they successful. These stories are personal, and for those that are willing, it is possible to watch the final moments of Russian soldiers every day and to witness the despair and resignation they feel as the outcome becomes clear.

At the other end of the scale, social media accounts claim to have tracked Russian losses – some days they note hundreds of destroyed vehicles in a single day's combat. Prestige kills still attract applause, the loss of a T-90M, long-range strikes against Russian air bases, or the sinking of a Russian ship in the Black Sea. And yet, the fighting continues, day after day. Other accounts, such as the British MoD's Defence Intelligence provide optimistic updates, often without the context that would make the updates valuable in so far as understanding the state of the war is concerned. For example, a 12 July 2024 update notes that Russian casualties had increased to a daily conflict high of 1,262 in May 2024 and 1,163 in June 2024. The same update claimed there had been 70,000 Russian casualties in the two months leading to mid-July 2024. There was no analysis of what these figures mean for Russia, nor are there reliable data on Ukraine's own losses, which makes them a poor proxy for analysing the current status of the war.

Instead, there are three elements that should be considered in assessing the current state of the war: Russia's recent successful strikes against Ukraine's critical national infrastructure – in particular its energy generation and distribution network. A holistic view of the situation on the frontline arrived at through those sources that are mapping the changes in the frontline combined with reported conditions there. And finally, an analysis of both countries' ability to continue the war. Together, these threads are shaping the trajectory of the war, and they must be considered in their totality to understand what has happened in 2024, and what might happen in the months ahead.

Credit: Ukrainian MoD

Ukraine has made extensive use of heavy drones such as the Baba Yaga. Russian troops are fearful of fighting in areas where their own electronic warfare is not prevalent as a result.

The bottom line up front is that Russia has succeeded in many of its likely aims for 2024. Ukrainians are already facing hours without power in the summer, with worse to come in the winter. Its armed forces have made steady gains on the frontline leading to extensive casualties on both sides. Sadly, those are losses that are harder for Ukraine to replace than for Russia. At the same time, Russia's defence industry has

Credit: Russian MoD

This image shows the moment a UMPK guidance kit-equipped glide bomb released from a Su-34 strikes a Ukrainian position. The bombs have proven effective in reducing Ukrainian fighting efficacy and morale.

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been mobilised and this is beginning to show results in terms of vehicles produced and refurbished, as well as the amount of ammunition reaching the frontlines and Ukraine's cities.

All of this together has created a trajectory that will be difficult for Ukraine and its Western partners to alter, on timelines that are challenging in the extreme. There is, of course, the US election and the possible return of a Trump administration to the White House where he has promised to "end the war quickly." Furthermore, a recent poll of Ukrainians found that 44% believed it was time to negotiate with Russia, against 35% who did not. Most rejected Putin's conditions for peace, but these figures nevertheless indicate that the war is fatiguing Ukraine's populace. While wider Western support for Ukraine remains firm in the face of several elections that could have changed the situation for the worse, few are providing support at the scale required to change the war decisively. It is likely that many are nervously considering the point at which they will have to focus on their own defence needs, at the expense of Ukraine's. This means that if the war continues on the current trajectory, Ukraine will likely be forced to negotiate a settlement.

Winter is coming

Russia's strikes against Ukraine's critical national infrastructure (CNI) between March and June 2024 have brought the country to the precipice. By early June, Russia had destroyed half of Ukraine's energy generation capacity, leading to regular blackouts across the country. Without securing additional power, Ukrainians will face a horrific winter that may weaken morale yet further. Ukraine's heating and power generation are often linked in combined heat and power plants (CHPs), such as CHP No. 5 in Kharkiv which provided heating and power for around 1.3 million people. CHP No. 5 was destroyed during a large Russian strike on 22 March 2024, which included 151 missiles and drones. Many more strikes have followed targeting most of the CHPs and hydroelectric power plants in Ukraine, leading to severe damage that will take years to repair. Some of the plants had only recently completed repairs following strikes conducted against them in 2022 and 2023. Russia's earlier strikes had tended to focus on the facilities that distributed Ukraine's power such as substations. These were easier to repair and could be fixed quickly to restore power once damaged. Now, however, Russia has destroyed entire power stations as well as the rare and expensive equipment that makes them work.

Credit: Ukrainian MoD

This BMP-3 was captured by Ukraine and put to use against the Russian forces. Despite its relatively light armour, the significant armament carried by the BMP-3 means that it can be an effective fire support system.

Russia was able to achieve this because Ukraine's air defence interceptors had been largely depleted and it had been unable to adequately resource all of its competing needs. Months of attacks by the Shahed-136 one-way attack (OWA) drones and cruise missiles had finally taken their toll and paved the way for more successful and larger-scale attacks. Another key element to this is Russia's shift to a war economy and the resultant increase in its defence production, which will be covered in the third analysis of this article. This meant that it could afford to launch a large and complex strike package against Ukraine using ground-based 9M720 Iskander quasi-ballistic missiles, the air launched and hypersonic Kh-47 Kinzhal aeroballistic missiles, Shahed-136 OWA drones, and various cruise missiles in a single night of airstrikes. Combined with the depletion of Ukraine's air defences, the 22 March attack was almost certain to succeed. Russia's patience had paid off. The West scrambled to replenish Ukraine's air defence systems, with additional Patriot batteries and interceptors promised in short order. This is important in helping Ukraine deflect the worst of Russia's future efforts; the F-16s may also add to the country's beleaguered air defence if properly employed. However, the same problem will occur again if those air defences and aircraft are not supplied with plentiful stocks of interceptors and air-to-air missiles.

For the average Ukrainian, there are already regular blackouts – some up to 12 hours in length – along with a litany of other challenges. They range from a loss of mobile phone coverage, which makes it difficult to reach emergency services, to no elevators, which are essential in a country where the dominant form of housing is an apartment block. More severe impacts include the loss of running water, the loss of refrigeration during a very hot summer, and disruption to surgery and other life-saving care facilities. As winter approaches, temperatures in Ukraine will drop, and for most they will hover around 0°C until February or March 2025. There are some estimates that blackouts will last for 20 hours during winter to help the energy grid cope with the demand placed upon it by people staying home for longer and by the need for heating. If Ukraine is unable to keep the heating going, it may face a winter of burst pipes and further damage to its CNI that will have to be repaired. There are an estimated 3.7 million internally displaced Ukrainians, along with a further 6 million externally displaced. Already there are reports of extreme challenges in housing and catering for internally displaced Ukrainians, with housing and support scarce and unsuitable in some cases. It is very likely that a winter without heating will drive many of those internally displaced towards the border with Europe.

This is not all. Ukraine had a large defence industry prior to the invasion, which has suffered significant damage at the hands of Russian missile strikes. The invasion spurred the growth of Ukraine's defence industry, which has progressed from a cottage industry to one that performs a vital role in keeping the country in the fight. However, it relies upon power – without power, it cannot produce new equipment and repair existing equipment, both of which Ukraine desperately needs. Although Ukraine does not depend entirely on its domestic industry to meet its needs, it cannot always rely upon the timely delivery of aid from its Western partners. This means that any loss of production capacity will have an impact upon the frontline that will in turn feed into the overall trajectory of the war.

In sum, Russia's campaign against Ukraine's CNI means that the country must prepare itself for what will undoubtedly be a difficult winter; one that will fuel the desire of many to bring the war to a close and end the day-to-day challenges they face. This is arguably the purpose of Putin's campaign

against Ukraine's energy infrastructure, and it appears to be a part of a strategic operation to compel the Ukrainian state to seek peace. So, Ukraine's energy situation is dire in technical terms. It does not generate enough power to meet its winter needs, that much is clear. It is harder to assess the impact that this will have as the Ukrainians have proven themselves to be hardy and there are no overt signs of low morale at present, despite the findings of the survey noted in the opening section. It stands to reason that the winter will play a role in shaping Ukrainian support for the war, and therefore the ability of the country to continue in its fight. This thread shapes the trajectory of the war by damaging and degrading Ukraine's domestic defence industry, by raising the pain of the average Ukrainian, and by forcing the Armed Forces of Ukraine (AFU) to make difficult decisions about where its air defences are located. This thread will continue alongside the constant violence of the frontline where it appears that Russia has a slight advantage.

Credit: Russian MoD

It is difficult to comprehend the vastness of Ukraine's battlefields and the immense challenges that the terrain creates for an attacker. It has driven dispersion and will likely continue to inhibit the ability of either side to advance into prepared defences.

The frontline

Distributed advances

An analysis of maps from organisations that are pro-Ukraine and those that are pro-Russian indicate that Russia has made small but consistent advances throughout 2024. The Institute for the Study of War has created time lapse maps of the frontline showing how territory has changed hands over time. The DeepStateMAP group, which is pro-Ukrainian, provides indications of Russian unit locations and their offensive directions as well as changes in territory. Soar.earth adds satellite imagery and annotated drawings to a regularly updated map showing Russian and Ukrainian advances. It indicates that the AFU has prepared defensive positions West of Avdiivka, that the Russian forces will soon come into contact with. Militaryland.net provides a range of maps showing how key battles like Bakhmut and Avdiivka developed over time, as well as current force dispositions and areas with intense fighting. The pro-Russian outlets Rybar and Lostarmour also provide maps showing Russian force dispositions and detailed maps on a smaller scale showing local advances and combat. Examining all of these sources, it is clear that Russia is pursuing distributed advances designed to put pressure on much of the frontline all at once, rather than develop a single line of advance. It is likely that the trajectory of the fighting on the frontline will continue in this way throughout 2024.

The foundations for what is now happening were laid in the summer of 2023 and the bloody battle of Bakhmut, which cost Ukraine many soldiers and placed a strain on its ability to regenerate forces in sufficient quantity to support the rest of the line. Ukraine's planned counter-offensive was unable to dramatically alter the trajectory and open the static frontline to manoeuvre, it also resulted in very heavy losses of Ukrainian personnel and equipment. Meanwhile, Russia attempted to stabilise and recapitalise its forces following the defeats of 2022 and delegated offensive action to Wagner (for a time), thereby shielding the bulk of the Russian armed forces from more costly types of action. The strongest signal that Russia was prepared to resume the offensive came with the siege and eventual capture of Avdiivka in February 2024. Ever since, Russia has made consistent advances on the frontline with the goal of seizing the Donbass Oblast in its entirety and extracting the maximum toll on the Ukrainian forces as it does so.

As of early August 2024, the Ocheretyne axis – heading towards Pokrovsk – now forms one of three that the Russian commanders have prioritised, along with Chasiv Yar, which is near Bakhmut, and a small city called Toretsk. If each axis is successful, Russia will have succeeded in taking much of the Donetsk oblast, which has been one of the long-held goals of the invasion. This has forced Ukraine into a position where it is always trying to manage the situation and prevent or limit any form of breakthrough rather than preparing for more decisive offensive actions.

The Kharkiv offensive launched on 10 May 2024 appeared to catch Ukraine's defenders somewhat off-guard and led to the rapid repositioning of Ukraine's well-equipped formations to the area to stop the Russian advance. Initially, the AFU lacked the ammunition and resources to properly respond, three months without US aid had taken its toll. However, once the supplemental was passed and ammunition began to reach Ukrainian units once more, artillery units in the area came to be well-supplied with ammunition and were able to contribute to stalling the Russian offensive. The opposing Russian units used this opportunity to engage hundreds of Ukrainian vehicles as they rushed to the area with Lancet loitering munitions, including successful engagements against valuable systems such as Caesar 155 mm howitzers. The goal of this advance was reportedly to bring Russian guns within range of Kharkiv, to make life unbearable for the 1.3 million Ukrainians living there. Furthermore, it has distracted Ukrainian attention from the Donetsk oblast and led to further losses for the stretched and under-resourced AFU.

Elsewhere, the Ukrainian beachhead at Krynky in the Kherson region finally folded after the loss of around 1,000 Ukrainian troops reported killed and missing. The

Credit: Ukrainian MoD

This still shows the moment that a Russian tank was destroyed during an offensive. Armour losses have been heavy on both sides, forcing infantry, drones, and artillery to create more favourable conditions for their deployment.

conditions for Ukrainian marines in Krynky were very difficult and it is remarkable that they were able to hold the area for nine months under constant Russian offensives. Both sides made extensive use of drones to the extent that Russian units came to regard a posting there as a death sentence. Ukrainian forces remain nearby, so it is unclear whether or not the end of the Krynky operation will lead to the repositioning of Russian forces elsewhere on the front.

Tactical evolution

Fortunately for Ukraine, Russia appears to be unable to bring together a consolidated force above brigade strength and deploy it on a single line of advance. If Russia were able to deploy division-sized forces into an attack it would likely be very difficult for Ukraine to prevent its advance while maintaining integrity along the rest of the front. Despite an inability to muster and command large formations in the field, Russian units had captured 880 km^2 of terrain by May 2024, Russia's defence minister, Andrei Belousov said. This statement was issued 20 days after the Kharkiv offensive was launched. There may be more to Russia's inability to employ large formations than a lack of command capability; Ukraine has routinely punished Russian units for concentrating in more than company strength, and the length of the frontline (over 1,000 km) is stretching and dispersing the force footprint on both sides.

This has led to a preference for small unit tactics in defence and offence, which makes a decisive breakthrough in any area unlikely. As a result of this, the trajectory of fighting on the frontline should be expected to continue on its current course, with small pieces of territory seized or recaptured each week. Small unit tactics have evolved throughout 2024 and the Russians appear to rely on a fairly consistent model of probing Ukrainian defences searching either for weakly-defended areas, or weaker units to target. The latter approach was pursued in Mariupol, where Russian units would target the joining points for Ukrainian units – the link between marines and the Azov forces, for example. They also look for vulnerable moments such as force rotations. Russian units were able to advance 5 km and inflict significant casualties in April 2024 as the 47th Mechanised Brigade prepared to exchange positions with the 115th Mechanised Brigade near the village of Ocheretyne, which is close to Avdiivka. Notably, many accounts of sudden Russian advances indicate that 5-8 km is the limit of what they can achieve in a given attack with their current force disposition. This is likely a result of the size of the units available and the location of their supplies, as well as Ukraine's ability to reposition its forces rapidly around the front.

Credit: Russian MoD

This still from a Russian MoD video appears to show a Krasnopol strike on a Ukrainian howitzer. The counter-battery fight has been critical to both sides throughout the war.

The exact nature of the vulnerability at Ocheretyne is unclear, however Russia was able to capitalise on a weakened Ukrainian force presence to seize the initiative and capture Ocheretyne as well as the vil-

Credit: Russian MoD

This image shows a FAB-3000 with a UMPK guidance kit during flight. The size of glide bombs has increased steadily throughout the war with the result that the much greater blast radius places a lower burden upon accuracy.

lages of Novobakhmutivka and Soloviove by 1 May. Success in these areas enabled Russian units to push toward Toretsk and Chasiv Yar; the latter occupies high ground, giving an advantage to Ukrainian defenders in inflicting casualties on Russian units in the area. Furthermore, the defences protecting Toretsk have stood since 2014, if both towns fall; Russia will be able to threaten Kostiantynivka, which sits on the intersection of two key highways.

Russian tactics appear to follow a pattern with inexperienced units made up of mobilised soldiers and prisoners used in an initial push to identify Ukrainian strong points. In Bakhmut, these tactics were used in waves and subsequently became known as the 'meat grinder'. Once the expendable troops had identified Ukrainian positions, these positions would be attacked by well-trained units using combined arms tactics to overwhelm the now-exhausted Ukrainians. Regular motorised rifle regiments would then be used to hold those positions as the better-trained units rotated out and prepared for the next opportunity. This pattern has continued, with one evolution being the focus on weak units, as opposed to weak points. This is combined with the use of overwhelming firepower in the form of massed artillery and glide bombs when opportunities arise. One Ukrainian commander indicated that entire units can be lost to a glide bomb strike through concussions. This is challenging when a platoon of 10-15 personnel might be holding several kilometres of the front.

The use of glide bombs and artillery is fairly consistent with Russian doctrine, and its forces have always tried to bring the maximum number of effects to bear upon Ukrainian positions. At times, Ukraine's strikes on Russian air bases and air defences are able to hold Russian air power at risk; in Krynky this reduced the number of glide bomb strikes from 80 per day to just 4, according to an interview with a Ukrainian soldier published by *The Times* in June 2024. However, Ukraine has depleted its air defence interceptors and is unable to provide for the needs of the entire frontline, which enables Russian drones to operate at depth behind Ukrainian positions, and fixed-wing aircraft to approach to within 20 km of the frontline to deploy their guided bombs. As noted above, a single bomb can destroy an entire Ukrainian position or incapacitate a section. Russia was able to employ over 3,000 of them in April 2024 alone. However, the Russian aircraft must get close if they are to strike a designated Ukrainian position. Here, the arrival of F-16s and further air defence missiles could drive Russian aircraft further back from the front and degrade their accuracy, making them less effective at reducing Ukraine's defences.

Credit: Russian MoD

Russia has made innovative use of FPVs to challenge Ukrainian defences and allow its troops to advance without losses in some areas. This marks a departure from total reliance upon massed artillery barrages, although the two often go hand-in-hand.

What is new to Russian units is the mass use of drones. In the drive toward Pokrovsk, Russia deployed hundreds of highly-trained FPV operators employing a new control frequency for their drones that Ukrainian electronic warfare (EW) was not prepared to jam. Their initial targets were Ukraine's logistics routes in the area. The use of different frequencies is a common occurrence and can drive almost weekly changes in EW doctrine and drone software to adapt to changing conditions. Drones are also used to target Ukrainian dugouts, forcing relocations and the building of new positions, as well as casualties. In other accounts, the Russian forces targeted a new Ukrainian unit exclusively with FPVs, shortly after they had occupied a new position in the village of Ivanivske. The drones reportedly killed or wounded 80% of the 70 soldiers occupying the trench. The relative precision of drones also makes them better suited to targeting small infantry positions and lone civilian vehicles providing logistics than massed artillery barrages. If FPVs do not succeed, however, Russian units can often resort to the use of artillery and mortar fire support where Ukrainians cannot. For the Ukrainians, drones are a vital lifeline and often the only form of fire support that they are able to employ.

Russian infantry often operate in teams of 3-4 and work slowly, using tree cover and EW to counter Ukraine's own fleet of drones and work their way forward. If they are able to infiltrate without being detected, the teams may assemble into a larger platoon of 15 or more and, once Ukrainian positions are identified, call on artillery, drones, and airpower to engage them before assaulting. The Ukrainian forces have to work hard to track the

Credit: Ukrainian MoD

Drone tactics have also evolved to include much greater use of night vision and strikes under the cover of darkness, which makes detection more difficult.

smaller sections and target them before they are able to gather into a consolidated force. Both sides occupy trenches that are separated at times by a just a few hundred metres, which makes offensive operations risky and places a premium on movement at night, and the consequent use of thermal and night vision scopes as well as suitably-equipped drones for reconnaissance.

Although Russian tactics struggle to generate momentum, they have proven successful against Ukrainian forces that are depleted and struggling to regenerate personnel, whilst also running much lower on ammunition than they did in 2023. One AFU unit reports being able to fire just 60 rounds from its D-30 122 mm howitzer at the worst moments of Russian assaults, and are almost unable to conduct meaningful fire missions at other times. By way of example, prior to the passing of the US aid bill, Ukrainian guns were completely silent during Russian bombardments in the Donetsk oblast. This leaves the Russians with fire superiority, which means that they can take the time necessary to degrade Ukrainian positions before conducting further offensive actions.

Overall, Russia is driving toward capturing all of the Donetsk oblast and causing as many Ukrainian casualties as possible through distributed advances. It may not achieve this goal in 2024, but the current trajectory indicates that the Russian forces will eventually be successful without dramatic changes to the AFU's ability to continue the war. This will enable the Kremlin to claim that it has successfully achieved some of its war aims such as demilitarising Ukraine and securing the Donbass. It could, if it chose, assume defensive positions at that point and demand greater concessions during negotiations – if and when they happen. The current methods employed by Russian units are difficult for Ukraine to challenge without ammunition, and even with greater supplies of ammunition, the losses inflicted on Ukrainian units are draining the AFU's ability to maintain its positions.

Continuing the war: Filling the ranks

Both sides have proven more resilient than originally thought. However, the data presented can be misleading. It is unlikely that the personnel losses suffered by Russia are as significant as many think, while the vehicle losses are challenging but many are being replaced. Research conducted by the BBC and Mediazona indicate that some 20% of Russia's 61,000 confirmed deaths in Ukraine were prisoners, and another 12.5% were mobilised civilians that had been recruited since early 2023, with losses of Russian regular troops proportionately much lower than at the start of the war. This is to be expected given the replenishment that has been required to keep Russia in the fight. However, the use of convicts as well as the forces of the former Luhansk and Donetsk People's Republics (LNR/DPR) – has shielded Russia's population from the worst effects of the war. The DPR alone suffered close to 20,000 killed and wounded by November 2022. Furthermore, Russia is primarily recruiting from rural districts where there are fewer employment opportunities, and it still maintains its annual conscription cycle, with conscripts frequently being used to defend Russia's borders.

Meanwhile, the high value Russian troops such as the airborne forces (VDV), artillery, and snipers, are used sparingly compared with those convicts and mobilised troops driven forward to find Ukrainian positions. Artillery troops have reported regular rota-

Credit: Ukrainian MoD

Snipers have always played a prominent role in Ukraine. They can suppress infantry and exact losses for a relatively low price. Sniper duels have occurred according to some accounts, however, the preference is for artillery and drone strikes on the suspected area.

Credit: Ukrainian MoD

Howitzer crews face difficult decisions. Traditional doctrine would have them relocate after a fire mission, leading to frequent moves within a unit's battlespace. Eventually they would expect to return to firing points that they had already occupied, which could present the risk of counter-battery fire. However, persistent observation and a relative lack of cover mean that relocation risks detection. This leads some crews to stay in place for multiple fire missions and rely upon camouflage instead; they may also leave their gun if detected and hope any damage is not too severe.

tions out of the frontline and bed down positions well back from the contact area that are intended to protect them from Ukrainian strikes when they are not providing fire support. Russian snipers are reportedly involved in frequent training sessions and close coordination with arms manufacturers away from the frontline to improve their capabilities. This indicates that Russia is working to maintain the capabilities of these units and that the losses suffered are unlikely to accurately reflect the nature of the impact that the war has had on Russia's armed forces and their ability to continue the war. Nevertheless, it is likely that Russia's mobilisation has not generated the number of forces that it had hoped for, and some reports indicate that 'spare' signallers are occasionally mobilised to serve in the infantry.

Ukraine is also struggling to recruit or mobilise enough personnel to maintain its units and has been drawing increasingly on its own rural population centres to sustain its forces. This marks a shift from the first year of the war when the ranks of the AFU swelled with tens of thousands of volunteers rushing to defend Ukraine. The country's training pipeline is struggling to maintain the quality that marked earlier Ukrainian forces out from their opposite numbers. Reports frequently observe that Ukrainian units are deployed with little training and lack experience because injuries have removed veterans from their ranks. This has led to highly-qualified operators such as trained drone operators or EW practitioners being sent to frontline units. In other cases, personal grievances have been settled by getting opponents sent to the frontline, and in others, a deployment to the infantry is used as a form of punishment – a trend common to both forces.

One notable difference is that Ukraine often has no choice but to use its most proficient and elite formations, such as the 47th Mechanised Brigade, in the defence of Chasiv Yar, or its special forces near Kharkiv. Many of these units are used continuously without rotation, whereas Russia's more capable units appear to regularly rotate out of direct contact, leaving motorised rifle troops to hold the line. The mortality rates amongst Russia's artillery and armoured formations are also lower than the infantry, which allows for the accumulation of experience and improvement of combat skills.

For Russia, casualty evacuation is a low priority, especially amongst the storm units that are used for initial reconnaissance and screening operations. Often, they will be told to wait in position once they have made some progress, even if severely wounded. Those that die may not be recovered and their bodies left in no-man's land. A prominent Russian blogger has reported that this is a deliberate strategy designed to keep casualty figures down. If wounded and evacuated, Russian troops face an uncertain future of poorly-equipped medical facilities and medical teams under pressure to return them to service. The high casualty rates amongst Russian infantry likely means that those units are slow to accumulate experience, especially if they are commanded by 'butchers', a term used by some Russian soldiers to refer to particularly callous officers.

Ukrainians can expect somewhat better treatment for the most part, with one report highlighting that 75% of the wounded are returned to service. However, another article that includes an interview with a surgeon, notes that the increase in homemade and 3D-printed bombs that are dropped from drones, means that magnetic extraction of fragmentation (a method used for mortar and artillery wounds) is now less effective as the fragments are mostly aluminium and polymer. The same surgeon also stated that there had been a dramatic increase in the number of severe burns as well as the use of Chloropicrin from drones, a chemical agent which affects the lungs and eyes. All of these injuries are more difficult to treat successfully and can lead to greater rates of infection, disability, and fatalities.

Overall, this indicates that manpower challenges are present in both forces. However, Russia's depth of potential manpower resources and firepower advantage mean that it can compensate for poor training and replenish numbers to some extent, whereas Ukraine is less able to accomplish the same.

Credit: Ukrainian MoD

The M109 is a reliable howitzer as it is a primarily mechanical design, which means that a lot of repairs can be conducted locally. It is also designed for prolonged high-intensity use. However, the shortage of ammunition has been very damaging for Ukraine's overall battlefield situation.

Equipping the ranks

Russia's defence industry is ramping up its production and restoration of armoured vehicles and ammunition. It is now stockpiling missiles as well as launching them at Ukraine's energy infrastructure and priority targets such as PATRIOT batteries and HIMARS launchers. While it is unable to produce as much ammunition and as many vehicles as its troops need, it can supply sufficient quantities to maintain the tactics described above. Ukraine, however, is reliant upon its own production of drones, which has likely been impacted by the strikes against its energy infrastructure, as well as Western aid. The greatest impact appears to come from US aid in particular, which may be in doubt if Trump is elected president.

Furthermore, many European countries have given very significant quantities of aid, and their industries are busy replenishing depleted stockpiles. This means that they must balance Ukraine's needs, with their country's own potential needs to deter Russia. If the trajectory of the war continues downward, it may become more likely that European states prioritise their own equipment needs over Ukraine's, which will further accelerate the decline of Ukraine's capabilities. Armoured vehicles and howitzers have, in some scenarios, given way to the mass use of drones, but they cannot be completely replaced in this way. This paradigm may partially ameliorate the immediate need for new vehicles and equipment for Ukraine, however, it continues to lose howitzers, air defence systems and vehicles such as the Bradley infantry fighting vehicle (IFV), which provide vital fire support and protected mobility.

The threads make a rope

All of these threads combine to reveal the trajectory of the war. At present, Ukraine's forces are able to exact a high price from Russian units as they seize towns and territory. The price they can exact depends on the level of Western support they have access to. More support increases the price as they can hold Russian aircraft at risk and return fire. Less support provides Russia with the opportunity to employ massive firepower to destroy Ukrainian positions without risking its own infantry. However, in general Russian units are showing greater tactical proficiency combined with more effective levels of firepower, which compound Russia's advantages and can counter some of Ukraine's strengths. If this situation continues, Ukraine will lose more territory and its position in any future negotiations will be weaker.

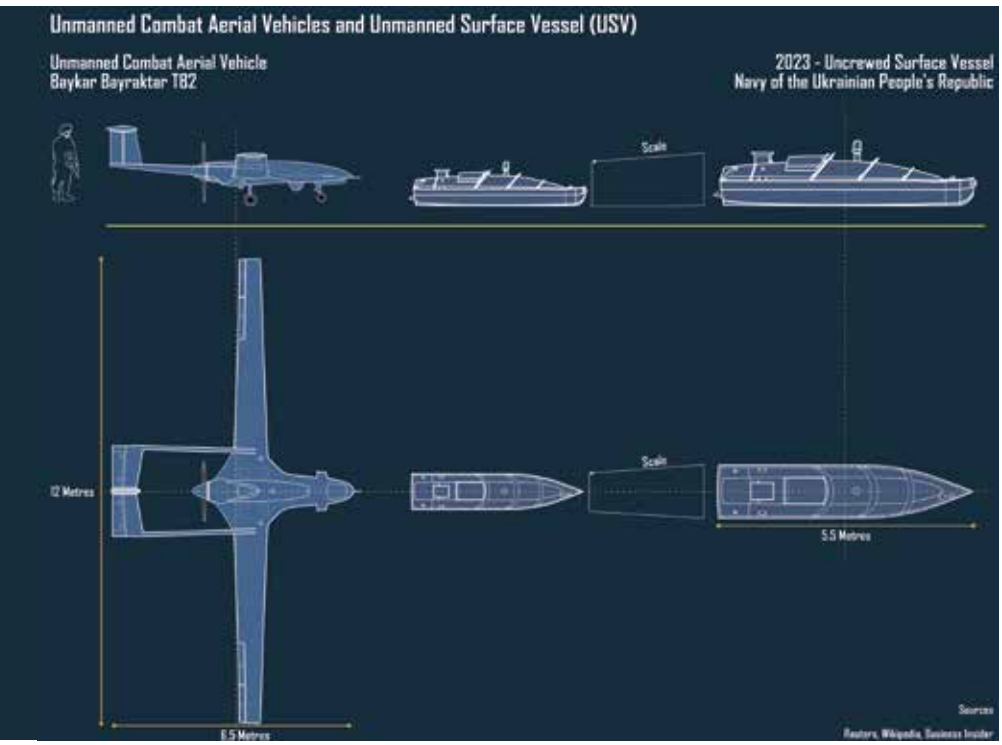
Ukraine may be able to reverse this situation if it can counter some of Russia's advantages and retake lost towns at a sufficiently low cost that it does not expose the frontline to further shocks such as the Kharkiv offensive. However, this is largely dependent upon continued US aid and an increase in available troops and training. The third thread is the power situation and the civilian population's willingness to continue the war. The frontline situation contributes to the overall sense of the country's ability to actually win the war and the likely outcome. However, it is likely that the severity of the coming winter and attendant suffering imposed without power will shape the number of Ukrainians who believe that it is time to negotiate. This means that the war is unlikely to end in 2024, either militarily or socially. However, if the prevailing conditions at the beginning of 2025 are sufficiently dire for Ukraine's population and its armed forces, the likelihood of an end to the war in that year increases significantly. In that sense, 2024 is a decisive year.

Sea drones at war: Tactical, operational and strategic analysis of maritime uncrewed systems

Giangiuseppe Pili

Since at least late-2022, Ukraine's ingenuity and necessity led it to experiment with maritime uncrewed systems (MUSs) or what in ordinary language are referred to as 'sea drones'. These have had a profound impact on its efforts to combat Russia's Black Sea Fleet.

In October 2022, Ukrainian video footage surfaced, obtained through GoPro-style camera mounted on several uncrewed surface vessels (USVs) getting closer to an *Admiral Grigorovich class* frigate, possibly the then-flagship (following the sinking of the Mosvka) of the Black Sea Fleet *Admiral Makarov*. According to the Russian Ministry of Defence (MoD), the attack involved eight USVs and allegedly four where destroyed and other three exploded on land, suggesting that those USVs where not employed for intelligence and reconnaissance but for targeting ships.



Credit: Giangiuseppe Pili

Size comparison of a Bakraktar TB2 UAV and a Magura V5 USV.

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Military analysts have more or less enthusiastically endorsed the Ukrainian capacity to use the MUSs to repel the Black Sea Fleet out of range of key areas, allowing the defence of Odessa and Snake Island from the sea. There are indications that MUS use had had some wider-reaching effects; for instance, through 2023 and 2024 Russia been increasing the capacity of a naval base in the occupied Georgian region of Abkhazia. This may be due to it representing a more secure port to dock its vessels, due to the threat of MUSs.

Thus far, relatively few analysts have paid attention to the marked difference between the effects of drone warfare on land and at sea. Gen Valery Zaluzhnyi previously admitted that no "beautiful breakthrough" was possible in the summer 2023 Ukrainian counteroffensive. One of the commonly-cited reasons for Ukraine's waning military success from mid-2023 has been the overall effect of drones within the land warfare sphere. Already by October 2023 RUSI Senior Research Fellow, Jack Watling, argued that Ukraine would need to prepare for a "hard winter". More recently, in April 2024, Kyrylo Budanov, the Chief of Ukraine's Main Directorate of Intelligence (GUR) stated that Ukraine is "facing a difficult period". While the full impact of Ukraine's August 2024 raid into Russia's Kursk region is still to be decided, to a large extent Ukraine is still facing difficulties along the majority of the front lines.

Drone warfare appears here to stay, as Zaluzhnyi, now Ambassador to the UK, recognised, explicitly advocating Ukrainian expansion in basically all technologies required to make the drones work. Examples include replacing satellite-based global positioning system (GPS) positional information with solutions using ground-based antennas, improving resilience to electronic warfare (EW), along with efforts to contest Russian air dominance, among others. The new commander in chief, Col Gen Oleksandr Syrskyi, in spite of having been criticised for being 'the product of the Soviet military doctrine', seems to not have significantly changed this approach toward drones and their use on the battlefield.

Although Russian attacks seem to be effective, they have still yet to pull off any 'spectacular breakthroughs', and their of-

fensive efforts exact a high toll in lives and equipment. Ukrainian lines in some areas are being pushed back, but are still holding in other areas, even amidst Ukraine's difficulties with recruitment. By contrast, Ukraine has seen what are arguably more strategically-significant successes in the Black Sea.

The strategic importance of the Black Sea: Still never fully appreciated

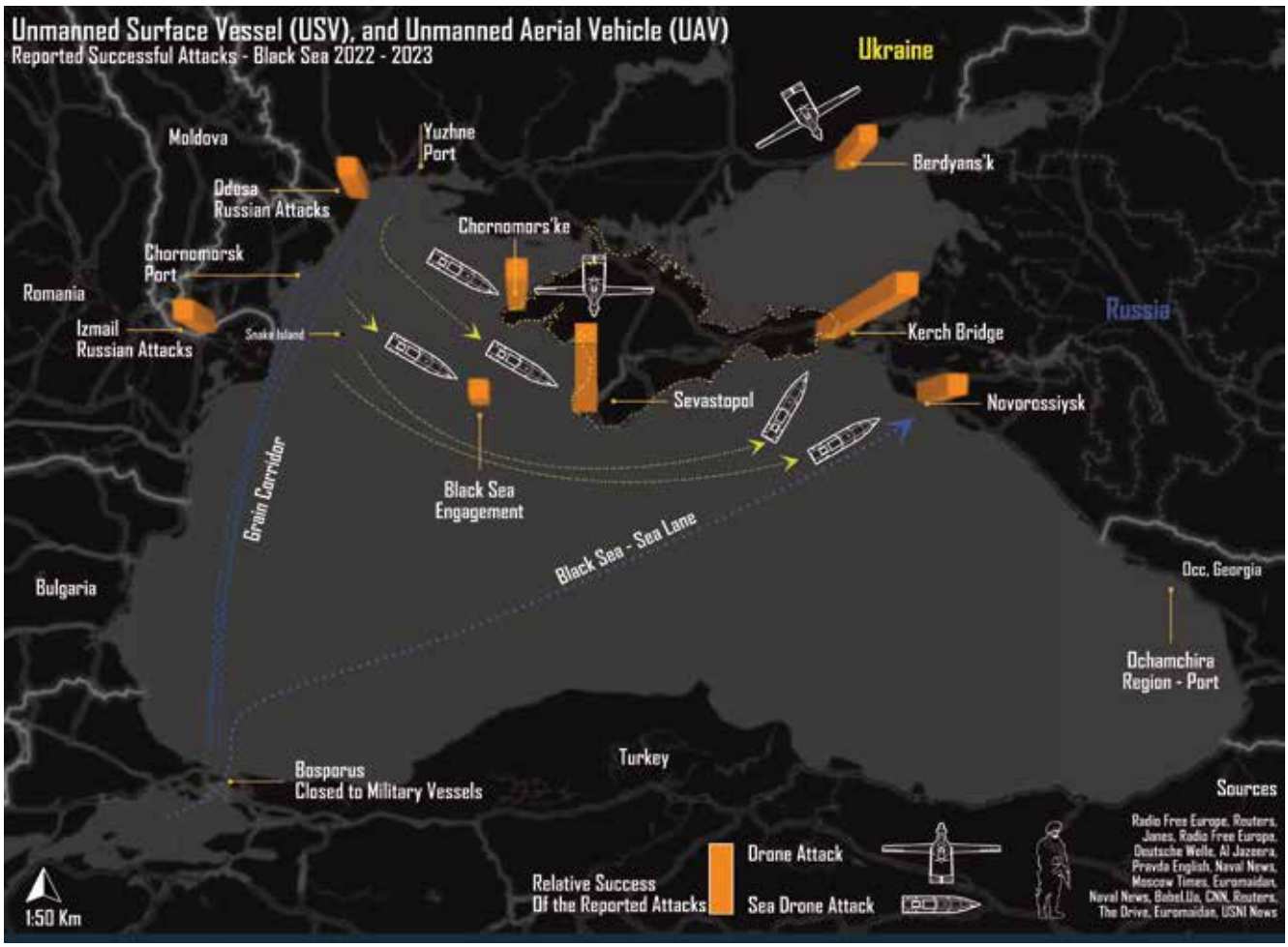
The strategic importance of the Black Sea lies primarily in its logistical value for Russia. Russian military logistics relies heavily on railroads and specialised brigades, such as the Material Technical Support (MTS) brigades, which play a pivotal role in supplying the armed forces. These brigades are vital for strategic and operational logistics, but they have faced challenges, especially during the early days of the full-scale War in Ukraine. One significant limitation is their capacity, as they can move only a fraction of what a large, capable cargo ship such as the SPARTA IV can carry. Moreover, in recent times, Ukrainian sabotage efforts have hindered the normal logistical flux through railways, although Russia was still able to move munitions from North Korea and the far east to the Ukrainian theatre. However, the situation is still far from ideal.

The Black Sea's importance to Russia's logistics network becomes evident when considering the difficulty of moving such large quantities of supplies by rail alone. Therefore, maintaining control and access to the Black Sea is strategically vital for Russia's military operations and Russia has a strategic advantage over Ukraine at sea.

Moreover, Russia has a significant military presence in the Black Sea, as it has an entire fleet and associated infrastructure in two major ports (Sevastopol, and Novorossiysk), minor ports (such as Fedosia), along with a likely refurbished naval base in Abkhazia, and it can use Crimea as effectively an 'unsinkable aircraft carrier' and logistics platform. Ukrainian attacks targeted the Kerch Bridge with USVs, Storm Shadow missiles were used in Crimea, which reportedly critically damaged the Rostov-on-Don Project 636.3 Improved Kilo class submarine on 13 September 2023. The same submarine was struck again on 2 August 2024, and claimed to have been sunk, though the weapon used was not mentioned. Russia tried to improve its defensive measures securing entry to the port of Sevastopol, but appear to have decided to relocate part of the fleet, especially after the repeated successful attacks mainly from the air.

In fact, the main successes of the Ukrainian efforts against the Russian overwhelming presence at sea were caused by missiles as much as from USVs. Ukraine sunk the flagship of Russia's Black Sea Fleet Moskva in March 2022, thought to have been through a R-360 Neptune anti-ship cruise missile manufactured in Ukraine (and so representing a major success for Ukraine's military industry). Recently, this happened again with the Kommuna submarine rescue ship, purportedly struck by another Neptune missile.

True, the Moskva possibly sunk thank to the Russian incompetence to manage the fire which broke out, but still, it was a major success. Secondly, the reported destruction of the Kilo class submarine, Rostov-on-Don, which will not recover for some time, was due to a UK Shadow Storm missile, not an MUS. After all, it was at the dry dock in Sevastopol, a difficult target from the sea but an ideal target from the sky. Third, they sunk the Saratov, an Alligator



Credit: Giangiuseppe Pili

Reported successful attacks by UAVs and USVs.

Credit: Giangiuseppe Pili

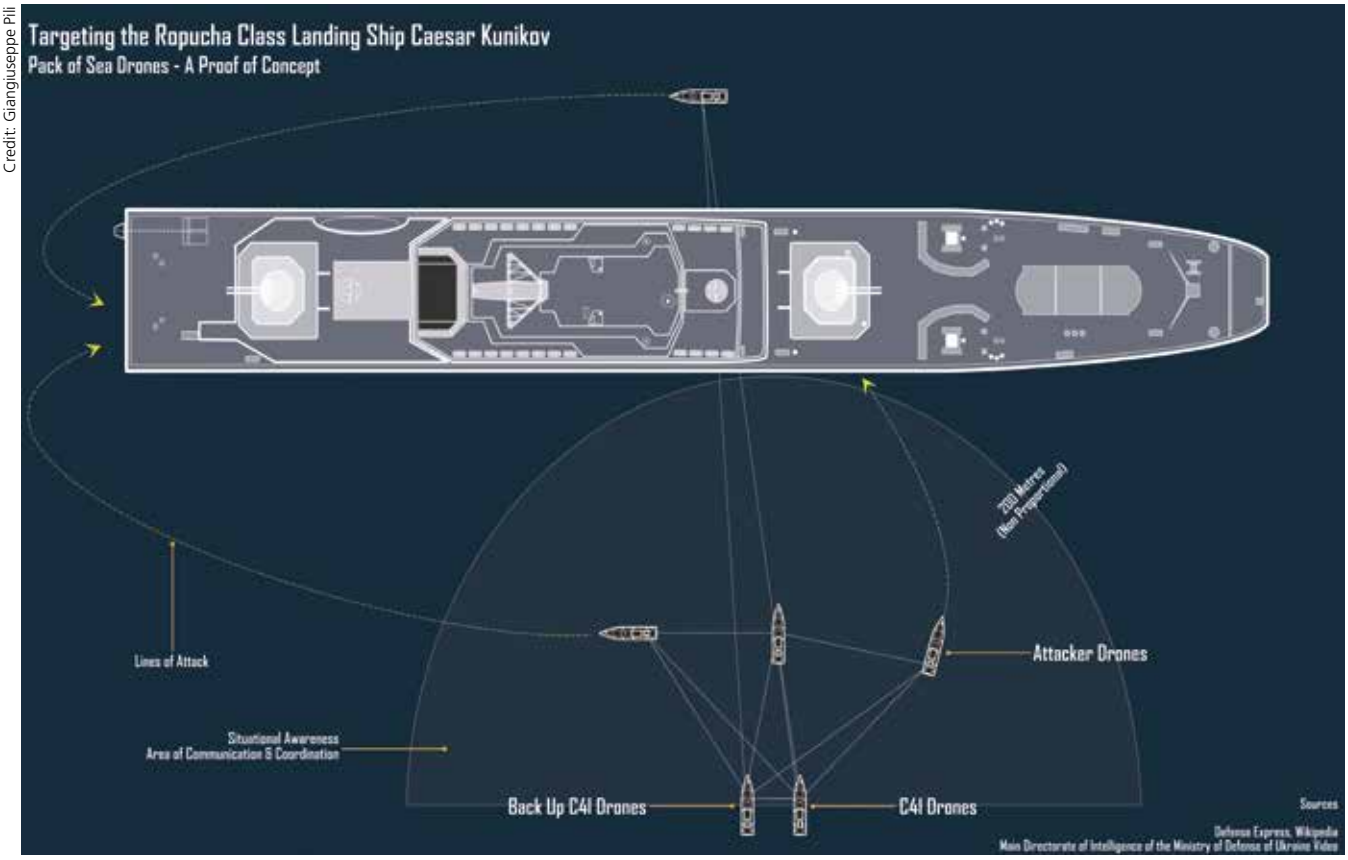


Diagram showing the process of Ukrainian USVs engaging the Ropucha class landing ship Tsezar Kunikov.

class landing ship tank (LST), but it was very early on the war, hence unlikely to have been hit by USVs, which started to be operated later. The Kerch Bridge was attacked by both missiles and USVs, some possibly carrying 850 kilograms of explosives. However, the operation which has the success in damaging the bridge was a truck bomb attack, but this is still possibly contested. As it stands, MUSs did not prove able to bring the bridge down and, at best, destroyed two spans of the bridge.

MUSs can face various challenges to successful employment; for instance, they can reportedly be repelled with machine guns once they are spotted. Moreover, they require significant work from the intelligence operatives, as the targeting process for multiple MUSs requires an impressive amount of work. This is true on land, and it is much more truer at sea, where there are often no visible points of reference, and the target has to be known far in advance to establish a successful operation to strike it effectively. This is quite clear from the footage released by Ukrainian units. In fact, MUSs are possibly mainly employed in special operations by Ukraine's GUR, who have proven to be among the most efficient and deadly groups in the war, able to have significant cross-domain impact.

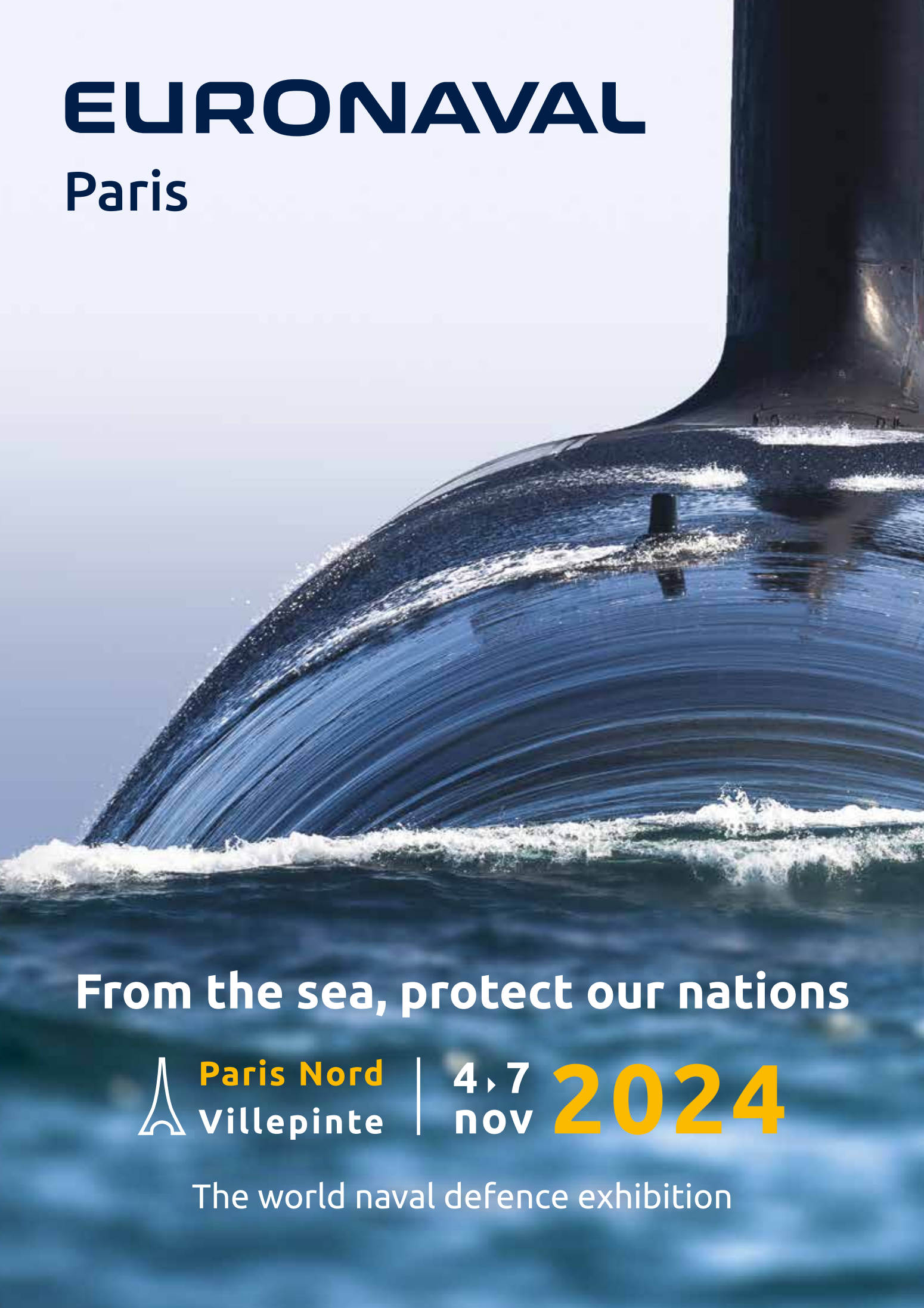
According to a recent video, at operational level, the MUS kill-chain should approximately comprise the following steps. Firstly, there is intelligence gathering on where the target (vessel) is located and when is going to move. Once this is ascertained, Ukraine launches roughly three to five attack USVs and at least one reconnaissance drone serving as a C4I-enabler, hoping to catch the ship hours from where it was last reported. When the ship is spotted, multiple attack drones are sent after the ship, possibly hoping to exploit an 'indirect approach-operational tactic'. Then, they try to strike the target at the centre (as with the Moskva), where the munitions and/or fuel is usually stored and the possibility to strike the target is higher. Thus far, these USV attacks have proven that they can sink a high tonnage vessel, but typically not with just a single USV; a concerted operation with multiple attacks on a vulnerable target is needed.

Remarkable tactical successes and some strategic gains

It took time for USVs to prove they can sink a vessel, which probably means that Ukrainian targeting units, possibly GUR, needed time to experiment with and test the appropriate intelligence cycle, operational and tactical planning, and proper execution. USVs were able to severely damage the *Olenegorsky Gornyak*, a *Ropucha* class landing ship, on 4 August 2023. The ship was visibly damaged, but it did not sink. The USV operator(s) possibly tried to hit the fuel and engine rooms, or it simply tried to hit the centre of the ship for maximising the chances for a successful impact on target.

In another case, a USV targeted a Russian tanker, the Sig, in August 2023. Its estimated 450 kg (992 lb) of TNT equivalent payload was able to damage, but not sink, the ship. In other instances, USVs were able to reach the port of Sevastopol multiple times, although the Russian MoD declared that it destroyed 17 USVs. While the Russian MoD figure should be treated with a degree of caution, it does seem the case that numbers matter in USV strike operations, and it is so far unclear how many are needed for effective strikes.

A notable incident in USV use occurred on 26 December 2023, when the Ropucha class landing ship *Novocherkassk* was struck in the Crimean port of Fedosia, and was reported to have been sunk. This marks the first occasion where USVs proved that they were able to sink vessels, and was closely followed by Ukraine's USVs sinking the Tarantul class corvette Ivanovets on the night of 31 January/1 February 2024. A pack of USVs were able to strike a hard target again on 14 February 2024, the *Ropucha* class landing ship, Tsezar Kunikov, and sinking it. Admiral Viktor Sokolov was removed as commander of Russia's Black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Credit: Giangiuseppe Pili

Possible course taken by Ukrainian USVs in the sinking of the Tarantul class corvette Ivanovets. Imagery sourced from: European Space Agency (ESA).

Sea Fleet on 15 February 2024, likely as a direct outcome of these attacks.

These are all remarkable tactical successes, which were able to reopen the grain corridor for the time being, allowing Ukraine to significantly increase its grain exports from the relative lows seen in the summer of 2023. The route is the most direct, and the time required to move the goods is still not back to normal, but the simple fact that Ukraine is able to move civilian cargo by sea at all is vital for the Ukrainian economy. Finally, the greater success is in what the USV facilitated: the significant removal of Russian ships from Sevastopol, with these being redeployed in Novorossiysk and possibly to the refurbished port in Abkhazia.

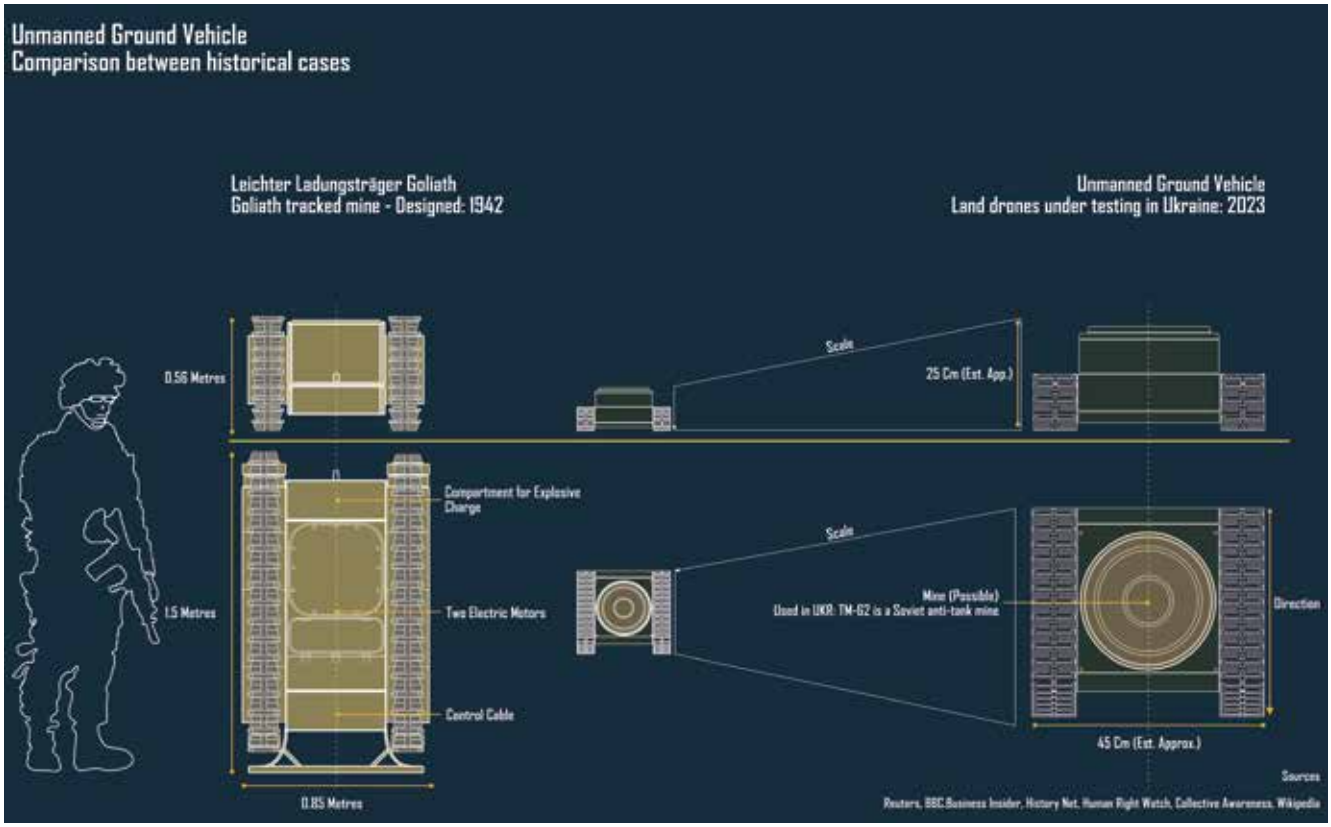
However, these victories, as remarkable as they are, are not due the USVs exclusively, but rather on a combinations of weapons that together act as an 'orchestra' in which USVs form a key part. USVs are therefore no doubt useful, but a comparison with the UAVs will show how different their effects are at the strategic level.

UAVs: more interesting than tactical nuclear weapons?

In the land warfare domain, UAVs allow their user to achieve multiple results. Firstly, as it was argued for in the case of tactical nuclear weapons, they restrict the opponent's capacity to concentrate forces on a sufficient scale to create the conditions for the acclaimed manoeuvre warfare. This is achieved for several different reasons. For starters, UAVs allow their user to conduct reconnaissance and gain situational awareness from afar, thereby also serving as enablers for systems such as artillery. Secondly, UAVs and loitering munitions can also be used to directly target and destroy armoured vehicles. Both measures together incentivise dispersion and can cause disruption to the movement and coordination of armoured formations, as well as degrading the level of firepower the opponent has available. Thirdly, they create an additional level of psychological burden, especially during movement. Considering the already heavy psychological toll inflicted through traditional artillery barrages, knowing that the drones are flying around searching for you is widely reported as a harrowing experience by both sides. Fourthly, UAVs allow their user to conduct guerrilla-style warfare, with lower levels of direct engagement, using equipment supplied mostly by Ukrainian civilian developers and engineers, who have proven capable of creating a variety of reconnaissance UAVs, as well as loitering munitions and first-person view (FPV) drones.

This means that the UAV-related technology is overall able to produce multiple types of drones capable of totally different operations but whose combination is able to inflict such a severe toll on the enemy that that they cannot properly coordinate, group, and attack with full effectiveness. As a result, there is enough friction inflicted to heavier armour to heavily disincentivise the accumulation of forces. However, footage also shows that these drones are sufficiently cheap to allow direct targeting of individual soldiers, with some disturbing results.

In essence, drones are defeating conventional armoured vehicles for multiple reasons. Firstly, they are cheap enough that multiple can be expended on the destruction of higher-value targets such as tanks or howitzers, with even the loss of many still being economically worthwhile against such targets. Also, by their nature, they can be replenished reasonably quickly, and (at least for the Ukrainian side) there is a low political price associated with their delivery and use, compared to the bureaucratic and diplomatic work required for Ukraine to receive and use some of the equipment provided by its allies. As such, Ukraine continues to develop a highly-capable drone industry to sustain its war effort.



Credit: Giangiuseppe Pili

UGV size comparison, a WWII-era German Goliath UGV with a 2023 Ukrainian UGV design.

Finally, flying drones face relatively few restrictions in their movement. Comparatively, there has been limited use of unmanned ground vehicles (UGVs), though experimentation in their development and employment continues. It is possible that more Ukrainian UGVs will end up seeing use in demining operations or used for casualty evacuation and delivery of supplied, as has been done by the Russians. However, it is difficult to believe they will soon reach the level of UAVs' capability for the simple reason that there is a lower demand for them. In this regard, land drones are more comparable to MUSs.

MUSs – Perhaps not a revolution in military affairs

It is a natural tendency to try to find revolution where there is only evolution. By themselves, MUSs can limit access to given portions of the Black Sea and impose a certain level of friction on the Russian presence in the region. However, as noted by Richard Dunley in his recent analysis on the history and applications of MUSs, they are hardly revolutionary.

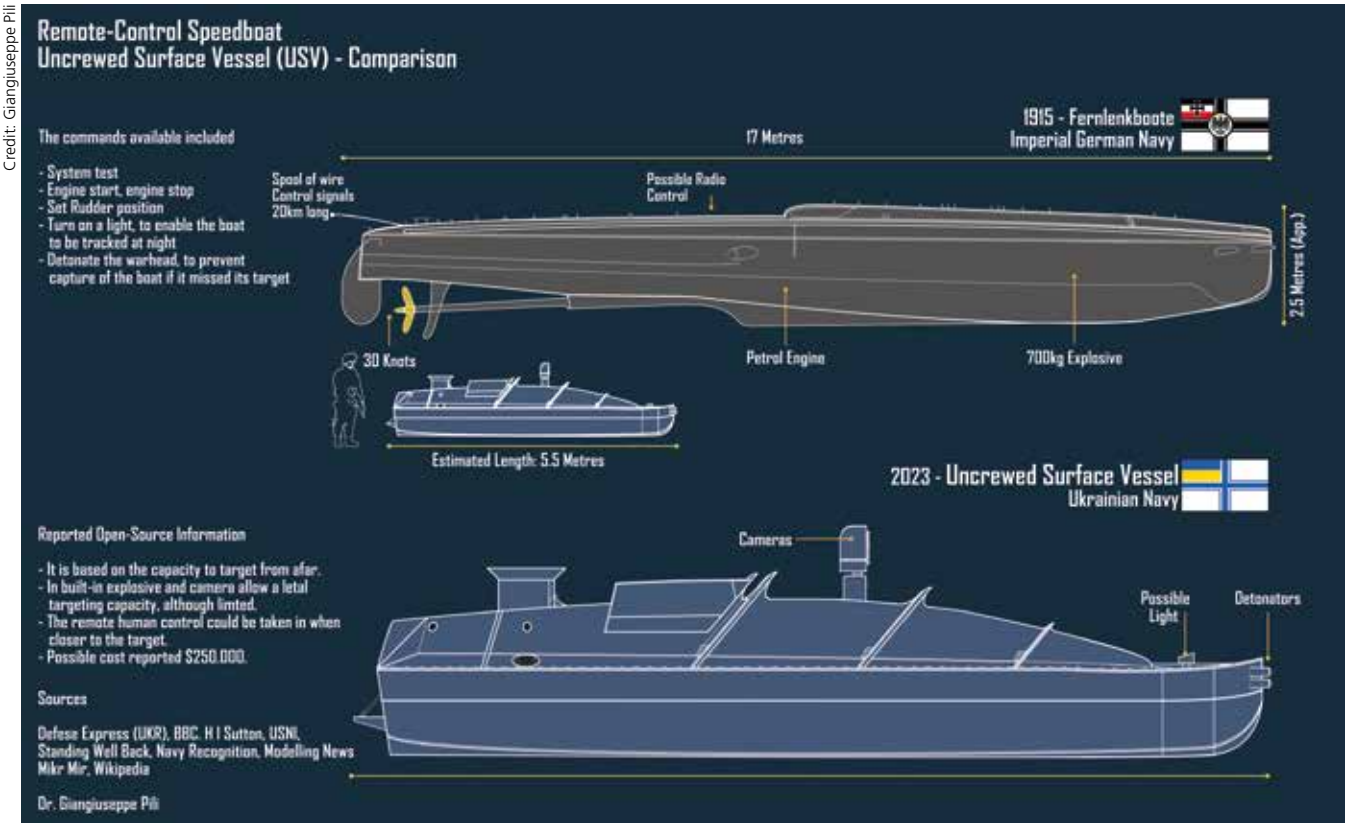
Experimentation with MUSs dates back to at least the First World War; indeed they are even older but only in WWI was the concept proven, albeit revealing difficulties with their practical employment. The Imperial German Navy pioneered early development of USVs, notably in the creation of the Fernlenkboote, a 'remote-control speedboat', whose use was exactly the same of the current USVs. These were guided with the help of an accompanying aircraft, whose job was to transmit course correction information to a control post, which could then send those corrections to the USV through a cable. The Fernlenkboote had a spool with 20 km of cable, which was understood to have been later replaced by a radio command system. All in all, the Imperial German Navy managed to strike one Royal Navy destroyer, the HMS Erebus, albeit without sinking it. It is not by chance that it was Imperial Germany which developed this technology, which was used again in WWII; the German Navy was the weakest of the main powers, and USVs appear more suited for use by the underdog. By a similar token, the Japanese Navy also employed MUSs during WWII, and experimented with swarm attacks. It is perhaps it is not by chance that the stronger navies did not have a significant development of MUS tactics, as their existing capabilities were adequate for the task. More recently, Russia is also known to have been experimenting with MUSs, not least because it would be much safer for them to threaten the Ukrainian cargo ships without direct exposure of their more expensive vessels.

It could be argued that MUSs are still relatively new and thus far too untested to be reliable and produced in large quantities. However, a Ukrainian MUS's cost was reportedly esteemed around USD 250,000. This is much more than most small UAVs used on Ukraine's battlefields, and around a quarter of the estimated cost of a Neptune missile, as was used in the sinking of the Moskva. Thus, the production cost is both higher than UAVs, and MUSs are mainly effective when used in packs or swarms, as employed by the Ukrainians. This economic reality somewhat hampers their development by a civilian sector at war, as MUSs are too expensive for individuals or cottage industries to develop.

Additionally, although they have come a long way from the limitations faced in WWI, MUS targeting processes remain more difficult than those of UAVs, which can rely on landmarks or terrain. By contrast, MUSs do not have anything comparable, due to the lack of landmarks at sea. This can be partially overcome by using technologies such as satellite navigation, but not entirely.

Targeting as such looks set to remain more challenging, as the Black Sea is a large space, and information regarding the positions of hostile military vessels is not as available as the locations of enemy positions of land. Finding a ship using sat-

Credit: Giangiuseppe Pili



A size comparison of the German Imperial Navy's 1915 Fernlenkboote to the Ukrainian 2023 Magura V5 USV.

ellites alone can be challenging work, and multiple data sources are often required. For instance, if the target is a civilian ship with military value, such as a tanker, it could have an Automatic Identification System (AIS) active, and if so, can be readily tracked. However, important logistics ships often switch off their AIS transceiver when in the Black Sea and follow various routes, aiming for zones where MUSs cannot go or cannot easily get to. It is very unlikely that the SPARTA IV and related ships have been stopped due to MUSs alone, as some have claimed, since MUSs cannot be stationed for long in a given area of interest, they cannot conduct strikes close to Turkey, and the intelligence and targeting cycle behind their use would likely be less effective over long distances. MUSs can be very effective under very specific conditions, but can be expected to be much less if these are not met.

Tactical successes, access denial, and strategic limitations

All in all, the friction imposed by the MUSs has a tactical value that translate into military gains from time to time. They can contest the territory in the best case, but they cannot be used to exert any meaningful strategic control of the sea, in the sense that they cannot directly or indirectly exert power over anything not immediately within their sailing range. This is exactly the opposite of what an aircraft carrier can do. As the US historian Theodore Ferenbach stated: "You may fly over a land forever; you may bomb it, atomize it, and wipe it clean of life – but if you desire to defend it, protect it, and keep it for civilization, you must do this on the ground, the way the Roman Legions did – by putting your soldiers in the mud." By extension to the maritime domain, this would require permanently stationing vessels capable of exerting power outside of their sailing range. This is why, despite all the hype around MUSs, the United States and China continue to build new aircraft carriers.

MUSs have secured their place in the range of options for denying access to given sea zones, but they are usually not able to project power at a distance, or to strike very far out, in the middle of seas or oceans, nor to serve as a replacement for the variety of weapon systems needed to overload the defensive capacity of the enemy. They can be deadly only under specific circumstances, and with a first-class intelligence cycle, along with remote sensing technologies, used in conjunction with human ingenuity. Russia's armed forces have been proving more adaptable than seen in early-stage reporting, and this adaptability could extend to finding countermeasures for MUSs. MUSs alone are not able to win a war, but they are able to buy time, and time is an invaluable strategic commodity.

Ukrainian MUSs have indirectly proven how tactical advantages do not necessarily translate into strategic advantages, or grand strategic rebalances. The proof is very simple: if Russia were to hypothetically remove the entire Black Sea Fleet from theatre, Ukraine would still not be able to control the Black Sea, nor meaningfully threaten Crimea from the sea. However, the upsides of this scenario are that Ukraine would not have to worry about missile attacks from the sea, nor the direct contention of its coast, and would have control of its vital grain corridor for exports. While these are undoubtedly beneficial, Ukraine would nonetheless likely prefer to have a conventional navy capable of exerting meaningful control, rather than relying on swarms of MUSs for area denial.

In sum, as all guerrilla fighters know, you fight with what you have, and if you wait long enough you could win. Time remains the key factor and as guerrilla tactics are aimed at buying time, Ukraine's MUSs may be capable of doing the job, though their overall impact will depend on whether or not the time they buy can be leveraged for meaningful changes to the overall strategic picture. ■

Viewpoint from Kyiv

Credit: Author

Assessing Ukraine's Kursk operation

Alex Horobets

The Kursk operation by the Ukrainian Armed Forces brought an unexpected turn to the ongoing war. At the time of writing, within just over a week, the Ukrainian Army has successfully captured more land than the Russian armed forces were capable of since the outset of their offensive in Kharkiv region early May 2024. As per the Commander-in-Chief of Ukraine's Armed Forces, Oleksandr Syrskyi, Ukrainian forces were holding nearly 1,000 km^2 of territory in Kursk region as of 12 August 2024, and were pursuing further gains.

Unlike the March 2024 lower-scale raid into Russia's Belgorod region, executed by a number of ethnic Russian units fighting alongside Ukraine's regular Army, which lasted about a month, the current stunt by the Ukrainian Armed Forces in Kursk region bears signs of a classic military offensive, run by a regular army, involving a large number of personnel, armoured vehicles, engineering troops, and air defence capabilities.

As the practice of Ukraine's previous successful offensive attempts to recapture its own territory has shown, in a modern war against an enemy force with a numerical advantage in both manpower and equipment, success is possible when unconventional solutions are applied. This is precisely the case with the Kursk raid, as it caught the Russians totally off-guard. Consequently, the pace of Ukraine's advance into Russia can be compared to that of the liberation of parts of the Kherson and Kharkiv regions back in 2022.

The Ukrainian operation exposed how unprepared the Russian Armed Forces were to engage in full-scale combat on their own territory, which has already led to another reshuffle top brass – namely in the form of Putin's appointment of FSB Chief Alexander Bortnikov to lead the operation in the Kursk region, taking on the task from Chief of the General Staff Valery Gerasimov. Allegedly, all of the most combat-capable units had been thrown into the offensive effort in the Donbas, in order to announce the capture of several important settlements in eastern Ukraine as soon as possible.

However, this left Russia's own border weakly-guarded, mainly by conscripts and border guards, over 100 of whom were captured by Ukrainian troops. This led to the rapid expansion of the Ukrainian bridgehead in the first days of the offensive in Kursk region. Russian social media covering the war reported, among other things, that Ukrainian air defences were highly active in the area, limiting Russia's ability to strike the Ukrainian grouping. This led to the Russian military being often forced to employ high-cost Iskander ballistic missiles on lower-value targets.

At the time of writing, the objectives behind the Kursk operation, and its outcome remain unclear. Some statements by Ukrainian officials have claimed that the operation aims to bring war back to Russia, to lay down a fairer basis for potential peace talks somewhere along the line. It remains possible that the offensive in Kursk region is only one stage of the broader operation, and that the zone of hostilities may deepen and expand, and may also spill over into other poorly-defended areas of the border, such as in the Belgorod or Bryansk regions.

The operation's consequences remain unclear. However, interim assessments suggest a mixed bag. The Ukrainian command will soon be facing two main challenges: reserves and logistics of both sides. Since the start of the Ukrainian Kursk operation, the Russian army has been slowly transferring reserves from some frontline areas to defend Kursk region, such as the Kharkiv offensive, relieving pressure on that front. However, at the same time, Ukrainian forces will need significant replenishments to defend territory seized in Russia. At the same time, in eastern Ukraine, the need to hold the line against the ongoing Russian onslaught remains urgent.

However, at this stage, Ukraine has proven that it is capable of seizing the initiative from Russia and forcing the Kremlin to review its operational and strategic assessments. It is also important that Ukraine's allies have practically endorsed its raid. Moreover, such success stories from the Ukrainian Armed Forces can further strengthen the allies' confidence in the need for further supporting Ukraine. After all, Russia has long retained the initiative across the theatre, slowly but steadily advancing in Donbas. Now at least on one of the new frontline axes, the Ukrainian Armed Forces went on the offensive, achieving major territorial gains. At the same time, reputation-wise, the significance of occupying Russian territories is higher than Russia's effort to capture towns and villages in eastern Ukraine, since for the first time since World War 2, a foreign military force is pursuing a major combat mission on Russian soil. The only difference is that Ukraine, unlike Moscow, has no intention of permanently occupying Russian territories. The main task is to launch processes that would lead to the liberation of its own lands, and the Ukrainian command will continue exploiting Russia's weak points in order to achieve these goals.

Decontamination of sensitive items

Dan Kaszeta

One abiding aspect of warfare and terrorism involving chemical, biological, radiological, and nuclear (CBRN) weapons is that many of them persist for a long time after use. Many, but not all, CBRN materials can pose a contamination hazard for hours, days, weeks, or even months, depending on the material used, the material contaminated, and environmental conditions. This means that CBRN materials could cause injury or death long after their initial use. Some CBRN agents, such as persistent chemical warfare agents like Sulfur mustard and the nerve agent VX, to name two of many, are principally intended to cause harm over a longer period of time well after their employment.

At the time of the dawn of chemical warfare in the First World War, military equipment was generally not sensitive and delicate. The most sensitive thing in the trenches in the First World War was the soldier himself. His rifle was easily decontaminated, abandoned, or replaced. He had no electronics. By contrast, the modern battlefield is riddled with sophisticated equipment and systems ranging from small personal electronic devices all the way up to aircraft and combat vehicles full of sensitive components. We have little to no experience in CBRN warfare with modern electronic systems. How do we deal with a touch-screen, an artillery fire control system, a main battle tank interior, or a helicopter cockpit that has been contaminated? Small amounts of hazardous CBRN materials could lurk about inside or on the surface of a sensitive item, providing both a contact hazard and a possible respiratory hazard through the process of desorption. CBRN contamination of sensitive items may involve those items emitting a small amount of hazard over a longer period of time. Substances lurking in the interior of an electronic system may desorb slowly over a long period of time or evaporate slowly as electronics heat up through use. Many CBRN hazards present types of damage to health that are cumulative over a period of time. Others provide health problems from slow chronic exposure to low levels over time that may not be well understood by modern medicine. Just because a vehicle or aircraft crew manages to not get immediately sick does not mean that there is no hazard present.

Credit: US Army Reserve/Maj Darryl Beatty

Not every item can be safely decontaminated with standard decontaminants.

The challenges

The biggest challenge posed by sensitive equipment decontamination is the potential damage done to electronics by existing decontamination products and materials. The typical processes for decontamination of military materiel such as tanks and artillery pieces generally involve water (either plain or soapy), or caustic substances such as alkaline solutions. While hot soapy water or dilute bleach is fine for a tank or a critical bit of pavement on a bridge, it is injurious to electronic systems. Water causes havoc with electrical circuitry, and both water and caustic decontaminating solutions cause corrosion. Even the smallest bit of corrosion can render an electronic device useless due to disruptions in electronic circuits. It is not only electronics that suffer. Some components such as seals, gaskets, turbine blades, or propellor blades can fail due to damage. Finding a method that will cause some sort of useful reaction with a hazardous particle or droplet, but does so in a way that is not going to physical damage electronics is no mean feat.

Various schemes have been tried in the past to accomplish sensitive equipment decontamination with varying degrees of success and failure. In this correspondent's own past, some of these schemes have ranged from the sublime to the ridiculous. One recalls meetings and briefings where bombardment with extremely high doses of gamma radiation or electron beams, or

Author

Dan Kaszeta's career spans 25 years in the defence and security sectors. He has served as an officer in the US Army Chemical Corps and as a civil servant in the White House Military Office and US Secret Service. He moved to the UK in 2008 and after three years at Smiths Detection has been working as an independent consultant and writer. He is the author of "CBRN and Hazmat Incidents at Major Public Events" (Wiley, 2012) and numerous articles, primarily in CBRN defence.

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dipping entire aircraft into vast tanks of now-banned fluorocarbon refrigerants. A concept for a microwave plasma torch has been noted in the technical literature. These ideas may very well have 'worked' in that they would have got rid of the chemical or biological hazard. Yet they were also expensive, unsafe and/or environmentally unsound. Some are the CBRN equivalent of burning the village in order to save it.

Another challenge in sensitive item decontamination is best illustrated when we pose the question 'how clean is clean enough?' This question has plagued CBRN specialists for a long time. The layman might answer 'clean enough is when all of the hazardous material is gone' but such an answer is highly problematic. How do you prove a negative? You cannot. From a practical perspective, the answer is more likely to be 'when we cannot detect the hazard any longer', thus intertwining the issue with detection. Every detection instrument and technology, which have been discussed in this magazine numerous times, has constraints. So, to a certain extent, the quest for better decontamination is related to the quest for more sensitive detection methods.

Current approaches, products, and technologies

Absorption and adsorption are tactics that can be used in decontamination. If you could introduce a particle into electronics that could either absorb (act like a sponge) or adsorb (act like sticky tape) a bit of a hazard. Depending on the material used for this role, the resulting mix of adsorbent/adsorbent and threat material could be vacuumed away from the affected area. Decades ago, this was, approximately, the principle behind using Fuller's Earth, a naturally occurring mineral powder, for skin or equipment decontamination. Now, imagine if a sorbent particle that would not harm or foul-up electronics and similar hardware.

This is the principle behind SX 34, a product fielded for about 15 years now by Cristanini, the Verona-based Italian decontamination firm. It remains one of the few truly specialist decontamination products in this niche. In full disclosure, this correspondent spilled simulated nerve agent (in the form of doctored olive oil) over his corporate laptop in 2010 and effectively decontaminated it with SX 34. The SX 34 material entraps the threat materials in a sorbent powder that is sprayed into affected equipment. The powder is then vacuumed out using a high efficiency particulate air (HEPA)-vacuum. Heavy contamination may need multiple applications, but it is very effective.

Credit: Cristanini

SX 34 operates by entrapping threat materials in a sorbent powder that is sprayed into affected equipment. The powder with trapped contaminants can then be vacuumed out of the equipment.

More significantly, numerous rigorous trials involving live agents have occurred and decontamination targets as complex as aircraft cockpits have been tested by third-party laboratories. By virtue of this product, Cristanini remains the lead in this segment.

Fumigation remains a viable option, particularly for biological contamination but also for chemical contamination. Introducing something in a gas, vapour, or aerosol form that can permeate into and through materiel in a way that reacts with hazards. This can be particular effective in confined areas like computers or avionics. Such an approach has long been used in the medical sector, as various types of medical objects and equipment need sterilisation by methods that are not destructive to the material involved. For example, numerous medical and dental instruments, devices, and consumables are routinely decontaminated by fumigation with Ethylene oxide, a strong oxidant. Chlorine dioxide was used at the US Capitol after the 2001 anthrax incidents.

Fumigation as an approach to sensitive item decontamination came out of the healthcare sector. Ethylene oxide is more usable in an industrial setting, due to its numerous hazards. Chlorine dioxide is problematic with electronics. Yet vapourised Hydrogen peroxide can be used in a similar way with fewer issues. It is a strong oxidiser. The US firm Steris, which is a global leader in such technologies for the medical sector and has been seen in the defence space. Other firms, such as MW (Sweden) and Bioquell (UK) are involved in peroxide-based

Credit: Dan Kaszeta

The Cristanini LDV-X can fumigate confined spaces and is less harsh on electronics than some other methods.

fumigation. Cristanini's name pops up again in the fumigation space, using a variant on the same theme. Their LDV-X uses catalysed Hydrogen peroxide to fumigate a volume with Hydroxyl radicals. This system has done well in testing in military applications. With such fumigation techniques, the biggest constraint is typically the supply chain to keep these systems supplied with Hydrogen peroxide.

If the hazards being decontaminated are strictly biological as opposed to chemical, a broader arsenal of technologies is available for use. By irradiating the target bacteria, virus, or spore with some form of radiation, it could be possible to render a biological threat inert. This has been a principle in industrial sterilisation for decades and it could be achieved by gamma radiation from a radioisotope, high energy x-rays (difficult in practice), electron beams, or various types of ultraviolet (UV) radiation. In practice, the energy required to do this for chemical hazards ranges from impractically dangerous to science fiction death ray in concept, but for biological hazards this is a possibility. For electronics, this remains a bit problematic due to the density of the target material and, for UV, line of sight issues. However, irradiation should not be ignored for some applications.

Civil sector requirements

Although military CBRN specialists do not often realise it, there is a significant overlap between military and civil requirements in this specialist area. On a microscopic and molecular level, there is not a lot of difference between decontaminating a bit of aircraft avionics in a fighter cockpit and decontaminating a piece of electronic equipment in the back of a civilian ambulance. Indeed, as has been mentioned above, some of the technologies in this area already exist in the healthcare sector.

Competent planning for response to terrorism with CBRN materials and response to accidents involving hazardous materials needs to consider contamination of sensitive items as part of the possible threat environment. A broad range of scenarios is feasible. Personal electronics or vehicles used by responders, aircraft used in emergency response, laboratory equipment used in forensic laboratories, critical electronics in national infrastructure, or large server farms could all be contaminated by hazards. Postal contamination and contamination of offices is something that was a seriously expensive problem after the relatively small amount of anthrax spores was used in the USA in 2001.

Credit: US Transportation Command/Michelle Gigante

Laptops and other sensitive electronics represent a decontamination challenge, as care must be taken to avoid damage to the electronic components.

One aspect of sensitive item decontamination is the threat of criminal damage to artifacts and relics. We have already witnessed ideologically-motivated vandalism of works of art. How does one deal with contamination of famous paintings, sculptures, an original flag, or a historic document? Simply put, can one decontaminate the Mona Lisa or Magna Carta without destroying it? As terrorism is about fear and ideas as much as, or even more than, actual practical impact, the social, cultural, psychological, and economic impacts of contaminating national treasures is an interesting line of inquiry.

The closest we have really come to this being a practical reality has been the anthrax spore contamination of various rooms in the US Capitol complex in 2001. Due to the location of those spores, no great items of historical or cultural importance were needed to be decontaminated, but some of that decontamination activity was very close to a number of such items. More investigation is needed in this arena. Interestingly, Cranfield University in the UK is advertising a paid PhD studentship for a scholar interested in investigating the detection of chemical hazards in archival materials. This is an indication that the subject is being taken seriously in some quarters.

Prospects

Sensitive item decontamination is certainly an area where there are more prospects for improvements to product lines and technologies. Some of these lines of enquiry are fundamentally low-tech, while others are high-tech.

Hardening is one approach that has not been fully exploited. This is a two-fold approach. First, can you make the equipment rugged enough that it can withstand the rigours of existing harsh decontaminants. Existing waterproofing and ruggedisation goes more than half the distance. If sixty years ago the US Army could design a radio that works in a tropical downpour in a Vietnamese rice paddy without shorting out, it is not beyond the realm of hope that a radio could be dunked in a bath of water with a bit of bleach in it to decontaminate hazards. By making it difficult for liquids or aerosols to effect ingress into a bit of equipment, the scope of contamination is reduced.

The other hardening approach is similar. If you can make the equipment resistant to decontamination, it follows that much of the same effort might end up with equipment that is actually resistant to contamination in the first place. In theory, there are many things that could be done to make various sensitive items more resistant to being contaminated in the first place. In order for contamination to physically occur, some hazardous material needs to actually be physically present inside or upon the item. There are ways to make individual items more resistant to contamination. One approach is coatings. There is precedent here with larger items. There has been a long history in the US Army of making combat vehicles more difficult to contaminate by painting them with expensive but effective chemical contamination-resistant paint. Advances in materials technology can make it more difficult for a sensitive item to absorb or adsorb a droplet of hazardous chemical. Therefore, one can look for the prospect of coatings or materials that do not afford CBRN materials the opportunity for entrapment.

A time-honoured decontamination tactic is one often euphemistically described as 'ageing and weathering'. In practical terms, it means sitting the items somewhere out of the way and letting time and nature take its course. Humidity in the air, rain, sunshine, and the passage of time will have an effect on CBRN contamination. For some short-lived radioactive isotopes, the pas-

Credit: Regional Command Southwest; Sgt Bobby Yarbrough

Modern militaries have greatly expanded the number sensitive electronic items carried by the typical soldier, with items such as radios becoming ubiquitous.

sage of time is probably the best option in many scenarios. For a tank contaminated with the nerve agent Sarin, a day in the hot sun may be a decontamination tactic that is safer and uses fewer resources than employing a squad of soldiers to wash it thoroughly, given the fact that Sarin degrades rapidly in open air at normal temperatures. There are ways in which the mechanisms that make ageing and weathering effective can be promoted and exploited. Imagine a helicopter heavily contaminated with a persistent nerve agent, both inside and outside. If one were to park this helicopter on the end of a runway in the hot sun and let it sit for some weeks or months, the non-volatile but highly dangerous persistent nerve agent would eventually evaporate and degrade, due to both the evaporation of the agent and the gradual reaction of nerve agent with humidity in the air, assuming that it was not the driest of deserts. Yet what if the temperature, vapour pressure, and humidity could all be tweaked to increase the degradation of the nerve agent? If one were to stick the helicopter in a sufficiently-large greenhouse, thus increasing the humidity and temperature, a hazard that might take a week to abate might be gone in three days. This would work for chemical hazards, some biological hazards, but not radiological hazards.

Credit: PEO Aviation

Sensitive electronics are critical in tactical environments

By taking a more rigorous approach to this 'greenhouse theory' of chemical decontamination, it is not difficult to foresee a product line of greenhouses, tents, and large ovens that increase temperature. It would not need to be hot enough to reach the point of damaging hardware, but even 60°C would be a huge increase in evaporation. One could also, if needed, introduce more humidity. Likewise, atmospheric pressure could be lowered to increase the vapour pressure of liquids. The hothouse could be vented through appropriate filters to entrap the evaporated chemical warfare agents. This approach would not be likely to decontaminate a tank soaked in a Sulfur mustard in an hour – but could it do it in a day or two, with less hazard to decontamination crews? Perhaps it is possible.

Another approach that has been of interest for some years is enzymatic decontamination. The idea is that specific enzymes can be developed that react with specific chemical warfare agents to promote chemical reactions that neutralise said chemical warfare agents. Unlike, say, Chlorine or Hydroxide reactions where a single ion reacts with a single chemical warfare agent molecule, one molecule of an enzyme might make it possible for thousands of such reactions. This would mean that a relatively small amount of enzyme could do a lot of work. Although enzymes would likely be specific to a certain threat chemical, a decontamination solution could contain dozens or hundreds of them, as a little would go a long way. While this approach shows a lot of promise in other areas of decontamination, it is likely to be a bit problematic with sensitive items. So far, enzymatic decontamination has been aqueous – it needs water to be able to work. Even if that could be overcome, some of the decomposition products that are the daughters of enzymatic reactions could, in themselves, be injurious to electronics. However, for objects such as archival documents, historic furnishings, or oil paintings, a bit of water (and often not much is needed, possibly even a fine mist) is not the worst thing that could happen to them, and enzymes might prove useful in such scenarios.

Gradual progression in materials science may yield new frontiers. Sorbents, such as the fine white powder used in Cristanini's SX 34 guide a path on the way to future possible improvements. With advances in materials technologies, particularly nanotechnology and nanoparticles, there is the prospect of new sorbent materials that could be used in decontamination.

Closing thoughts

Sensitive item decontamination is still a largely untested space. The institutional memory of chemical warfare operations is now quite dated, and dates to a period of time when militaries simply did not field electronics more complicated than a telegraph set or a field telephone. Avionics was not even a word. We do not even have a very good understanding of how big the problem may be in a future conflict that uses CBRN materials, nor are the logistics of massive CBRN sensitive item decontamination operations well thought-out. There is the distinct possibility that the hazard does not really matter so much. However, there is also the risk that key military systems could be rendered inoperable because their skilled operators cannot use them properly and that taking a critical system or two out of the battle for a few days could affect a battle or even a whole war. Sensitive item decontamination is, sadly, a necessary tool. ■

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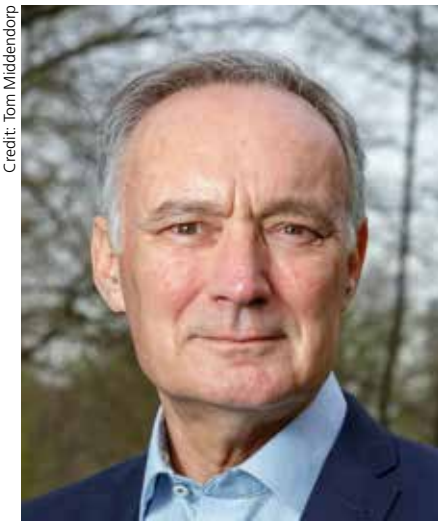
BADAR EXPO SOLUTIONS

The Climate General: Weighing the impact of climate change on security and how militaries should evolve

Mark Cazalet

In June 2024, ESD got the chance to sit down with General (ret.) Thomas Antonius Middendorp, of the Royal Netherlands Armed Forces to discuss his thoughts on the links between climate change and security challenges, as well as the benefits to be gained by modern militaries through the adoption of 'green' technologies.

Credit: Tom Middendorp



Gen (ret.) Tom Middendorp, the former Dutch Chief of Defence.

General Middendorp has witnessed first-hand the effects of and security risks posed by climate change during his time in uniform. Middendorp has previously served as the Dutch Chief of Defence for five and a half years, he commanded operations in Afghanistan and was responsible for the Dutch contribution to operations in, Bosnia, Iraq, Mali, North Macedonia, and Somalia. He now serves as Chairman of the International Military Council on Climate and Security (IMCCS), and in December 2023, he also published a book titled, 'The Climate General: Stepping up the fight' to outline some of the key threats to security and stability posed by climate change.

In an interview with ESD, Middendorp explained how he first became aware of the links between climate change and security: *"My first interaction with the issue of climate change was at the rank of Brigadier, when I became task force commander in the South of Afghanistan. Here, I led a multi-national task force, including some French troops, by the way, in the province of Uruzgan in the South. We had daily fights with the Taliban. At one moment we were involved in a very big fight around a district centre to free it from the Taliban. After several days we succeeded in doing that, but only to find out that the tensions in that village remained, and that the Taliban could return any moment. They used those tensions to create kind of a foot on the ground there. It took a while before we found out that water scarcity was the driver of those tensions – they're all farmers, they need water. When we negotiated a solution to divide the water between the farmers and once that solution was accepted the tensions disappeared. The Taliban could not return and it became very quiet in that district. A year later, I could even walk through the main street of that village with our current King [Willem-Alexander] with limited protection, which showed the enormous turnarounds that happened there – and not because of the fighting, or not just because of the fighting, but because we identified and addressed the root cause. And the root cause had everything to do with a changing climate. For me, that was an eye-opener."*

As an aside, it is worth noting at this point that Afghanistan is no stranger to anthropogenic ecological impacts fuelling conflict. The cultivation of heroin in the country was itself a product of earlier human-caused changes to the local ecology, according to a 2002 article in the *Journal of American History*, titled 'Damming Afghanistan: Modernization in a Buffer State', by Nick Calluther. In 1946, Mohammad Zahir Shah, then King of Afghanistan, hired US firm Morrison Knudsen to construct a network of dams on the Arghandab and Helmand rivers, with the primary dams respectively completed in 1952 and 1953. However, as Calluther noted: "Large reservoirs raise

Credit: US Army/Sgt Aubrey Rundle

Supplies are offloaded from a CH-47 Chinook helicopter into a poppy field in Kandahar, Afghanistan, on 6 May 2007.

the water table in the surrounding area, a problem worsened by extensive irrigation. Waterlogging itself can destroy harvests, but it produces more permanent damage, too. In waterlogged soils, capillary action pulls soluble salts and alkalies to the surface, leading to desertification." According to Calluther, these changes to the local ecology were then exacerbated by other factors: "In 1957, floods nearly breached dams in two places, and water tables rose, salinating soils throughout the region. The reservoirs and large canals also lowered the water temperature, making plots that once held vineyards and orchards suitable only for growing grain." These changes in the soil's characteristics rendered it unsuitable for growing many types of crops, however, as Calluther pointed out, "[t]he opium poppy grows well in dry climates and in alkaline and saline soils." This newfound suitability for growing opium poppies, along with their high market value per kilogram compared to other crops, then incentivised farmers to grow it. Opium subsequently became a widely-cultivated crop in southern Afghanistan, particularly in Helmand province, and at various points, served as a lucrative source of funding for the Taliban.

Through his formative experience in Afghanistan, Middendorp became aware of similar scarcity-based patterns cropping up in various other conflict zones, noting: *"I have been involved in more than 20 different crisis areas, which gave me a better understanding of the root causes and the dynamics of conflicts and of different types of conflicts. And also here, I increasingly realised that climate change is a factor in driving that conflict. In Iraq, Daesh occupied the Mosul Dam and used water, access to water, as an instrument of power. In Somalia we were countering piracy, but only to find out that many of the pirates that we caught were just poor farmers, driven into the hands of piracy by the increasing droughts. In Mali the increasing droughts in the North fuelled tribal tensions and dissatisfaction, making people more susceptible to extremist influences. I realised that in many of these crisis areas we are addressing symptoms of a deeper problem, and that deeper problem is driven to a large extent, to an increasing extent, by a changing climate. Climate change is acting as a risk multiplier in fragile regions throughout Africa, the Middle East, and also South Asia (because of flooding and extreme weather). This directly affects local and regional stability and causes increasing migration flows and breeding grounds for organised crime and extremism."*

As these impacts became more apparent, Middendorp began to incorporate these into Dutch defence strategies, *"When I became Chief of Defence I was also responsible for the design of our future forces. In that Defence review process, we recognised climate change as one of the drivers of change to our security environment. The US called it a 'risk multiplier', and I think we recognised the relevance of that. So it became a factor in designing our future strategies."*

Credit: DIMOC/Spc Michael Carter

An Afghan girl pumps water from a well pump in Panow, Paktika province, Afghanistan, on 27 June 2007. Access to water is easily weaponised by extremist groups, and this access can be used to pull local populations into the hands of extremist groups.

However, as Middendorp stated, despite the very real security implications of a changing climate, it has been a challenge for militaries to recognise and respond to: *"I also realised that this is a topic that has never been recognised by militaries. There have been many reports, and especially the US intelligence was the first, I think two decades ago, to publish reports on the nexus between the two, but within the defence communities the relevance of this was never really recognised. In all the NATO- and EU-meetings that I attended, the word 'climate' has not been mentioned once. I was the first active serving general within NATO to address this publicly, which attracted a lot of attention, to put it mildly. Especially in my own country, there was a lot of fuss, political debates, screaming headlines in the media and I went viral on social media. It gave me the nickname, 'Climate General'. I decided to embrace that nickname as a title of honour and to dedicate my post-military life to this topic, because I was convinced that climate change might be the biggest challenge that we are facing on this planet, that will probably lead to much instability in the regions I mentioned before and can develop into a driver of conflicts around the world. This makes it very, very relevant also from a security perspective."*

By approaching the topic of climate change from a security perspective, Middendorp has found that many audiences can become more receptive to the topic, as the focus shifts toward its wider impacts beyond the purely ecological. As Middendorp explained, *"I also realised that addressing climate change from a security perspective can help depoliticise the whole debate around climate change. Until recently climate change was mainly seen as an environmental issue for left-wing (green) parties and many people just don't feel part of that and don't want to recognise that. But when you show the relevance from the security impact side, then suddenly people start listening. People in the private sector, people in the public sector, people from more of the right-wing parties, they start listening and start realising that there is something at stake here. It's not just environment – it's also economics, it's also security, it's also societal resilience that is at stake. So it helps to broaden discussion and get it out of the political realm to create more momentum."*

Assessing the impact on militaries

In July 2024, the International Military Council on Climate and Security (IMCCS), of which Gen Middendorp is Chairman, recently released their 'World Climate and Security Report 2024', which sought to investigate, among other things, how military research and development efforts could be used to enable emissions reduction while also improving the self-sufficiency of military units and facilities.

Credit: USAF/Airman 1st class Alison Martin

The aftermath of Typhoon Mawar landing in Guam. The total damage to military facilities on the island was estimated at USD 10 billion.

While many previous discussions of militaries 'going green' have focussed on the procurement and operational burdens imposed by the introduction of green technologies, the IMCCS report still places a strong emphasis on the importance of measures not diminishing mission effectiveness, noting that, *"Investments, including the research investments upon which this report focuses, prioritize missions over emissions, though smart investments can address both without imposing a trade-off. In essence, the military must be able to "walk and chew gum at the same time," when it comes to reducing climate risk and meeting mission requirements. Both are necessary. Furthermore, a longer-term look at mission requirements reveals that reducing climate impacts that may exacerbate future security risks is itself an important contribution to mission success."*

However, the report further points to the recent past and current physical impacts of climate change-driven extreme weather on overall force readiness. As examples of the damage extreme weather events can cause, the report notes: *"Damage from the worst of these events has imposed billions of dollars of costs in addition to forcing personnel and missions to relocate. Within the United States, frequently cited examples are hurricane damage at Tyndall Air Force Base (AFB) in Florida and flood damage at Offutt AFB in Nebraska. More recent examples include the impact of Hurricane Sally on Pensacola Naval Air Station and Typhoon Mawar, which did more than 10 billion dollars of damage to military installations across Guam."*

Indeed, these incidents can prove costly – for instance, following Hurricane Michael hitting Tyndall AFB in 2018, according to Florida's Senator (Rep) Marco Rubio, 31% of the base's F-22 Raptor fleet (equating to some 17 airframes) were designated non-mission capable and could not be flown out of the base to avoid the hurricane and had to be left behind to face the storm. Although the US Air Force (USAF) did not confirmed how many were damaged and to what degree, post-incident reports have revealed that while no airframe was destroyed, a number did indeed suffer some damage, with an 8 May 2019 Lockheed Martin press release indicating that least four "sustained damage in multiple areas including coatings, doors, canopies, leading edge and engine inlet."

The press release further noted that while the base's Raptors appeared to have been largely fortunate and avoided major harm, the damage to the base's building was more extensive, noting that "Tyndall's flightline was decimated. Large roof sections were ripped from aircraft hangars and several buildings completely collapsed as sustained winds of up to 155 mph [249 km/h] pummelled the base. Hurricane Michael damaged 95 percent of the buildings at Tyndall."

The release further cited Brett Haswell, then director of F-22/F-16 Field and Depot Operations at Lockheed Martin, as stating that some 70% of the buildings would need to be bulldozed.

Going beyond immediate physical impacts, the IMCCS report notes that extreme weather events are also increasingly resulting in militaries being called in to respond to climate-related disasters occurring within their borders, with at least 250 such instances (a conservative estimate, as the report notes) identified since June 2022.

It would seem fairly evident that pulling military personnel away from their core tasks to fight disasters will put a strain on many militaries' resources and readiness, as well as the possibility for disrupting training cycles or planned deployments. To better illustrate the latter point, one should consider the difficulties faced by small and mid-sized militaries to conduct effective training exercises, or to carry out an operational deployment, when a large portion of their logistics vehicles and/or aircraft are otherwise preoccupied with delivering disaster relief, or engineer units are being used to provide civilians with alternatives to flood or storm-damaged bridges. This is especially problematic considering that many militaries already have trouble with maintaining sufficient numbers of operationally-ready vehicles.

Credit: AFRC/Tech Sgt Kelly Goonan

A Tyndall AFB building in the aftermath of Hurricane Michael. Much of the base suffered extensive damage to infrastructure.

Global, regional, and local impacts

The multiple challenges brought by climate change can be understood at various different levels, from the global to the regional, to the local. Looking at the problem at *the global level, Middendorp explained: "I think climate change should be seen in a wider context of increasing populations around the world. The world population is increasing to almost 11 billion people [by 2100]. It's enormous. After that, it will go down, but we are facing an almost doubling of the world population within this century, which means a doubling demand for space, water, for food, for all kinds of goods. On the other side, we have increasing resource scarcity, as you mentioned. And climate change plays negative on both trends. Climate change reduces the liveable, usable space in the world, reduces the availability of resources like water and food, and negatively affects this growing global gap between demand and supply. We have a doubling demand and we have a dropping ability to meet that demand. And to me, that is the big challenge of this century – how are we going to sustain a growing world population in a way that we don't end up fighting all kinds of conflicts?"*

Regarding the regional level, Middendorp stated: *"I just visited Somalia…and I saw deserted villages. There are farmers who have been living in those areas for centuries. They know how to deal with the heat, and they know how to deal with droughts. They've been living there for centuries, but they can't live there anymore. Because the one certainty that they had is gone. And that one certainty was a rain season every year. During the last five years, they had two rain seasons, which means that they their cattle is dying and their farmlands become unusable. In the end they have no choice but to move away. So they move to the cities. They can't find work in the cities, these cities become a kind of breeding grounds for all kinds of negative influences, like extremism and organised crime. The majority of this population is young, still minors. They lose the perspective of life in their home country and they lose the faith in their governments that are not able to solve those problems. This causes an increasing instability and many of them just want to flee away, become migrants in their regions or outside the regions towards other continents. And this is not just happening in Somalia, but also in many other countries in Northern Africa and the Middle East. Those are the indirect security effects of climate change and it is happening right at the borders of Europe. So for Europe, this is very, very crucial. We can expect a lot of instability around Europe that will affect us, that will bring all these negative effects to our streets, that will affect the supply chains to our industries and the offset markets of our products. So there is a big thing at stake here for Europe as well. And that's the regional dimension."*

Credit: USAID

Somali men on a 'technical' (a pickup truck with a mounted weapon). Factors such as falling crop yields push rural populations to the cities in order to find work and survive. However, many do not find work, and unemployed youth in particular become at risk of turning to extremism and organised crime.

Rounding out the lowest level of the effects of climate change, Middendorp explained: *"On the more local level we witness the impacts of natural disasters becoming more intense and frequent. We are confronted with larger periods of increasing droughts and shorter periods of more intense rainfalls. Our climate is becoming less moderate, which means that we need to adapt – we need to adapt our water management systems and our energy systems, which comes with a price and also has an economic dimension. This need for adaptation and mitigation also brings more social unrest in our in our countries with people protesting for or against climate-related policy-changes."*

What is to be done?

Given what is at stake, in recent years, there has been increasing interest in tackling climate change within military and security circles, as Middendorp explained: *"I also realised that there are more people like me, military leaders who are concerned. So we raised this International Military Council on Climate and Security (IMCCS), which now has experts, military and other security experts, from all over the world from more than 40 countries as a member. This network is much broader than NATO and EU. The interesting thing is that it combines the experiences from these experts with research. So we have a nucleus of four research institutes in France, in the US, and in the Netherlands. But around that, the whole research network is also developing with 26 other institutes that are affiliating themselves. So we have two networks now, an expert network and a research network, that reinforce each other, and that creates a lot more understanding and insights in the nexus between climate and security."*

Beyond purely military and security-focussed organisations, cooperation with civilian organisations can also help to expedite efforts to enact change on the military side. Europe already has a large ecosystem of cross-sectoral collaboration efforts, including various civil organisations, industry associations, and advocacy groups tackling the problem of climate change or related factors such as energy demand reduction, from the civil side. Examples at the European level include the Cool Heating Coalition, the Coalition for Energy Savings, Clean Heat Europe, along with various others. I asked Middendorp what in his opinion would be the best ways for organisations such as these to engage with the defence and security aspects of Europe's energy transition.

Middendorp replied: *"The key-word is cooperation. We can reinforce each other. Defence can be a test bed and a platform for innovation and the private sector can bring new technologies to the table that can help defence to become more self-sufficient. Institutions like NATO and EU can play a big role to connect the different worlds of defence and technology. These worlds are now often separated. For the EU, it's im-*

Credit: AM General

A CG render of the AM General 'Humvee Charge' hybrid electric vehicle. There are numerous operational benefits to be reaped with the adoption of hybrid electric and battery electric vehicles into service fleets. These include acoustic and thermal signature reduction, along with exportable power, and in the case of hybrid vehicles – increased range.

portant to create more synergy between functional areas and breach the functional stovepipes; different Commissioners run different functional programmes. These programs can reinforce each other if we create more unity of effort and overarching focus. More concretely, if we recognise climate change and increasing resource scarcity as main European challenges, then we need to identify overarching goals on these areas and mainstream that in the policy development in all functional areas. Climate goals can be integrated into goals of the European Defence Fund, for instance, and by integrating those goals into other programmes you create more synergy, and more collective strength."

Pivoting back to the military side, Middendorp emphasised the operational benefits that embracing such technologies could provide: *"A second one is on the military side; by understanding the need to participate in it and also the opportunities that it gives. Many military leaders don't see the relevance of climate change for their work and they often experience new climate related policies as new obligations that draw away money from other necessary operational investments. It is important to look at new green technologies from an opportunity perspective. To operate in any area the Military needs huge logistics on fossil fuels and other supplies. Logistics is the biggest cost driver and also the biggest vulnerability of a mission, with long supply chains running through hazardous areas.*

New 'green' technologies can help deployed units to reduce that logistical burden and become more autonomous. If you can produce and store your own energy, you can take away that vulnerable dependency and become more self-sufficient. Militaries around the world have always been the first to embrace new technologies and I think the military needs to embrace and look for the opportunities that new civil technologies on green energy bring us. It can help us become more autonomous, it can help us reduce the logistical footprint, it can even help to reduce the noise- and heat-signature of our units. There is a lot of potential benefit if we look at climate goals from a more operational perspective."

Pushing for a clearer picture of the concrete steps which would realistically be acceptable right now to a modern military, I asked Middendorp about some of the current objections to militaries taking steps to decarbonise. These included the frequent lack of infrastructure in-theatre to support battery electric vehicle (BEV) fleets, along with the supply chain risks of new critical raw material dependencies on other countries to produce such vehicles, along with the seeming impossibility to make certain items 'green', such as rocket motors and explosives. Responding to this, Middendorp said:

"It is important to approach this very pragmatically. You cannot make a turnaround in one step, that's impossible. You need the technology that doesn't negatively affect operational readiness, you need the logistical support for it and you need to redesign your forces and the way they operate. In the past we went from the horse to steam, from steam to fossil fuels, and now we have to move to other new technologies. Such changes always come with resistance, so you have to do it smarty, by starting with proven technology that's already out there, like the military real estate. Adapt your infrastructure in such a way that it is more climate resilient, that you're not susceptible for flooding, or wildfires etc. and whether you create local smart energy hubs using existing civil technologies and proven concepts. If you look at the US, they are now establishing smart grids in all their military bases in the US, so they're completely making that turn towards green energy in their military bases and that's one big step. Existing green technologies can also be used in light military vehicles and unmanned systems without negatively affecting their operational effectiveness. For the more heavy equipment like tanks, naval vessels and fighter planes, these technologies aren't developed far enough to replace current systems. On these areas, the military can start with using biofuels. This is also an area of cooperation with the private sector. Defence can be a testbed for the development of alternative

Credit: USAF/Staff Sgt Thomas Swanson

Participants of Active Communications International's (ACI's) 9th National Conference on Microgrids toured the Otis Microgrid at Joint Base Cape Cod on 16 April 2019. The US has made significant efforts for more than a decade to develop smart grids and microgrids for bases and installations. The Otis Microgrid was the US DoD's first wind-powered microgrid, and provides energy resiliency for the USAF 102nd Intelligence Wing. It was also the first microgrid to provide a cyber-secure connection to the regional power grid.

Credit: Office of the President of Ukraine

A ruined building in Kharkiv region, taken during a 1 March 2024 working visit by Ukrainian President Volodymyr Zelenskyy. War often exacts a twofold toll on the climate – one for destruction, and another for reconstruction.

propulsion systems, for instance future naval vessels. So there is an increasing range of possibilities where current technologies can be part of that solution, or where we can help find future solutions."

However, some changes would simply take time, as Middendorp noted, *"It is important to realise that we are at the beginning of a huge transition and that there is a lot of innovation underway. Within the EU we need ten years to make the shift towards electrification of our vehicles, and we need another five to ten years for our heavy trucking, and another five years for our shipping. So, also on the civil side you see a phased approach based on the speed of development of technology and I think the military can - and should - change in that same speed. They are not leading the energy transition, but should be a smart user and integrator of new civil technologies on that area, utilising the enormous amount of innovation that's happening now in the civil side, but translating that – and that is the innovation that the military can bring – to the more mobile environment."*

Expounding his vision for what a more sustainable and 'green' military deployment could look like, Middendorp explained, *"If you can produce your own drinking water in a mission area, you don't need to transport millions of bottles of water. If you can print your spare parts there, you don't need to transport thousands of containers with spare parts to mission areas. So you can create self-sufficiency of military units in many ways using the new technologies that are out there, and that's the change that the military needs to adapt and accept."*

While advocating the adoption of green technologies by militaries, Middendorp had no illusions about the highly polluting nature of war as a practice, noting, *"Of course, war is always a polluting effort, war involves a lot of destruction that you need to rebuild. Rebuilding Ukraine will cost an enormous amount of efforts, which also has a climate price, so yes, war per definition is destructive and per definition is a negative influence on climate goals. So the best thing we can do is prevent wars from happening, and when they happen, make them as short as possible. My concern is that because of climate change, we will see more wars and more conflicts, which only makes it more important to address this."*

Starting somewhere

Fully taking on board Gen Middendorp's advice will seem a daunting prospect for many militaries, particularly in an era of stretched budgets, and deep concerns about Russia as a threat actor dominating European thinking in the defence and security sphere. However, it is important to recap the plethora of potential benefits to be gained by militaries if climate change mitigation measures are implemented, as noted by Gen Middendorp and the IMCSS report. These include:

- Decreasing the rise of scarcity-driven extremism and conflict abroad, thereby reducing the need for expeditionary counter-insurgency/counter-piracy operations, while also decreasing refugee flows.
- Decreasing the frequency with which militaries need to be deployed on disaster relief missions, either internally or abroad.
- Increasing the resilience of our economies and power infrastructure, as well as decreasing the exposure level of base infrastructure to natural disasters.
- Decreasing the degree of leverage held by hydrocarbon-exporting powers over our economies and foreign policy.
- Decreasing deployment costs, and consequently providing the budgetary headroom to reallocate these resources to other priority areas if needed.
- Decreasing logistical footprints, making deployment and sustainment in-theatre less reliant on external resupply. Not having to wait for spare parts to be shipped could greatly decrease repair and maintenance times, thereby improving platform availability rates and increasing the overall combat effectiveness of the force over time.
- Platform-level benefits such as decreased acoustic and thermal signatures, along with the capability to be recharged without depending on fuel resupply.

The steps taken should, however, ensure that they do not lead to a reduction in capability or combat effectiveness, as noted by Middendorp, *"You need to introduce green technologies in such a way that it does not affect the effectiveness of military units but if possible even increases the military effectiveness, and that's the balance we need to find."*

Credit: USMC

A portion of the fractal microgrid used by the USMC's Camp Pendleton. This comprises several microgrids, combining concentrated solar, photovoltaic solar, along with a flywheel-based energy storage system, and smart building energy automation systems, to sustain uninterrupted power for the base. Microgrids such as these are a good example of 'starting somewhere'.

These changes will not be simple, they will require the integration of new technologies, as well as the implementation of new logistical systems, new supply chains for critical raw materials, new manufacturing processes, and not everything will be possible all at once. So while there will doubtless be challenges encountered along the way, the benefits on the table are hard to argue with, and small steps can be taken in the present. Perhaps the best advice in terms of getting started can be found in Middendorp's maxim: "Think big, act small, start somewhere."

New British government works on structural changes to defence

David Saw

The election of a new Labour government on 4 July 2024 offers the opportunity for a change of direction at the Ministry of Defence (MoD) and the potential for the much-needed reform of the British procurement system. The task of addressing the dysfunction of the MoD and the procurement system falls on the shoulders of the recently appointed Defence Minister John Healey, or as he is officially known, the Rt Hon John Healey MP, Secretary of State for Defence.

Healey has been an MP since 1997; in the first Blair government he started off as a junior minister before becoming Economic Secretary to the Treasury and then Financial Secretary to the Treasury between 2002 and 2007. Understanding how the Treasury, the British finance ministry, works will be extremely advantageous for a defence minister, since relations between the Treasury and the MoD are seldom that positive.

In the Brown government from 2007 to 2010, Healey held ministerial roles in local government and then housing and planning. After Labour lost the 2010 general election, Healey held a number of Shadow Cabinet Positions. With the election of Sir Kier Starmer, the new British Prime Minister, as Labour leader in 2020, Healey was appointed Shadow Secretary of State for Defence in April 2020, meaning that he is rather well-prepared to manage the defence portfolio.

One thing we do know is that Healey is firmly in support of assisting Ukraine; less than two days after becoming defence minister, Healey visited Ukraine, meeting with President Zelenskyy and defence minister Rustem Umerov in Odesa. He confirmed a previously promised aid package of ammunition, missiles, ten more AS90 self-propelled howitzers (SPHs) to add to the 32 already supplied, and an AS90 support package. There are rumours of a further military aid package that would see the transfer of a substantial number of British Army Warrior IFVs and support variants to Ukraine; it is difficult to see Healey being averse to something like this.

The new British government has actioned a Strategic Defence Review (SDR), with the objective of balancing commitments against capabilities versus available budgets. The government has said that it will move towards increasing defence expenditure to 2.5% of gross domestic product (GDP), according to the House of Commons Library: "The UK spent an estimated 2.3% of GDP on defence in 2023." No firm date for this increase in defence expenditure has been given; however, the Defence Review will help to determine when the increase in defence expenditure can take place.

Credit: Crown Copyright 2024

The UK Prime Minister Sir Keir Starmer (right) and the Secretary of State for Defence, John Healey (left), have instituted a Defence Review that will report in 2025. Balancing British military commitments versus capabilities will be a daunting task.

Work on the Defence Review has already commenced, with the report due to be delivered in the first half of 2025. The review will be led by Lord George Robertson, a former Secretary General of NATO and a former Defence Secretary in the Blair government. He will be assisted by Fiona Hill, currently Chancellor of Durham University, previously at the Brookings Institution and the Council on Foreign Relations, before becoming Deputy Assistant to the President and Senior Director for European and Russian Affairs at the National Security Council in the Trump administration. Born in Britain, Hill is a US citizen and regarded as an expert on Russian geopolitics and strategy. The final member of the review triumvirate is General Sir Richard Barrons, former Commander of Joint Forces Command from 2013 until his retirement in 2016.

The review team will deliver its report to Prime Minister Kier Starmer and Chancellor Rachel Reeves, as well as to Defence Secretary Healey. Right at the start of the review process, China, Russia, North Korea and Iran were clearly being described as areas of strategic concern for UK defence planners.

Reform agenda

There is no hiding from the fact that there is something deeply wrong with the British procurement system; that John Healey intends to deal with this problem was evidenced by his speech to the Policy Exchange think tank on the theme of 'A New Era for UK Defence with Labour' at the end of February 2024 when he said: *"We have to secure better value for public money. And we also need a more strategic approach to procurement, looking to boost British industry, reinforce national resilience, strengthen our NATO leadership and exploit technology to raise the UK's international standing. Again, we need to meet the challenge of procuring and innovating at a pace that matches the increasing and diversifying threats."*
Under Healey's announced plans, this will be achieved by strategic leadership in procurement via the appointment of a National Armaments Director (NAD) – presumably replacing Andy Start, who was appointed NAD under former Defence Secretary Ben Wallace in 2023. According to Healey, "The NAD will be responsible to the strategic centre for ensuring we have the capabilities needed to execute the defence plans and operations demanded by the new era. I envisage core delivery tasks that currently I don't see vested anywhere in the system, led with sufficient authority or accountability to carry them out effectively. This leadership includes:

- Alignment of defence procurement across all five domains to cut waste and duplication.
- Securing NATO standardisation, collaboration with allies and driving export campaigns.
- Delivering a new defence industrial strategy.

"He or she will be an important part of the corporate centre, sit in the Department of State and serve on the Defence Board. Defence Equipment & Support (DE&S) will continue operate as the professional contracting authority to manage defence procurement and to provide the high-level commercial expertise required for larger programmes. It will focus on delivery and execution. Direction from NAD. Delivery from DE&S."

Troubled horizon

Nobody can disagree with the need for a credible Defence Review and the need to reform procurement; while positive noises about the UK defence industrial base are also welcome, there is a potential downside though!
Prior to the July 2024 election, UK media reported that Labour MP for Leeds North East Fabian Hamilton speaking at the Baab-Ul-Ilm mosque in Leeds said: "If we win the election next week we will stop arms sales to Israel immediately." Hamilton is on the left wing of the Labour Party, but he suggested that David Lammy, the new Foreign Secretary, supports this arms embargo. Certainly an arms embargo on Israel would allow the government to appease its left wing and Muslim voters, a voting bloc that cost Labour a number of seats in the election. Hamilton then went on to say that the new government would: "Stop arms sales to Saudi Arabia." The implication was that Lammy would be in support of this embargo as well.
An arms embargo on Israel allows the government to take a moral stance, appease some of its party base, and have relatively limited economic consequences. However, bearing in mind the government has said it wants to boost British industry, such a move would probably prove unhelpful for the British subsidiaries of Elbit and Rafael, not to mention support for certain key systems such as Sky Sabre, which uses the Rafael MIC4AD command and control (C2) system.
Saudi Arabia is a slightly different matter for UK exports. In recent years, Saudi Arabia has been one of the most important defence export markets for Britain. An embargo would have significant economic consequences for the UK's defence industry and others, added to which, with Saudi Arabia being a key strategic player in the Middle East, the inevitable post-embargo rupture in relations would arguably weaken British influence in an important region of the world. Such an embargo would also cause problems with international partners on collaborative programmes; for example by blocking Eurofighter sales to Saudi Arabia. Also bear in mind that Saudi Arabia was interested in partnering into the Global Combat Aircraft Programme (GCAP); a Saudi contribution to development costs and potentially significant order uptake, would be extremely helpful to the programme, while an embargo would put paid to that possibility. In short, the British government is faced with difficult political, economic and strategic decisions on the embargo question.
Aside from these, the government still has numerous other obstacles to surmount if it wants to repair British defence capabilities. The first obstacle is money, since there is simply very little available to increase spending, especially as the economy is presently growing at a sclerotic rate. Then there is inflation, which erodes the value of the defence budget as it causes price rises across all defence expenditure headings. Fixing British defence procurement will help matters, but past experience makes many observers deeply cynical that the deep-seated problems within British defence can be easily overcome. ■

Credit: Crown Copyright 2024

New British Defence Secretary John Healey (left) and Ukrainian President Zelenskyy (middle) visit recovering casualties in an Odesa military hospital. Healey visited Ukraine soon after taking office and confirmed a previously offered military aid package.

Inside Russia's 2024 military-industrial complex

Alex Orlov

With the understanding that the Russo-Ukrainian War has transitioned into a protracted phase and that the Russian army's command has adopted a war of attrition strategy, the capabilities of the Russian Military Industrial Complex (MIC) have become one of the central issues among others that allow for assessing the course and prospects of the armed conflict. A lack of clear understanding of what, how much, and for how long the Russian military-industrial complex (MIC) can produce has caused strategic uncertainty at the highest levels in the West.

At the outset, it is important to stress that much of the key information regarding the Russian MIC has always been highly classified. While some data was publicly available before 2014, the vast majority of information has remained confidential since the times of the USSR. This applies, for instance, to the so-called 'mobilisation industrial capacity' of the MIC, or, simply put, mothballed plants, production lines, and other reserves.

Since 2014, when relations between Russia and the West became tenser, Russia gradually began to classify more and more sensitive information. In 2016, for example, Russian plants ceased publishing annual financial data. The share of classified state expenses in the Federal Budget has also been growing since 2014, getting to 21.7% in 2016, and reaching an all-time high of 22.6% by 2023. It was forecast by RBK that the share of classified state expenses might grow to 26.8% (RUB 9.8 trillion) in 2024.

Furthermore, in February 2023, the State Duma of the Russian Federation passed a law allowing for suspension of the publication of any statistical information. Prior to that, in April 2022, the Federal Customs Service of the Russian Federation had suspended the publication of export-import statistics. Since then, a substantial share of statistical information – such as data on industrial output, export-import operations, and demographics – has been deemed sensitive by Russian officials, resulting in its suspension, delayed release, or publication in a generalised form. The most recent instance occurred in July 2024, when the Central Bank of the Russian Federation decided to suspend the publication of daily statistics on the over-the-counter (OTC) currency market. The reason for this measure, as reported by TASS, was "limiting the pressure of sanctions."

Credit: RecoMonkey

A T-90M on display at the Army 2023 exhibition. This example is fitted with overhead protection and the 'Nakidka' thermal and visual camouflage package, along with a row of Kontakt-1 explosive reactive armour (ERA) over the toe plate.

The same limitations apply to any official statements released by enterprises of the Military-Industrial Complex or issued by high-ranking officials.

In other words, external observers, regardless of their allegiance or political stance regarding the conflict, are operating in an increasingly opaque and nearly impenetrable environment. This is not surprising, given that Russia is a country at war. However, it is crucial to consider the scale and intensity of the efforts Russian authorities apply to information security, which results in a scarcity of information available for analysis.

Estimating the figures

Since the nature of the Russo-Ukrainian conflict has evolved into a war of attrition with tube and rocket artillery playing a leading role, the capacity of the Russian Military-Industrial Complex (MIC) to produce artillery shells and rockets has become a critical concern for analysts and intelligence agencies. Additionally, it serves as a significant indicator for assessing the capabilities of the Russian MIC.

Most estimates rely on available pre-war data, with further calculations based on official statements made by Russian

Credit: RecoMonkey

A 2S35 Koalitsiya mod.2020 self-propelled Howitzer (SPH). Of note are the doppler radars affixed either side of the gun, which are used for measuring the velocity of each shell fired, in order to conduct fire correction.

military and political leadership. Some of these estimates suggest that between 2014 and 2022, the production output of ammunition for tube and rocket artillery experienced steady growth, reaching as many as 733,260 shells and 15,727 rockets (748,987 in total) in 2021.

It was reported that as of 1 January 2013, the Russian Armed Forces possessed a surplus of 3.7 million tonnes of ammunition of all types, including 2.6 million tonnes of serviceable ammunition and 1.1 million tonnes of ammunition requiring repairs.

While it is impossible to break down these numbers by type of ammunition, it is possible to estimate the approximate amount of available artillery ammunition using 152 mm rounds as a reference.

Given that the weight of a standard 152 mm artillery projectile is 43 kg and a full charge cartridge case is 15.4 kg, totalling approximately 60 kg,, one million tons of ammunition would be equivalent to roughly 16.6 million 152 mm artillery rounds. Based on these calculations, it can be concluded that in 2013, the Russian Army had a surplus of at least 43.3 million serviceable artillery rounds, plus another 18.3 million units requiring repairs.

The pre-war capacity to repair unserviceable rounds was estimated at 300,000 per year in 2020. In other words, the Russian Army would require 61 years to repair all the available artillery projectiles in its arsenals, assuming no additional assistance from the industry was provided.

Even considering that this data is 10 years old and may be inaccurate, it is reasonable to suggest that at the beginning of the Russo-Ukrainian conflict in 2022, Russia had a surplus of tens of millions of rounds for tube and rocket artillery, and its production output was already increasing.

These estimates, based on publicly available data, likely form the basis of many official statements and assessments regarding the capabilities of the Russian MIC.

For instance, in July 2023 Admiral Sir Tony Radakin speaking to The Financial Times, suggested that in 2022 Russia "fired 10mn artillery shells but at best can produce 1mn shells a year. It has lost 2,500 tanks and at best can produce 200 [new] tanks a year".

In February 2024, RUSI confirmed the figure for 2022 and estimated the ammunition production capacity for 2023 at 1.3 million 152mm shells and 800,000 122mm shells (2.1 million in total). Interestingly, the authors cited the Russian Ministry of Defence (MoD) and the Military-Industrial Complex (MIC) as sources for this data. However, throughout the course of the war, neither the Ministry of Defence nor any representatives of the MIC have released any statements, let alone any industrial requirements, containing specific figures regarding military production.

The RUSI report was followed by another, released by the Estonian Foreign Intelligence Service. The authors of the report suggested that the Russian military industry surged the production and refurbishment of artillery rounds from 400,000 in 2021 to 3-4 million rounds in 2023, with the total production output for 2024 forecast at 4.5 million rounds.

Finally, in late May 2024, Sky News forecast that the Russian MIC would produce and refurbish 4.5 million artillery rounds, citing research on artillery rounds conducted by the consulting firm Bain & Company.

Table 1: Russian ammunition production estimates (per year)

Source	2020	2021	2022	2023	2024
Eurasia Daily Monitor, Jamestown.com		748,987			
Radakin			1 million		
RUSI			1 million 152mm	2.1 mil, 122 and 152 mm	
Murakhovsky	300,000 (refurbished)				
Estonian Foreign Intelligence Service		400,000 (produced and refurbished)	600,000 (produced)	3-4 million (produced and refurbished)	4.5 million
Sky News, Bain & Company					4.5 million (manufactured and refurbished)

Credit: RecoMonkey

The ISDM Zemledelie (foreground) remote mine-laying system, followed by its transloader vehicle (background).

What conclusions can be drawn from these figures and estimates?

Firstly, a stable upward trend in artillery munition production is evident, as indicated by statements from state agencies, officials, and expert groups. Although there is significant variation within the estimated figures, there is general agreement among observers that production output is increasing, with estimated figures roughly doubling each year.

Secondly, despite many negative forecasts made in 2022 and early 2023 regarding sanctions crippling Russia's ability to produce weapons, the country has entered the third year of a large-scale war with increasing production output and a growing army. It is possible that the ammunition sector is not an isolated example of industrial growth, but can serve as an indicator of the wider capabilities of Russia's entire military-industrial complex (MIC).

Third, it is also reasonable to suggest that the strategy of attrition became a deliberate choice, following the highly-troubled Russian offensive efforts of 2022 and early 2023, and to an extent reflects the type of warfare the Russian economy and industry have been preparing for. On the latter point, the Russian sanctions-proofing and import substitution efforts witnessed since 2014 were probably not directly intended to facilitate a long-term, high-intensity war, but rather to weather sanctions in case of a major political fallout with the West, as did indeed occur in 2022. However, both have made it easier for Russia to conduct a long war as a related benefit, though many supplemental measures were needed on top of the previous measures.

The gears powering Russia's war machine

The Russian military industry possesses three critical advantages that bolster Russia's war effort: vast reserves, centralised administration, and the ability to set strategic priorities for military production. Some of these advantages have existed for centuries, while others result from actions taken by the Russian military and political leadership before and during the War in Ukraine.

Hidden reserves

The Russian arms industry was already on the rise by 2022, with an increasing flow of state investments being allocated to the sector. By September 2022, the Russian MIC began a gradual transition to a 'special mode' of operation, which included overtime work, three-shift production in some sectors, longer shifts, and the delaying or cancelling of days off and vacations, among other measures.

One of the most significant decisions aimed at boosting the production output of the Russian MIC was made in October 2023, when the Russian government allowed the military industry to use all available resources, including the so-called 'mobilization capacities' of the industry. In other words, the Russian MIC was permitted to utilise previously mothballed industrial capacity, such as facilities, surplus raw materials, production lines, etc.

These measures were further supported by attracting and hiring a substantial workforce. In February 2024 Russian President Vladimir Putin said that 'the national defence industry has created more than 520,000 new jobs over the last eighteen months,' referring to the period between 2 August 2022 and 2 February 2024.

By engaging these reserves, the Russian MIC likely saved time and achieved numerical and financial advantages over the arms industry in Europe and the US, which, according to some sources, still face difficulties in increasing their production capacity.

It is important to note that engaging these reserves would have been ineffective without preparations initiated before the war, and was undertaken in parallel with the ongoing modernisation and expansion of the military industry.

Credit: Alex Orlov

Orlan-30 reconnaissance UAVs on display at Army-2023. Orlan UAVs have been and continue to be the backbone of Russia's fleet of unmanned aerial reconnaissance vehicles, thanks to their simple design and low production costs.

Centralisation and Control

Centralisation and state control over the military industry, as well as other strategic industrial sectors, have probably been the defining features of the Russian MIC since the time of the Russian Empire and were further developed during the Soviet period. After the collapse of the USSR and the transition from a socialist economy, many enterprises of the Russian MIC became privately owned. However, over the last 20 years, the state has gradually regained control over the majority of strategic military enterprises. Since the beginning of the conflict in Ukraine, the leadership of the Russian MIC has moved toward even greater centralisation. Industrial clusters with clearly defined specialisations—such as engines, armoured vehicles, ammunition, and artillery systems—are being created. This structure allows for more efficient resource allocation, as well as focused development and production of essential military technologies and equipment.

Among recent examples is the transfer of fourteen ammunition and special chemical plants under the management of the Rostec Corporation. The decree was signed in January 2023 by Prime Minister of the Russian Federation, Mikhail Mishustin. In April 2023, Rostec announced plans to transfer some assets of Uralvagonzavod (Plant No. 9, TsNII Burevestnik, and Uraltransmash) to the Tekhmash concern in order to consolidate the manufacturers of artillery systems and ammunition for these systems under one roof.

The primary aim of these measures is to enhance controllability and resource management to improve the efficiency of the entire military-industrial system. Available information suggests that at least some of these measures have yielded positive results.

The figures provided by Commander-in-Chief of the Armed Forces of Ukraine (AFU), Col Gen Oleksandr Syrskyi, in July 2024, and by the Russian MoD in December 2023, may be debatable. However, as in case of artillery ammunition production discussed previously, the upward trend is evident. According to Syrskyi, "Since 2022, the number of Russian tanks has 'doubled'—from 1,700 to 3,500. Artillery systems have tripled, and armoured personnel carriers have increased from 4,500 to 8,900." Syrskyi's figures are summarised in Table 2, alongside figures reported by TASS.

Even though a large portion of Russian equipment delivered has consisted of older models taken from storage depots and later refurbished, the numerical growth is still quite impressive. Additionally, these figures suggest that many observers likely inflated the estimated losses of Russian equipment, while the production capabilities of the Russian MIC were, in contrast, underestimated. An additional factor which may explain some of the aforementioned discrepancy is underestimating how much damaged and abandoned equipment was recovered and returned into service. Since individual tanks and AFVs are typically not tracked, damaged/abandoned vehicles which were returned to service and then subsequently damaged/destroyed later would likely have resulted in the phenomenon of 'double counting' – thereby artificially inflating loss figures.

Table 2: Key Military Equipment Deliveries

Platform	RU force estimate, 2022 [Syrskyi]	New/refurbished production 2023 [TASS, RU MoD]	RU force estimate, 2024 [Syrskyi]
Tanks	1,700	Over 1,500	3,500
Various Armoured Fighting Vehicles (AFVs)	4,500	Over 2,200	8,900
Transport vehicles (unarmoured)	n/a	10,600	n/a
Transport vehicles (armoured)	n/a	Over 1,400	n/a
Uncrewed Aerial Vehicles (UAVs)	n/a	Over 22,000*	n/a
Artillery	Unknown	Over 1,400	"Tripled"

Notes:
*Does not include commercial off-the-shelf (COTS) UAVs made by the private ventures, volunteers and donated to the Army. These figures would likely significantly increase the overall number delivered.

Credit: Alex Orlov

A BMP-2M IFV equipped with a survivability enhancement kit at the Army 2023 event near Moscow. Before 2022, the Russian army procured these kits in limited quantities. By 2024, however, protection kits – including steel and slat armor screens, EW countermeasures, top-attack protection, and the 'Nakidka' camouflage system – had become much more common on various Russian vehicles, including BMP-2, BMP-3, and BMD-4.

Setting Priorities

Strategic prioritisation has ensured that the most crucial needs are met swiftly. Vivid examples can be found among the programs for new tube and rocket artillery systems. In October 2023, Rostec reported the com-

Credit: Rostec

A Malva SPH at the proving grounds in 2023.

pletion of state trials for the newest 2S35 Koalitsiya-SV self-propelled howitzer (SPH). In December 2023, Sergey Chemezov, the CEO of Rostec Corporation, announced the start of low-rate serial production of the Koalitsiya-SV. Then in late December 2023 or January 2024, the first production batch was handed over to the army. It is important to note that, at this time, nothing is known about the fate of the 2S35-1 Koalitsiya SV-KSh, the wheeled version of the Koalitsiya SPH.

Similar progress can be observed with other artillery and special-purpose systems, such as the2S40 Floks 120 mm self-propelled mortar, the 2S41 Drok 82 mm self-propelled mortar, the ISDM Zemledeliye 122 mm remote mine-laying system, the TOS-2 Tosochka 220 mm thermobaric multiple rocket launcher (MRL) and the 2S43 Malva 152 mm SPH.

In the case of the latter, the expedited timeline is evident. The first conceptual drawings were presented to the public in October 2019, and then the prototype vehicle was publicly displayed in July 2020. In July 2023, the Malva had completed state trials. In October 2023, Rostec delivered the first production batch to the army, and it appears to have seen its first combat use in November 2023. Footage of the Malva in combat in Ukraine was released in June 2024, and on June 25, 2024, the second batch of serially produced 2S43 Malva SPHs was delivered.

Furthermore, upgrades appear to be in the pipeline. In August 2023, Rostec announced the development of a new version of the Malva SPH with an increased firing range, along with a new range artillery ammunition, including guided natures., In April 2024, Bekhan Ozdoev, Industrial Director of Weapon Systems at Rostec State Corporation, announced that the new version of the TOS-3 Drakon thermobaric MRL was already in development and that the prototype has already been delivered. This prototype was then publicly displayed on 3 June 2024 at an event dedicated to the 45th anniversary of the formation of the 1st Guards Mobile Nuclear, Biological, and Chemical (NBC) Protection Brigade.

These facts reveal the system behind many decisions determining the prioritisation process:

Firstly, after the army identifies the urgent needs, the MIC offers systems based on serially-produced components that share commonality with already in-service systems. For example, the Malva shares the same 152 mm 2A64/L47 gun as the Msta-SM2 SPH. This allows for streamlining development and testing, with systems brought to serial production within 4-7 months instead of 5-8 years.

In some cases, when a cheaper system is unavailable or a critical capability is needed, the army opts for a modern, technically sophisticated, and more expensive system, such as the Koalitsiya-SV. However, in the vast majority of cases, the MoD opts for simpler and cheaper systems that are available for mass production on an expedited timeline. A further example here is the Russian MoD opting for modernisation of the T-72/T-80/T-90 families to the T-72B3M/T-80BVM/T-90M standards over the more modern T-14 Armata design.

Secondly, this approach enables the production of more units more quickly and at a lower cost than with more sophisticated and low-commonality equipment. To some extent, it helps industry avoid the setbacks that are inevitable when adopting new products for mass production.

Credit: Alex Orlov

A Z-STS protected vehicle by Remdizel was showcased at the Army 2022 International Military-Technical Forum. Developed within a few months in 2022, the Z-STS was delivered by May-June 2022. The Z-STS is based on serially-produced components, which streamlines production by 7-10 times compared to the Taifun family of vehicles, according to Remdizel.

Credit: Alex Orlov

ZALA Kub (left) and Lancet Izdeliye-51 (centre) loitering munitions, along with the Supercam S350 (right) reconnaissance UAV, on display at the Army 2023 exhibition. Prior to 2022, Russian loitering munitions existed mostly as prototypes, but evolved and proliferated rapidly during the conflict.

Additionally, industry can react quickly to feedback and new requirements from the Army, streamlining continuous modernisation. In certain cases, by the time the MoD receives the first production batch, the MIC has already initiated R&D projects on the next generation of weapon systems, as seen with the improved Malva SPH and the TOS-3 Drakon.

Finally, the key benefit to the Army is that, within fairly short timescales, it receives systems it is more familiar with, that are relatively easy to maintain, and integrate into the existing organisational structure, and require relatively little effort for training or retraining personnel.

Planning for a long war

Measures undertaken by Russian military and political leadership between 2014 and 2022 suggest that a protracted conflict was likely one of the scenarios considered by the Russian military and political leadership as early as the beginning of the 2010s. Starting in 2014, many preparations were initiated to decrease the exposure of the economy and industry to external shocks, including the technical re-equipping of the military industry, political agreements with allied or neutral countries, along with economic measures aimed at increasing sustainability and resilience.

These measures, along with additional supplemental measures taken since 2022, have allowed the country to effectively weather Western sanctions and ensure the relative stability of the economy. Other measures have facilitated the continuation of international trade and the import (including through smuggling operations via front companies in third countries) of technologies and materials needed for Russia's military industry. The details of these measures extend far beyond the scope of this text. However, thus far the Russian economy has proven itself resilient, resourceful, relatively self-sufficient, and capable of generating sufficient resources to sustain over 2.5 years of high-intensity warfare while operating under severe sanctions.

What is the state of the Russian MIC in 2024?

Firstly, it is evident that Russia has a relative advantage in mass production of critical materiel over the rate at which Ukraine can obtain it (whether via domestic production or deliveries from allied countries), with Russian output continuously growing. Secondly, Russia does not seem to have difficulties in manufacturing and deploying at least some types of advanced systems and technologies. One notable example is Russia's UAV industry. This was very small prior to February 2022, yet since then the production of loitering munitions and reconnaissance UAVs has surged, notably in late 2022 and throughout 2023, and remains high to this day.

The exact production figures are not publicly available and remain very hard to estimate. However, given the additional volume of industrial capacity (both mobilised and newly-established) deployed between late 2023 and the first half of 2024, the level of production output is likely higher than was expected before the war or in 2022-23.

It is worth noting is that the modern Russian MIC was built on the remnants of the Soviet military industry, which was designed to operate under pressure and produce huge volumes of equipment in a protracted conflict with NATO. While much of this was either unused, neglected or lost in the 1990s and early 2000s, the 2010s saw significant recapitalisation of this dormant potential. While output figures are in key sectors such as new-build tank production are still far below Soviet levels, nonetheless, this still leaves Russia with fairly high output for many key systems compared to many other countries. This relative advantage over Ukraine has most evidently been leveraged through Russia's adoption of an attritional warfare strategy in Ukraine.

There are, however, many challenges facing the Russian MIC, such as shortage of skilled workers, weaknesses in some areas of high-tech military production, disruption of supply chains and others. Whether the Russian military industry can overcome them remains to be seen. ■

Progress in Poland's defence industry

Robert Czulda

The War in Ukraine has pushed Poland to significantly boost its military spending. This represents a substantial opportunity for the Polish defence industry, which is now operating at full capacity. The industry is also counting on new orders and investments.

The War in Ukraine, which escalated to the point of full-scale invasion in February 2022, poses a significant threat to NATO, especially to the countries of Central and Eastern Europe. Still, it also presents a major opportunity for defence industries, and Poland's is no exception. In recent years, Warsaw has intensified its technical modernisation and increased its military spending. In 2024, defence expenditures are projected to reach a record EUR 37.6 billion (approximately 4.5% of GDP). Unfortunately, around 70% of this spending is on imported armaments.

Additionally, the war in Ukraine has provided a promotional opportunity for Polish armaments and the domestic defence industry. Poland has supplied Ukraine primarily with used equipment, including MiG-29 aircraft, T-72M1 tanks, BMP-1 infantry fighting vehicles (IFVs), and Mi-24 assault helicopters. However, the Ukrainians have also received equipment from the Polish defence industry, which has proven highly effective in combat. These include PT-91 Twardy tanks, previously considered somewhat outdated, but very useful in practice, as well as modern systems such as Krab 155 mm self-propelled howitzers (SPHs), MSBS Grot 5.56 mm assault rifles, and various drones, including Polish-made FlyEye surveillance/reconnaissance UAVs and Warmate loitering munitions. The Piorun man-portable air defence system (MANPADS) has also achieved particular renown in Ukraine, effectively countering Russian helicopter defensive countermeasure systems.

Rising capacity

Many Polish factories have capitalised on the war in Ukraine to boost their production capacities. A notable example is the Łucznik factory in Radom, which designs and produces small arms, including the Grot assault rifle. The first batch of these rifles was delivered to Ukraine in March 2022. In the same year, the production of Grot rifles increased to 17,000 units, and in 2023, it increased to 35,000. By 2026, Łucznik aims to produce 100,000 rifles annually. The Polish Armed Forces alone have placed an order for 236,000 Grot rifles, with at least 80,000 already delivered. Simultaneously, work is underway on the Grot A3, which will compared to the previous variant will feature a shorter barrel and a more ergonomic design.

Poland's Huta Stalowa Wola (HSW) is now doubling its production capacity; the company manufactures several leading systems, including the Baobab-K automated mine-laying vehicle, 120 mm Rak self-propelled mortar, the WR-40 Langusta 122 mm multiple rocket launcher (MRL), and most notably, the Krab 155 mm self-propelled howitzer. HSW has acquired new land and facilities, and is increasing its workforce. This expansion is largely due to the company receiving EUR 141 million in capital last year, with an additional EUR 282 million promised in the near future. These funds will also facilitate the modernisation and enhancement of production capabilities at HSW's Autosan plant in Sanok, which produces both civilian and military vehicles.

Credit: WB Group

The WB Group Warmate loitering munition has been manufactured at scale, with Ukraine being a key customer.

Credit: Polish MoND

Baobab-K is an automated mine-laying vehicle from HSW. 24 vehicles were ordered in 2023. Deliveries will be made between 2026 and 2028, and possibly earlier.

Author

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Credit: Polish MoND

The ORP Kormoran mine hunter conducting sea trials in August 2016.

In 2023, PGZ's Jelcz, known for its various trucks (4×4, 6×6, 8×8, 10×10), has also received additional funding. The company is now involved in several projects, including chassis (Jelcz 662D.43) for new naval missile units (MJR), wheeled MS-20 Daglezja-S bridgelayers (Jelcz C662D 6×6), and South Korean Chunmoo rocket launchers (Jelcz P882.57 TS T45).

Poland is also striving to rebuild its naval industry. Over the past 20 years, the Polish shipbuilding industry lost the capability to design and build modern ships, especially combat vessels. The first attempt to change this was the Gawron class corvette project (Project 621), based on the Meko A100 platform from Germany, but it was unsuccessful. A breakthrough occurred in 2013 with the signing of a contract to design and build the Project 258 Kormoran II mine hunter, which was fully designed in Poland. Three ships have already joined the Polish Navy, with another three under construction. This project demonstrated Poland's potential to revive its shipbuilding capabilities.

Both Remontowa Shipbuilding and PGZ Stocznia Wojenna are currently involved in the construction of three next-generation multipurpose frigates from the Miecznik series. This project leverages foreign technology acquired from Babcock International Group (the Arrowhead 140 frigate design) and Thales UK (TACTICOS Combat Management System). The ships will be built in Polish shipyards with significant involvement from the Polish defence industry. In 2022, PGZ Stocznia Wojenna reported a profit of EUR 634,000. Although modest, it is noteworthy for two reasons. Firstly, it was the first profit in a long time and secondly, before its acquisition by PGZ in 2017, Stocznia Wojenna was on the brink of liquidation due to bankruptcy.

Great hopes are pinned on the planned expansion of Nitro-Chem in Bydgoszcz, the largest producer of TNT and other high-energy materials in Europe. In 2023, Nitro-Chem began automating the filling of explosive materials and is systematically increasing its production capabilities. Currently, TNT is produced in three shifts, operating 24 hours a day. Due to its importance, Nitro-Chem, which produced 10,000 tonnes of TNT annually before Russia's full-scale aggression against Ukraine in 2022, is now a highly protected company, including counterintelligence measures. Nitro-Chem is also active in exports, being the largest supplier of TNT to the US Army. Its current production capacities are classified.

Main challenges

The Polish defence industry continues to face significant challenges. Many issues stem from years of neglect, underfunding, and a lack of developmental vision. Currently, one of the key problems is the still relatively small contribution of the Polish defence industry to the technical modernisation of the armed forces. General Artur Kuptel, Chief of the Armament Agency, recently acknowledged that the goal is to place as many orders as possible with the Polish defence industry, but production capacities are currently being fully utilised. A prime example is the top product of the Polish defence sector, the Krab SPH. Ukraine has previously ordered 54 Krabs, and received an additional 54 as a donation. In 2024, under a commercial agreement, Poland is to deliver the third batch of 18 howitzers. This contract has completely exhausted HSW's production capabilities, prompting Polish authorities to purchase Korean Hanwha K9 howitzers. The situation may improve in the near future, as HSW plans to build four new halls, doubling production, but this is a long-term process.

Credit: Polish MoND

Shown here are three Rosomaks with the original Hitfist-30P turret. In July 2024, Poland signed a second contract for the KTO Rosomak. Under this agreement, 58 vehicles will be fitted with the ZSSW-30 remote turret, which are designed and manufactured domestically.

General Kuptel recently revealed that the Polish defence industry would like to receive additional funding of approximately EUR 3.3 billion. Deputy Prime Minister and Minister of National Defence Władysław Kosiniak-Kamysz added that the government's ambition is to place 50% of orders with the Polish defence industry. Poland's priority is not so much the 'Polonisation of products as the 'Polonisation' of production.

Another issue is the limited innovation and few proprietary new technologies. So far, Poland has been better at modernising military equipment than creating it from scratch. Additionally, using acquired foreign know-how to create indigenous systems has been problematic. This is evident in the Rosomak 8×8 wheeled armoured personnel carrier project, which is both a success and a failure. On the one hand, it is an undeniable success for the Polish defence industry. The vehicle is a Polish domestic licence-produced version of Patria's AMV design, and the rights to manufacture it were purchased from Patria in 2002.

Since then, hundreds have entered service with the Polish Armed Forces. The Polish defence industry has successfully acquired foreign technology, created its own production lines, and delivered numerous variants. In the meantime, Polish experts have prepared hundreds of improvements and several specialised versions. The project provided development opportunities for entities such as HSW and WB Electronics. Unfortunately, the product failed to attract foreign customers for several reasons, including licencing restrictions and limited production capabilities. Nontheless, in July 2024, the Armament Agency ordered 58 Rosomaks with the new ZSSW-30 remote turret, which was locally designed.

Competition in international markets is fierce, and Polish companies often lack experience, courage, and sometimes even the will to compete; the latter is particularly true for state-owned enterprises where decision-makers are often politically appointed, whereas private firms tend to perform better. Consequently, international cooperation for Polish firms is typically one-sided — foreign companies enter the Polish market and establish business relationships. Even good and proven products such as the Rosomak and Krab struggle to find foreign customers. For example, while 40 Patria AMVs were produced for the UAE, this contract was awarded to Patria, not Rosomak S.A.

Credit: Polish MoND

In 2023, ZM Bumar-Łabędy delivered 18 Leopard 2PLM1 tanks. While 142 tanks were initially planned for upgrade, 14 were donated to Ukraine. To date, 62 Leopard 2PL tanks have been delivered to the Polish Army. PGZ and ZM Bumar-Łabędy are collaborating with Rheinmetall AG on this project.

A significant weakness of the Polish defence industry is its continued reliance on assembling artillery ammunition from foreign-sourced components. This limits Polish companies to producing 30,000–40,000 artillery shells annually, while the Russian military consumes that amount in just a few days. In the face of a potential prolonged military conflict, this is a crucial issue, especially since Poland has already transferred most of its ammunition reserves to Ukraine.

In December 2023, PGZ signed a contract for the production and delivery of 300,000 units of 155 mm artillery ammunition. The implementation is scheduled for 2024–2029, with an estimated value of EUR 2.6 billion. This contract is part of a plan that includes spending EUR 470 million to build production capacity and another EUR 2.8 billion to produce around 800,000 rounds.

According to Paweł Poncyljusz, CEO of Polska Amunicja, by 2028, Poland's capacity to produce 155 mm ammunition will exceed 100,000 units annually. This will also mark the point where ammunition will be entirely produced in Poland without any licencing restrictions. A factory is planned to be built in Lower Silesia to achieve this goal. A major disappointment was the European Commission's decision to allocate EUR 500 million to European defence companies to increase artillery ammunition production, with only one Polish company – Dezamet, part of the Polska Grupa Zbrojeniowa (PGZ; ENG: Polish Armaments Group) – receiving around EUR 2.1 million from this fund.

Poland also hopes to enhance its armoured vehicle industry, which has significantly shrunk since 1989 and is now primarily limited to offering repair services and minor upgrades. For instance, PGZ's Bumar-Łabędy in Gliwice is involved in the modernisation of Leopard tanks under the Leopard 2PL project. Simultaneously, in February 2024, WZM (Wojskowe Zakłady Motoryzacyjne) in Poznań opened a service centre for M1 Abrams tanks, as Poland ordered 116 M1A1 FEP tanks (deliveries completed in June 2024) and 250 M1A2 SEPv3 tanks (deliveries due to be complete in 2025).

A critical project for the industry is the acquisition of technology for the South Korean K2 tank, which is expected to be 'Polonised' as the K2PL variant. Negotiations with Seoul are ongoing, but it is already known that the maintenance and servicing of these tanks will be handled by WZM in Poznań. Regarding Leopard 2 tanks, PGZ aims to produce more spare parts, but the German manufacturer KNDS Deutschland has not agreed to this. In recent years, Poland obtained a licence to produce barrels for Leopard 2A4 and 2A5 tanks.

Poland is expected to acquire additional know-how through other projects, including Homar-K (Based on Hanwha's K239 Chunmoo multi-calibre MRL) and Narew (a medium-range air defence system (MRAD) based on MBDA's EMADS system, armed with CAMM-ER surface-to-air missiles (SAMs)). For the latter, the PGZ-Narew Consortium plans to produce over 1,000 CAMM-ER SAMs and 138 iLauncher transporter erector launchers (TELs) in Poland, sufficient to outfit 23 Narew batteries. The Narew system will also be equipped with locally-designed and produced P-18PL VHF radars for early-warning, considered a unique system within NATO, as it can not only detect low radar cross-section targets from a long distance, but also ballistic missiles.

Leading products

The dominant player in the Polish defence industry remains the state-owned PGZ, a holding company comprising 50 defence sector companies. PGZ offers a wide range of products, including ammunition, air defence systems, armoured vehicles (such as the wheeled Rosomak), optoelectronics, radars, and small arms. In 2023, PGZ's revenues exceeded EUR 2.6 billion, a significant increase from less than EUR 940 million in 2015. The total value of PGZ's contracts with units under the Ministry of National Defence (MON) exceeds EUR 3.3 billion. Another leading company is HSW. A notable private company excelling in international markets is WB Group, which offers Command, Control, Communications, Computers, and Intelligence (C4I) systems (FONET), fire control and battle management systems (Topaz), UAVs (FlyEye, FT5), and loitering munitions (Warmate), many of which have been sold abroad.

Besides Nitro-Chem, PGZ's Mesko from Skarżysko Kamienna is performing well in markets globally. The company produces the Grom/Piorun series MANPADS, which have been successfully used in Ukraine. The latest variant, Piorun, introduced into service in Poland in 2019, is an advanced version of the Grom system, itself a modification of the Soviet 9K38 Igla system. Mesko's anti-aircraft system can engage targets at ranges up to 6.5 km and at altitudes up to 4 km. Currently, Mesko is working on a new version of Piorun. The Grom/Piorun series have been purchased by countries such as Estonia, Norway, Latvia, the United States, and Lithuania. There is also the Poprad, a mobile VSHORAD vehicle armed with Grom/Piorun, of which 79 units were delivered to the Polish military in 2020-2021, with this system now also offered to Portugal.

Credit: Polish MoND

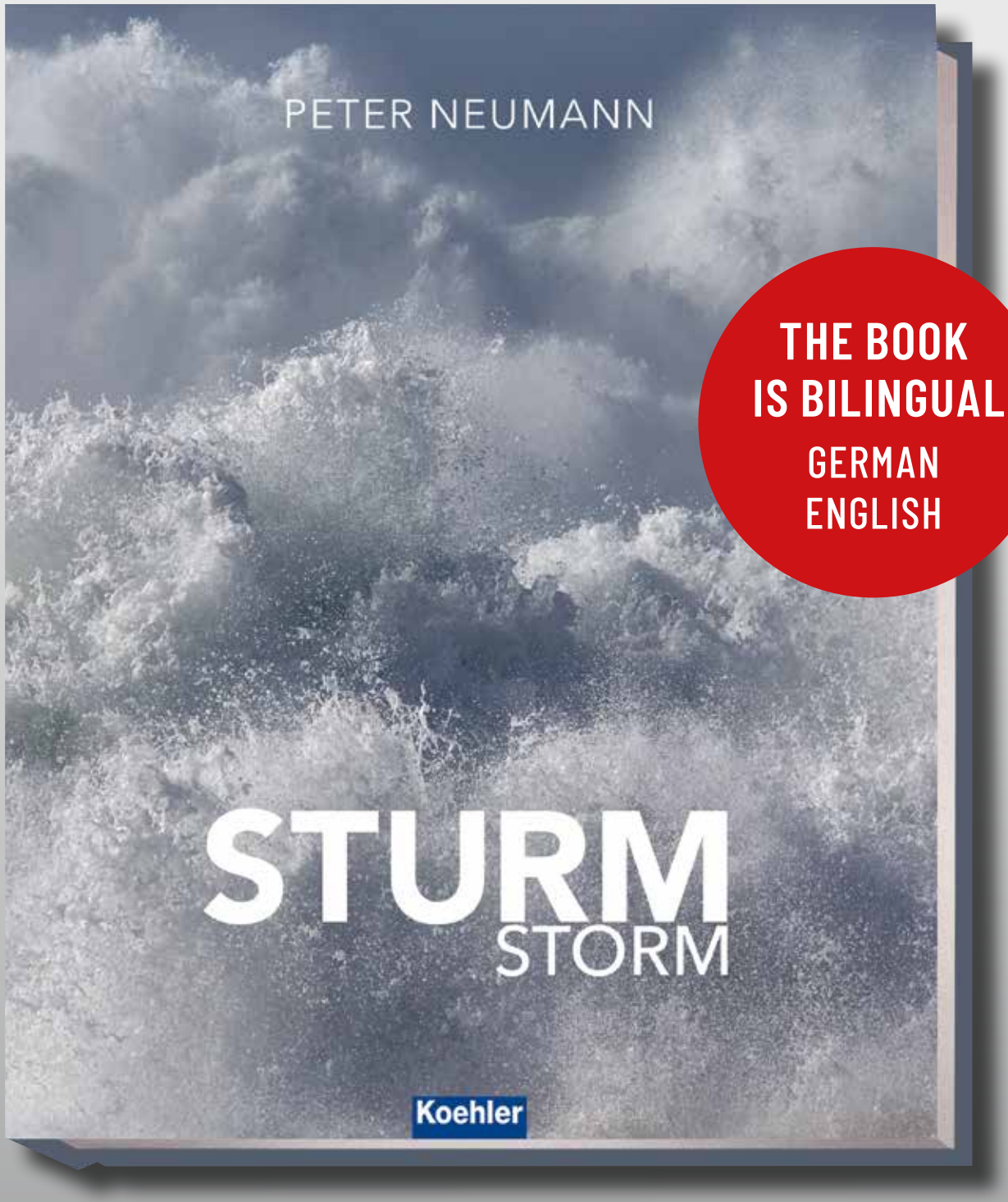
Borsuk is a key indigenous project of the Polish defence industry. Huta Stalowa Wola (HSW) is preparing to start serial production.

Belma, based in Bydgoszcz, has unveiled an upgraded version of the MPBK-ZN anti-armour roadside landmine. This mine is effective at ranges of 2–50 m and is equipped with a proximity fuse (acoustic and thermal). According to the producer, it can be used in urban areas, mountain passes, or conditions unsuitable for conventional anti-tank mines. The MPBK-ZN directs an explosively-formed penetrator (EFP) towards its target, intended to strike the side of a target vehicle, and capable of engaging a moving target. The EFP is capable of penetrating up to 100 mm of rolled homogenous armour equivalent (RHAe) at 50 m. The mine is resistant to countermeasures such as electromagnetic mine clearing, lightning discharges, and nearby explosions. Importantly, it can be easily deactivated and removed, and is now ready for production.

Another significant project in the Polish defence industry is the Borsuk tracked IFV, equipped with a Mk 44S Bushmaster 30 mm automatic cannon and Rafael Spike-LR2 anti-tank guided missiles (ATGMs). The vehicle has completed the technical part of its qualification tests and is awaiting orders for serial production. A framework agreement signed last year plans for the acquisition of approximately 1,400 units, including over 1,000 in the IFV configuration. The Borsuk, with a combat weight of around 28 tonnes, can transport a crew of three and six dismounted soldiers. It was recently showcased at Eurosatory 2024, near Paris. Additionally, the Polish defence industry is developing a heavier IFV, which will be used alongside the Borsuk, based on the Hanwha K9 platform. ■

Credit: Polish MoND

Poprad is a VSHORAD system produced by PGZ's PIT-Radwar. In total, 79 systems, equipped with Grom/Piorun missiles, were delivered, with the last batch handed over in 2021.



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Zero tax for 20 years: Lithuania as a route to the EU market

With the historic June 2024 signing of a memorandum of understanding (MoU) between Lithuania and Rheinmetall for the establishment of a new ammunition plant, ESD's Stephen Barnard (SB) had the opportunity to speak with representatives of the Lithuanian government during Eurosatory 2024. Namely, with Vice-Minister of the Economy and Innovation of the Republic of Lithuania, Erika Kuročkina (EK), and Economic and Commercial Counsellor, Daiva Kirkilaite-Chetcuti (DK-C).

Credit: Lithuanian Government

Erika Kuročkina, the Vice-Minister of the Economy and Innovation of the Republic of Lithuania.

SB: What is your goal with this interview?
EK: When you are talking about the Lithuanian defence industry it's not only about military capability, it's about deterrence strategy and about the compatible economy as well. At the moment, in Lithuanian society, there are some tensions because people think that while we are strengthening our defence industrial capability, and attracting foreign investors such as Rheinmetall, we are preparing for war, and potentially we are increasing our attractiveness as a target. So right now we're trying to send a message that no, it's part of our deterrence strategy to have more foreign investors, foreign direct investment in Lithuanian defence. Having a strong local defence industry and investing in defence innovation are about a strong economy and about sending the message that we are ready.

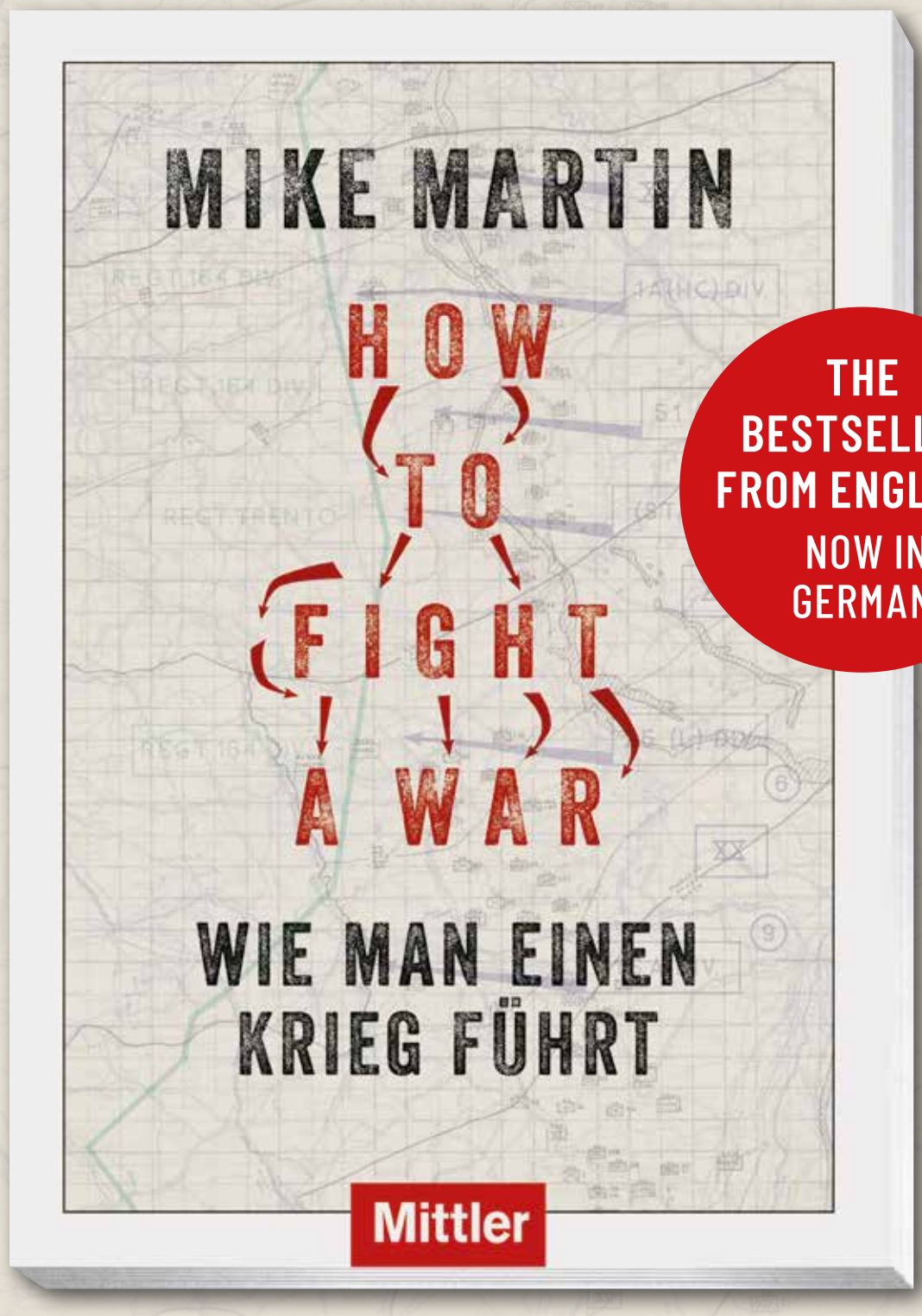
SB: Are you extrapolating lessons learned from watching what is happening in Ukraine?
EK: Of course. The conflict in Ukraine shows us that warfare has changed. Now we have to be smarter, faster, more innovative on the battlefield, so we are trying to change direction and priorities. That applies to air defence, to our innovative solutions, lasers, optics, and all the niche competencies that we have. Basically, innovation will create advantage in the battlefield.

SB: One of the problems that has emerged in Ukraine, in the case of artillery, for example, is the ability to manufacture enough ammunition.
EK: Oh yes, that's true. Ukraine has led to all the stockpiles being emptied, which is a huge problem, so that's why Rheinmetall – even US companies – are trying to invest in identifying and capturing technical capabilities in Europe. So that's why we decided to work with possible investors – and also we wanted to build the ammunition manufacturing capability, including in smaller calibres, because that's very pressing.

SB: In terms of building this industrial capability, is that to be driven by developments within the country or does it require external investors and companies that are, or may already be, experts in optics, and CBRN, and so on?
EK: We're thinking about the reintegration of local capabilities. Rheinmetall is coming with a huge investment, that's true, but one of our requirements of Rheinmetall is the integration of our local defence and traditional manufacturing capabilities. We want not only to benefit our own defence and build our stockpiles; we want to drive the economy, and ensure that our businesses benefit from collaboration with the giants from a technological R&D side. That applies to the local workforce, and it will also drive exports. And just recently we launched an absolutely new law regarding the defence and security industry, so that bigger investors in Lithuania, which have contracts with our MoD, will also have to make contracts for local industry and maybe academia. It will be case by case – we will search together with the company or would-be investors, addressing what capabilities they will want to use from local companies, and collaboration with the universities. I'm also thinking about maybe a special programme for engineers, like a STEM initiative. Lithuania is famous for engineering: we have three big universities, which basically produce engineers, and we just met one company from France who noted that our engineering is better than theirs – that's a direct quote! 20% of our GDP comes from traditional manufacturing. Lithuania's market is highly diversified: we have everything, which is probably why we're resistant to global pricing pressures, and why during COVID our economy was largely unaffected. And within two years we'll be energy independent and most of our energy will come from local sources – including, I think, the biggest offshore wind farm in the Baltics.

SB: Does this Lithuanian initiative extend across to Latvia and Estonia as well, or is this purely at the moment Lithuanian?
EK: Purely Lithuanian.

SB: Is there a subsequent phase where it becomes a pan-Baltic initiative?
EK: All three MoDs have their plans, and therefore think about cooperation, but there's no business case yet - at the moment we are working independently.
SB: What about the bigger picture?
EK: One brand new thing is that Lithuania offers an extremely "green" corridor for defence companies. That's green as in "fresh", in terms of flexibility and availability of the Lithuanian market. What this means is that foreign defence companies have an opportunity to start numer-



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Credit: US ANG/Maj Ellis Parks

Lithuanian Army vehicles participating in a parade marking the 100th anniversary of the re-establishment of the Lithuanian Army, in Vilnius, Lithuania, on 24 November 2018.

ous factories in Lithuania in six months. It means that we are helping them to, with almost no bureaucracy and no construction agreements or restrictions, to start building their facilities. These can be for individual projects, of national importance. For example, Rheinmetall will be the first to use the green corridor. We're helping them to get through the bureaucracy, and we'll help them to find the right location, because they have very specific requirements for land and resources. And of course, we're helping them to search for the partners locally. We're currently working on the industrial part, but we'll also have some conversations about the workforce. Probably, naturally, they'll start with their own workforce, but talking about project implementation, construction works and so on, everything will be covered from the Lithuanian side. And also, for live skills projects we offer tax exemption. For example, if the investment is bigger than 150 million Euros, then such a project can receive tax exemption of zero corporate tax for 20 years. It's a very nice cherry! But I think flexibility and non-bureaucracy are also very attractive. For example, it is truly important for some German companies, and French companies, it's really our speciality. Lithuania is a small country with a small market and it's really hard to compete with Poland. Very hard. They have their own strong defence factories, they're attractive to investors and have a big home market, but Lithuania is more open, its smaller size makes it easier to contend with the Polish defence industrial establishment – companies and politicians – so that's a major advantage.

SB: Being relatively small implies a much greater degree of agility, and some big companies can be very cumbersome, difficult to penetrate, and quite difficult to work with.

EK: Yes, and I'm happy that a lot of other defence industry giants are quite active in Lithuania, and are searching for visibility. The message that we're sending that you don't need to be afraid of the defence industry: it's a branch of the economy that helps to strengthen the country in various directions, including the economy, welfare, schools, education, R&D – as we mentioned in the beginning. Everything is very much interconnected. The main difference between the Ministry of the Economy and Innovation and the MoD, is that MoD is thinking about armed forces capability – that's natural. From my side I want to say that it's all a part of the economy, it's all part of our security. So that's my main message. The second message is about the niche competencies in Lithuania, and the prioritisation of more investment. Lithuania has the fastest growth in start-ups in the Central and Eastern European region, so for us it's really interesting to work on that dual direction. These partnerships have enormous potential, remembering that during the First and Second World Wars, the Cold War, and the various arms races, basic technologies and technological advances came from the military. Later, of course, everything changed and defence and defence innovation spending, especially in European countries became catastrophically low. Now, however, from a technological point of view there's strong demand for synergy across the military and defence industry and civil industry – and I feel that in Lithuania as well – so the prioritisation of technology sharing and development between civil and defence is inevitable. Geopolitics always plays a role, but in Lithuania we have thorough export controls, and we've never had a case of selling a product to a customer and then preventing them from using it: it's not even part of the discussion.

DK-C: Historically, if you look at the European countries, the top 50 or 100 defence contractors emerged from specific technologies or programmes during wartime. Lithuania as a country doesn't have that so we want to attract big names, especially from the USA. It's quite an important step for us. They will come to our country, where there's none of the competition that they would experience in Germany, Ukraine, Poland or Czechia. There may be similar products competing in the regional market, but if you have a foot on the ground in Europe, you are a European company, and European militaries look to buy European: our version of 'Buy American'. And that would apply to other non-EU countries: Lithuania is a route into the EU market.

SB: Thank you both.

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